# The edited proceedings of the European Seminar on Knowledge Management and Information Technology

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# Introduction

D. Kuiper and N.G. Röling

## The seminar

This book results from the European Seminar on Knowledge Management and Information Technology, held November 23rd and 24th 1989 in Wageningen, The Netherlands. It contains the edited, and often more elaborated versions of most of the papers presented, supplemented by some articles that were written after the seminar closed. A seminar designed to explore the challenging problem of improving the performance of knowledge and information systems (KIS), using knowledge management and information technology (IT) to do so.

The 25th anniversary of the Department of Extension Science at Wageningen Agricultural University, provided the occasion for the seminar. When it started in the sixties, the Department focused on agriculture, extension methods, and the diffusion of innovations. At 25, it had embraced health education, environmental protection education, empowerment and extension in rural development, and had broadened its perspective to include e.g., KIS theory and the use of purposive communication as a policy instrument.

This 'imperialistic' behavior of the Department was provoked by demands of students from other (non-agricultural) Dutch universities, and was facilitated by the fact that the Dutch concept "voorlichting" (which features in the Dutch name of the Department, and which we chose to translate with "extension") embraces all forms of adult education, mobilization, and public information, in all sectors, such as health, small business development, environmental protection, and agriculture.

Covering such a width field, it is little wonder that KIS theory and IT now features prominently in the Department's research and teaching. We therefore decided to mark its anniversary with a seminar on knowledge management and IT, deliberately covering agriculture, health, and the environment. By inviting both scientists and managers, we tried to combine scientific theory and reflective practice. The former allowed us to lift off, the latter prevented us from sky rocketing. As could be expected, the Seminar did not achieve closure. A great many fascinating issues were raised and insights gained. It can be considered a heuristic event.

That, at least, was the impression of William Dunn, the editor of "Knowledge in Society", whom we had invited to close the seminar with an attempt to place the achievements of the seminar in the research tradition of knowledge generation, exchange, and utilization. He invited us to publish some of the papers presented

in this journal. In March 1991 a special issue of "Knowledge in Society", which reported on the seminar and presented 11 selected and edited articles, was issued: *Knowledge in Society*, 3(3).

The Department would like to thank the Wageningen Agricultural University, the Koninklijke Nederlandse Academie van Wetenschappen (the "Royal Dutch Academy of Sciences"), and the Commission of the European Communities for the financial support that made the seminar possible.

Sincere thanks are also due to the Landbouwschap (the "Federated Farmers' Organizations") that assisted in organizing the seminar, and the LEB-Fonds ("the Agricultural Export Promotion Fund") that made publication of the proceedings possible.

A special word of thanks goes out from the authors, who coordinated the seminar, to Jetty Kentie of the International Agricultural Center (IAC), where the seminar was held. In the hectic last weeks before the seminar started, her patience and dedication pulled us through.

## The articles

The articles cover four different fields: agriculture, health, environment, and industry. Still, as experiences often transcend the divisions that we make, it could be worthwhile to explore the insights gained by other fields than one's own: the reader stands to gain by taking a broad view. The short introductions below, therefore, could serve as a first impression on the content of the included articles.

Within each field articles that concentrate on KIS theory and knowledge management are presented first, followed by articles that deal more specificly with IT and its applications.

We start out with an article from N.G. Röling and P.G.H. Engel, presenting the conceptual framework for this issue. They provide an entrance to KIS theory and state the issues that arise when looking at IT from this perspective.

With the next article we make way for "Equivocations on knowledge systems theory: an actor-oriented critique". It is written by C. Leeuwis, N. Long, and M. Villarreal, and suggests a different approach when looking at knowledge processes. Instead of operating from a KIS perspective, they take the different individual actors, and their attempts to create space for their own 'projects', as starting point for analysis.

After these two introducing articles we focus on agriculture. First, P.G.H. Van Beek applies the systems approach to analyze the Queensland (Australia) dairy KIS, using an interface matrix. He concludes that the approach led to new insights and has practical value for managers.

In the following article D. Kaimowitz examines the dynamics of third world agricultural KIS, and tries to generate management tools. It is argued that KIS institutions must receive strong and focused external pressure, which should be

exercised by other elements in the system, to function synergetically over sustained periods.

Paul G.H. Engel looks at knowledge management in the realm of primary production. His article deals with KIS concepts and tools, and the insights gained from comparative research. It explores the vital qualities of agricultural knowledge and information systems, and tries to provide a more specific definition of the tasks and areas of attention of the knowledge manager.

The article of J.T.M. Bos, M.D.C. Proost, and D. Kuiper outlines the recent reorganization of the Dutch agricultural extension service. They focus on the Information and Knowledge Centers (IKC), a new institution that was designed to collect, translate, and transfer information to all actors involved in the Dutch agricultural KIS, and therefore is supposed to play a major role in knowledge management.

M. Le Gouis looks at experiences gained by farmers' organizations in their efforts to manage the French agricultural KIS. One of the major questions addressed is what strategies, in such an 'upstream' approach, might lead to knowledge generation and dissemination that benefit the farming community.

K.J. Blokker explores integrated chain management (ICM), which is becoming increasingly important in Dutch agriculture. ICM can be described as "the management of procurement, transport, storage, processing, and packing activities from the supply of raw materials to the farmer up to consumer marketing". For efficient ICM good communications are essential. This article examines the likely consequences for agricultural cooperatives, with special reference to automated networks.

The article of A. Fearne gives, first, an overview of the various ways farmers in England obtain agricultural information. Recent developments (such as investment in IT and the shift in the way the public sector delivers and promotes information) suggest that, in the future, this information dissemination network may well change. In order to gain a better understanding of the potential impact of these developments, the article considers the farmers' point of view, based on empirical research. The final part regards the future role of IT as an aid to farm management.

The article written by U. Nitsch considers the role that IT systems can play in farm management. Introduction of these systems is often preceded, as in many other fields, by great expectations; some even tend to think that eventually the computer will take over farm management. Nitsch tries to make an assessment of the validity of such expectations.

In the article of C. Leeuwis it is argued that we cannot understand the use of an IT application without examining it as an activity with a highly social character. The debate on IT in primary production, therefore, needs considerable reformulation, if one wants to arrive at effective and efficient use. Furthermore, the relevance of existing classifications of IT applications and the meaning that is commonly assigned to the term 'user-interface' is questioned.

G. Schiefer takes farm management's dependency on outside information for production control and market engagement as starting point. He focusses, therefore, on communication, and discusses present and future developments directions, in relation to recent experiences with IT introduced into the farming community of various European countries.

M. Harkin addresses the issue of strategic investment in support systems for European agricultural videotex. He gives, first, a European overview, followed by a closer look at some of the countries involved (France, The Netherlands, United Kingdom, Ireland, Germany). Finally, an attempt is made to integrate findings and produce some general statements and recommendations.

The article of L.N. Netter examines Teletel, the French videotex system, with around 120 services that focus exclusively on agriculture. The article explores the nature and importance of these videotex services. It presents a classification that allows comparison of services. Using this classification, some observations and comments on recent and future developments are made.

J. Bryden and B. Misener present experiences of the Arkleton Trust (established to study new approaches to rural development and education in the highlands and islands of Scotland, and to stimulate greater interaction between policy makers, researchers, and field workers) with Rurtel: a pilot project designed to explore the use of new information and communications technologies, using electronic mail and a computer conferencing system.

Q. Scally and M. Wilkinson look at two applications on AgriLine, the videotex system for Irish agriculture: the Clinics and the Closed User Group. Clinics are services established to provide farmers with answers from agricultural specialists on their farm management problems. A Closed User Group is a 'farmer driven' service that allows members to share the market information that is supplied by the farmers themselves.

The article of C.I. Houseman documents the establishment of a corporate strategy and a permanent institutional capacity within the UK advisory service ADAS to design and support IT applications and projects. The process of establishing them was based on careful systems analysis of research, extension, and practice, covering a four year period. The article singles out extension for an in-depth analysis of strategic investment in IT.

C. Leeuwis, N.A. Hamilton, and G. Moorman focus on IT applications that sup-port communication processes between extension workers and farmers. They address two major questions: the identification of problem areas that require, or are suitable for the development of extension support systems (ESS); and the methodologies that are appropriate for ESS development. Their article reflects on several case studies.

The article of R. Ausher examines what computer support can actually mean for third world agriculture. He provides strategies for the promotion of computer support, with a special focus on computer aided activities in extension services, making it clear that the experience gained in developed agricultural systems

indicates several erroneous concepts and strategies that should not be replicated. The article, furthermore, elaborates on the expected changes in advisory work that might result, and their organizational implications.

This last article concludes the agricultural section. The next five articles focus on health. In the first article, M. Koelen and A. Brouwers look at the Dutch health sector from a KIS perspective. They pay attention to historical developments, especially in public health, and explore the contribution that ideas about KIS functioning and knowledge management could make to the field.

N.E. Warmenhoven and J. Hagendoorn focus on two institutions in the Dutch health KIS. First, as an example of organizations functioning at local level, the Municipal Public Health Services (GGD) are described. Second, experiences with the Health Education Center (the LCGVO), an organization at national level with a distinct knowledge management function in the national health KIS (e.g., documentation, information, and research), are reported.

The article of E. de Leeuw concentrates on Dutch policy considerations in the area of health promotion, and their relation with information, networking, etc. The efforts of the Dutch government to increase the feasibility of an effective health policy are described, with special attention to the use of information as an instrument to carry out or develop this policy. This is done, first in more abstract terms, then followed by some examples related to networking and knowledge management.

J. Ashton presents two case studies, both situated in Liverpool, that reflect on the results of policies to enhance public health. Policies that have made an important shift in the last decade, and now consider physical characteristics, lifestyles, and the environment, and often look for active participation of other parties (e.g., the public at large) in formulation and execution. These developments are illustrated by some experiences with a health fair and travelling health double-decker busses, followed by a discussion of the origins and formulation of the World Health Organization Healthy Cities project.

The article of A. Van Schoonderwalt is about creation of artificial intelligence systems for counseling patients. First, she outlines the advantages of computerized counseling and the prospects of AI programming techniques. Followed by experiences with actual implementation of a prototype of such a system, which was based on elementary knowledge about two dental diseases (caries and paro) and related oral conditions.

The Environmental section start out with an article of R. Jeltes. First, it gives a broad analysis of the impact of human activity on the environment, and the subsequent reactions of policy makers. Second, current Dutch environmental policy is described, with its shift from sectoral to integrated approaches. Finally, the information requirements of this policy and the quality and quantity of the information available are explored.

C.M.J. Van Woerkum and P. Van Meegeren also deal with government policy and the use of information to attack environmental problems, but from a different

perspective. Their article examines the policy process, making a distinction between knowing and deciding. Special attention is given to the role of communication in a so called intervention-mix.

The article written by C.S.A. Van Koppen and D.G. Goldsborough explores the role IT can play in municipal environmental policy. Dutch municipalities are confronted with an increased number of prescribed environmental tasks, and with a growing demand, both from the central government and environmental pressure groups, to undertake environmental activities on their own initiative. The article investigates the possible impact of computer applications, presents a classification, and distinguish a formal and informal knowledge domain. Special attention is given to expert systems.

P. Van Meegeren examines the possibilities of videotex as a medium to provide environmental information about consumer products. At first sight its role as an aid in efforts to change consumer behavior seems promising, but is videotex still such a promising medium at second sight? The article tries to provide an answer, and addresses three issues: the influence knowledge of environmental consequences exerts on consumer behavior; consumers' motivation to search for information about environmental consequences; the characteristics of videotex, when compared with two other media used to provide environmental information.

R.N. Tucker presents Ecodisc, an environmental education program about a nature reserve, developed by the British Broadcasting Corporation and dependent upon a particular configuration of equipment. The software which controls the videodisc and the statistical data is stored on the videodisc itself and has to be down-loaded into the memory of the special videodisc player. The article considers some of the didactic implications of interactive media in general and the Ecodisc in particular.

The last section of three articles deals with industry. The article of C.A. Coehoorn, E.E. van de Lustgraaf, and N.G. Röling makes it clear that industry is an economic sector with clearly different characteristics than e.g., agriculture. The article examines the consequences of these characteristics for the efforts to establish an efficient institutional knowledge and information system for small and medium enterprises (SME).

The purpose of the article of S. Bruin and C. Okkerse is to provide some insights on how Unilever, one of the world's major multinational companies, manages its research and development (R&D). They make it clear that industrial R&D is a very complex activity, and provide an overview on how Unilever deals with its sophisticated organization.

The last article is written by A. Swinkels and H.J. Veerkamp, and looks at Hendrix Voeders Holland (a Dutch feed company), and how it manages its internal and external information flows. Their article concentrates on the Support System: an IT application that allows the Hendrix' advisors to store and retrieve information in a structured and uniform way, facilitates the information exchange with 'headquarters' (e.g., gives the managers access to their information), and

makes immediate feedback and action possible.

The articles are followed by short bio-statements on all authors, and a brief overview of the Department of Extension Science.

# IT from a knowledge system perspective: concepts and issues

N.G. Röling and P.G.H. Engel

*Studying knowledge utilization and related processes calls for a conceptual framework. We look at the actors that engage in these processes in a specific field of human activity, and the interfaces and linkages between them, as a knowledge and information system (KIS). Although this KIS perspective originates from agriculture it also can be applied to other knowledge domains. Evidence gathered shows that for a KIS to be effective the actors (e.g., researchers, extensionalists, and clients) must act synergically. This inspired us to look for basic KIS principles that indicate opportunities for intervention. This article provides a brief state-of-the-art overview, presents some insights gained to date, and states the main issues for the use of information technology (IT) in knowledge management.*

Scientists often deform themselves to see things others cannot. Often this approach leads to a mere wonderland for self-indulgence, but sometimes it does lead to useful concepts, tools, procedures, or technologies. We manage to rise above the wonderland only occasionally. The KIS perspective, and especially its potential contribution to knowledge management and to understanding IT, seems to have fired the imagination of some and the abhorrence of others sufficiently to allow a modest claim of success. In fact, it is the positive reception of one of our earlier efforts at a seminar on IT in agriculture in London that led to the seminar in Wageningen.

## Knowledge and information

The two central concepts of the KIS perspective are knowledge and information. Knowledge occurs between the ears, a property of the mind. It cannot be heard, seen, or touched. "Meanings are in people" (Berlo, 1960). We distinguish between knowledge and the 'real world, although many consider what they believe to be

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reality. People use knowledge to operate in the real world. They build theories that attribute causes to effects and apply these to control the environment for their purposes. If things do not turn out as predicted, they adapt their knowledge or ignore the real world to avoid inconsistency. Knowledge utilization is a mechanism for survival, and consideration of the knowledge/real world interface has heuristic effects.

Concepts describing interface processes include feedback, inference, perception, reification, attribution, reality testing, and communication. A crucial interface device is information. It can be defined as sensory input that maintains or improves the goodness-of-fit between knowledge and the real world. On the one hand, information is explicit, visible, touchable, hearable, and thus is transferrable. It consists of matter and energy. On the other, information assumes that a receiver can impose a pattern upon this matter/energy so that it takes on meaning and makes sense. Information, therefore, is more than data or mere sensory input. It also implies an interpretable pattern. Information must not only anticipate its receiver's ability to interpret it, but, to be informative, it must also anticipate upon an existing discrepancy between the receiver's knowledge and the environment. Deliberate information provision through communication must pay considerable attention to anticipation. One finds marketers and other professional 'informers' investing much in gathering information from and about their intended receivers and cultivating client orientation. Its anticipatory nature is a crucial difference between our concept of information and the one used in computer science.

Knowledge and information are key factors in most intentional behavior. In a rapidly changing world, in which human activities are becoming increasingly knowledge intensive, they require deliberate development of useful concepts, methodologies, and tools.

## The emergence of the KIS perspective

Extension science started with the question: "how do we get the message across?" - a rather unfruitful perspective focusing on extension methods. Predictably, it led to the question: "why don't they do what we want them to do?". At first, the invariable answer was: "they are resistant to change". Therefore, we spent much time studying resistance (e.g., fatalism, lack of innovativeness). Only slowly did we begin to realize that it is more helpful to focus on the nature of the offering. We learned a lot from marketing (Kotler, 1975). The question became: "how can we assist the client's decision-making?" (Van den Ban, 1971). And: "how can we design our offering so that it fits the client's felt requirements?". We became interested in targeting the extension offering.

At this point, our focus on extension proved of limited usefulness. The 'offering' is not a question of extension alone. It cannot be considered without taking into

account research, technology development, policy, and the conditions that determine the offering's relevance and availability. But we also realized that the different actors together must form a whole that has properties not manifest by the set of individual actors. In other words, evidence (Moss Kanter, 1983; Engel, 1989) shows that, to be effective, research, extension, clients, and other actors must act synergically: their combined contribution becomes more than the sum of their individual contributions. We embraced the knowledge and information system (KIS) (Röling, 1988): "the persons, networks and institutions, and the interfaces and linkages between them, which engage in, or manage, the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information, and which potentially work synergically to improve the goodness of fit between knowledge and environment, and the technology used, in a specific domain of human activity".

This concepts suggested analysis of phenomena interesting far beyond the boundaries of conventional extension science, and promised opportunities for practical contribution: synergy provides a guiding principle for diagnosis, design, intervention, and management. Embracing KIS made us part of the research tradition of knowledge utilization, that includes Lionberger (1986); Havelock (1969, 1986); Rich (1981); Rogers (1985, 1986); Swanson (1986); Bunting (1986); Beal et al. (1986); Dunn (1986); Van den Ban and Hawkins (1988); Nagel (1981); and Freire (1973).

In spite the fact that we discovered KIS through its applications in agriculture, it allows a comparative perspective. Wherever knowledge and information are utilized systematically, especially where specialized institutions exist, the KIS perspective can be applied. Thus it can be used to advantage in health promotion, in small and medium industries support, and in R&D in multinational companies.

## Criticisms

The KIS perspective allows a statement of what is desirable and what is not. Given sufficient comparative research, it should be possible to impose the KIS perspective on real world phenomena and diagnose causes of malfunctioning, identify leverage points, suggest courses for intervention and provide tools for knowledge management.

Adepts of actor-oriented theories (e.g., Long, 1984), who are more inclined towards inductive analysis for drawing conclusions than towards systems analysis for decision support of management and intervention, came down on us like a ton of bricks. Here were technocrats at work, ready to impose top-down models on phenomena and use them as a basis for intervening in peoples' lives, without regard to the diversity and the strategic behavior of various actors who cannot be cajoled into deductive models. Instead, such actors battle for advantage, following their own objectives and strategies. From one's hide, one can watch their antics in

the arena of life. It is preposterous to think of intervening to some useful purpose, let alone that the actors can be considered a system amenable to management. Other critics argued that our earlier assumption that the KIS had an intrinsic mission was basically false. Knowledge systems, as complex organizations, only acquire a mission as the outcome of the stakeholders' (often conflicting) objectives.

It is especially our exposure to Checkland's soft systems methodology that made us come to grips with some of these criticisms. In addition it aided us to develop a methodology that allows shared learning and participatory KIS development while making use of knowledge accumulated through comparative KIS research.

## Systems

Widely different phenomena can be characterized as systems. The main advantage to this approach is that an emphasis is placed on the wholeness of the phenomena. A car is more than a heap of spare parts. Instead of reducing the whole to its constituent elements, systems thinking emphasizes the properties that emerge when one looks at it as a whole (Checkland, 1981). Systems thinking therefore emphasizes the system states and the relationships between the constituent parts required for the emergent properties to become operational.

Systems that have clear purposes, such as a car, can be called "hard systems" (Checkland, 1981, 1985). They are amenable to the powerful goal seeking techniques of systems engineering. Using such techniques on human activity systems, or 'soft systems', has proved difficult because they do not have unambiguous purposes. If they have, it is the result of management efforts to create consensus among the human actors. Another difference between hard and soft systems is that the latter are not as clearly definable. The definition of boundaries is often a question of arbitrary agreement. When phenomena can be expected to have emergent properties when looked at as a system (e.g., when they combine to a higher performance than when they are a 'heap of spare parts'), we feel we gain by viewing such phenomena as a system.

The 'performance' of a system is the outcome of human purposes. For a set of actors to acquire emergent properties, shared learning, joint decision-making, and management are required. Recognition of this point is, in fact, the essence of the soft systems methodology (SSM) developed by Checkland (1981). It calls for an advisor to take a set of actors, who experience problems, through a series of steps that allows them to impose systems thinking on their problems and make joint decisions to enhance the emergent properties of their human activity system. Instead of social engineering, SSM is a technique for participatory system development. 'Imposing systems thinking' means both inductive analysis with a minimum of preconceived ideas, and deductive imposition of theory gained through comparative research. In the former case, one uses systems concepts to

create an image of the local human activity system together with those concerned (Van Beek, 1989), defining its actors and their relationships, its environment, and possibly its desired and actual performance. In the latter, one applies theory to the local system. For example, the advisor assumes the need for synergy among components to attain the system's emergent properties.

**The knowledge and information system**

The human activity system (HAS) with which one is concerned, be it growing mushrooms, keeping aquariums, or staying alive in Bangladesh, covers a certain knowledge domain. Household survival strategies, industries, sectors, branches, and disciplines are typical ways for segmenting knowledge in domains. A KIS is either an aspect system of a HAS (i.e., when knowledge and information are important inputs into HAS purposes), or a subsystem (i.e., when knowledge and information are outputs of specialized institutions within the HAS). A typical example of the former is a farm where knowledge is an important production factor, but not a deliberate output. An example of the latter is a system with experiment stations, trial farms, an extension service, and farmer networks.

A key point in describing the KIS is its potential contribution. As we have seen, a KIS is not intentional and, if it has purposes or goals, these are the results of consensus between its constituent actors. But a KIS potentially makes a different contribution from, say, an economic system. That contribution is to improve the goodness-of-fit between the collective knowledge of the actors in the HAS and the environment they seek to control, or have to adapt to, in order to reach their objectives. The very stuff of a KIS are, therefore, the processes at the interface between knowledge and the real world, and their sharing through communication. We impose a KIS conceptual framework when we anticipate that the solution to problems experienced in a HAS lies in improving the manner in which goodness-of-fit between knowledge and environmental opportunities is attained.

Its contribution means that KIS performance must be measured in terms of the efficiency, effectiveness, and equity of innovation, prevention, and/or sustenance of (re)production. It also means that its emergent properties and the task differentiation, integration, and coordination that allow them to emerge, concern basic KIS processes, such as generation, transformation, exchange, and utilization of knowledge and information.

Functional differentiation, integration, and coordination are typically concerns of knowledge management. In some cases, a KIS is managed centrally. Usually, however, the various institutions comprising the KIS are more or less autonomous so that knowledge management can come about only through shared learning, joint decision-making, a 'corporate' awareness of belonging to a KIS, and external pressures created through such aspects as policy, market forces, or the threat of environmental calamity.

**Some insights gained to date**

KIS theory to date is based on reflective practice rather than on empirical research. Nevertheless, we shall try to formulate some of the highlights. For the time being, they are little more than hypotheses.

*Optimal KIS performance requires balance between the intervention power of specialized institutions and the countervailing power of clients.* Those who specialize in producing information must actively anticipate the receiver. This approach requires: (a) using information about clients in designing information products; and (b) pretesting them in client conditions. Experience shows that neither happens unless clients can wield effective control over specialized institutions and processes, such as technology development. Therefore, commercial companies use marketing research, consumer panels, product testing, and other devices deliberately to enhance client orientation and expose R&D processes to market forces. Shaping that exposure is one of the never-ending tasks of knowledge management.

Client control is a critical quality of an effective KIS (Rogers, 1986). Scientists, experts, and others concerned with 'transfer' tend to only consider 'downstream' flows of 'solution messages' and forget that 'upstream' flows of 'problem messages' are equally important to close the anticipation cycle (Havelock, 1986). The performance of many a KIS could be greatly improved simply by mobilizing the countervailing power of users over generation and exchange processes. However, a KIS in which only clients control decisions is likely to be ineffective and slow to adapt and respond. The specialized institution needs intervention power and room for maneuver. Both top-down and bottom-up flows are necessary.

*Optimal KIS performance requires affirmative action.* The default is that client control is exerted only by the best-educated, best-informed, and resource-richest and that specialized institutions perceive many incentives for focusing on them. Knowledge accumulates where there is most of it already. Economic mechanisms tend to acerbate the consequences of such inequity by providing windfall profits to innovators and by squeezing those who cannot keep up with technology propelled development. To be effective, a KIS therefore requires affirmative action that involves: (a) complementary targeting of opportunities on the knowledge, goals, and capacities of 'forgotten' categories; and (b) their deliberate empowerment and enhancement of their capacity to innovate.

*Optimal KIS performance requires responsiveness to diversity.* The usually high diversity in opportunities and constraints, as well as in actor goals and capacities, requires that a KIS must be capable of differential response, which is situation-specific, adaptive, and redundant. The default is often a uniform, standardized response. It is difficult to develop adequate institutional knowledge systems for highly diverse and complex knowledge domains (e.g., the survival mechanisms of farmers in highly diverse eco-systems). Helping experimenting farmers organized

in lateral networks has been suggested as an alternative (e.g., Chambers & Jiggins, 1986).

*Optimal KIS performance requires synergy among the tasks of its constituent actors.* An effective KIS presumes the performance of a number of vital tasks. Earlier these tasks were perceived to consist largely of generating and using knowledge and moving information. In fact, researchers were said to generate knowledge, extension to move it, and clients to use it. We now know this view is too simple: researchers also utilize and move, while clients are usually active generators in their own right. It is too simplistic for another reason as well: the emphasis on moving (e.g., transferring, exchanging), as if information were a commodity, has led to neglect of vital tasks with respect to transformation and synthesis. Typically, entrepreneurs synthesize vast amounts of information from different sources into knowledge that is useful in their business.

Synergy is necessary for the KIS to acquire its emergent properties. On the one hand, synergy requires task differentiation. That is, actors must develop specialized tasks that are mutually complementary, so that optimal KIS performance is possible within the limits of the resources available to the KIS. Sometimes, the institutional calibration of the science-practice continuum (Lionberger & Chang, 1970) shows 'fatal gaps' (McDermott, 1987), so that vital tasks cannot be performed.

Functional differentiation is but one condition. Synergy also requires integration. Actors must play complementary roles, anticipate each other, and provide the inputs that are mutually required. Integration requires that the interfaces among actors (i.e., the 'force fields' between them) are marked by appropriate linkage mechanisms (Kaimowitz, 1990), that allow interchanges of matter and energy, including information. Knowledge management is, to a large extent, interface management. It is among the actors that crucial information processes occur. The 'interface matrix' (Van Beek, this volume), in which the cells represent the interfaces of all pairs of actors in the KIS, is a useful management tool. The introduction of IT to create or improve linkage mechanisms, also creates new interfaces (e.g., between substantive experts, system analysts, and programmers), for which appropriate linkage mechanisms have not always been developed.

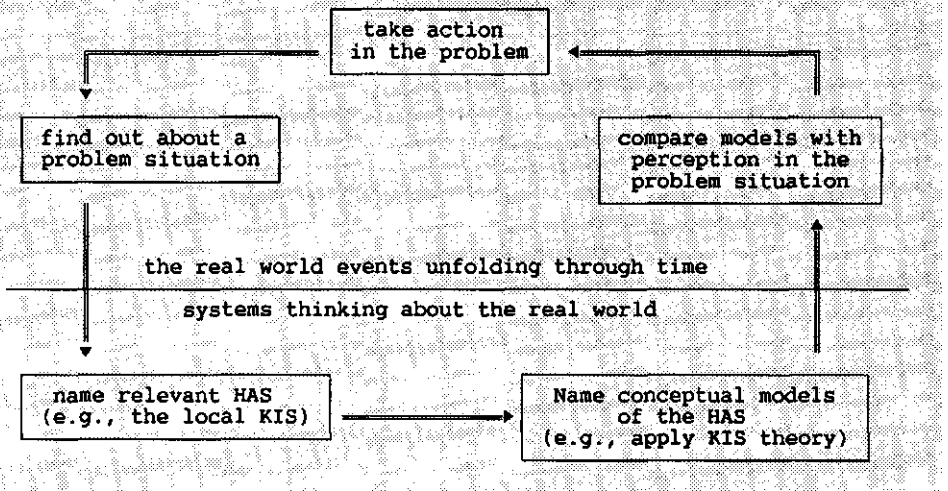
*Optimal KIS performance requires mobilization and play off of forces that can overcome the incentives for default and entropy* (Sims & Leonard, 1989). Default options are those that happen unless one takes special measures. A typical default is for the KIS to serve those who need assistance least (Havelock, 1969). Another default is for KIS constituent institutions not to work together. Hence strong coordination by special forces is required for the KIS to realize its emergent properties and make the system 'tick'. These 'prime movers' can be consumers who exert demand, commercial companies that exert pressure, clients who demand appropriate information and technology, managers who use various incentives to nudge institutions towards common goals, and policy makers who create suitable conditions for integration. In short, improvement of system

performance requires people who can act to improve the system through coordination.

*Optimal KIS performance requires a conducive KIS environment.* It is easy to focus too much on what happens within the KIS and neglect the KIS environment, especially the effect of economic factors and policies on the KIS. For example, in agriculture, Ruttan and Binswanger (1978) speak of "induced innovation" as a result of changes in relative factor prices. In other words, knowledge processes could be managed through economic conditions. The KIS can be considered a black box: all policy makers need to know is the input required for the desired output. We consider this myopia to be reminiscent of earlier claims that, if prices are right, diffusion is automatic and extension not necessary. It now is generally recognized that extension requires large investments of its own and that farmers' information needs only increase with agricultural development. On the other hand, we ourselves would be myopic if we did not recognize that external economic and other factors, often manipulable by policy, have their own role to play in affecting KIS performance. This role concerns the resources invested in the KIS, the extent to which feedback resource loops 'reward' the KIS for its contribution to the performance of the larger system, the measures taken to integrate the KIS into the larger system, and the importance of knowledge and technology in different development situations.

*Optimizing KIS performance requires a methodology.* Checkland's SSM discussed earlier is illustrated in Figure 1.

Figure 1: The soft systems methodology (SSM) in summary.




Source: Checkland, 1985.

Engel and Seegers (1989) have begun to develop a methodology for the rapid analysis of agricultural knowledge systems (RAAKS) that fits well with the SSM whenever it can be usefully assumed that the problem is served by imposing a KIS framework. If the assumption can be made, one can apply the RAAKS fields of analysis to the major steps in SSM, thus generating a methodology for participatory KIS development with 'hybrid vigour' (Figure 2).

Figure 2: A 'hybrid' methodology for participatory KIS development.

| SSM | RAAKS |
|---|---|
| FIND OUT ABOUT A PROBLEM SITUATION | - What are the symptoms and likely definition?<br>Is knowledge/information a vital resource?<br>IF YES: |
| NAME RELEVANT HUMAN ACTIVITY SYSTEM | - What local KIS are we talking about?<br>(domain, components, linkages, environment)<br>- Who does what in the KIS?<br>- To what development in agriculture is the KIS supposed to contribute?<br>- What outputs does the KIS produce?<br>- What is the perception of the KIS by those involved?<br>- What are the environmental conditions? |
| NAME CONCEPTUAL MODEL OF THE HAS | Use KIS conceptual framework for modelling the local KIS described above, using hypotheses about:<br>- balance of powers;<br>- functional differentiation and integration (synergy);<br>- coordination (prime movers);<br>- environmental conditions. |
| COMPARE MODEL WITH PERCEPTION OF THE PROBLEM SITUATION | - Who can act to change the situation?<br>- What are the points of leverage?<br>- What tools can be applied?<br>- What are desirable intervention goals? |
| TAKE ACTION | - Who will act? |

Adapted from Checkland, 1985; and Engel & Seegers, 1989.

## Definition and characteristics of IT

IT refers to computer-based systems used for collecting, exchanging, processing and/or producing information. We do not consider process automation. Applications of IT include databases, information synthesis tools, calculation programs,

and expert systems, as well as bulletin boards, conferencing systems, and other network applications.

Computer-based IT has a number of potential advantages over traditional technologies: (1) IT applications can reduce time constraints by being extremely fast, both in communication and processing of information; (2) IT applications can reduce time constraints by permitting a-synchronic communication. People do not have to be in the same place at the same time to communicate; (3) IT applications can effectively bridge physical distances between suppliers and users of information and they can be used to extend the information market into inaccessible areas; (4) IT applications can help to consolidate the total supply of knowledge and information within a system, subsystem, or network and make storage and retrieval easier; (5) IT applications can be used to provide access to external automated databases; (6) IT applications can be used to measure, regulate, and/or control information and data flows; (7) improvement of data handling capacities of hardware allow IT applications, theoretically, to handle a high degree of diversity.

There are also a number of disadvantages or purposes for which IT cannot (yet?) be used: (1) IT applications have difficulties in interpreting contextual information. As a consequence, they cannot easily validate sources of information and knowledge; (2) compared to people, IT applications have very limited associative and interpretative powers; (3) IT applications mostly cannot handle conflicting, non-anticipated, pieces of evidence, unless they are able to learn by asking for input; (4) IT applications do not socialize easily. They do not maintain social relationships; (5) reliability, protection, and privacy of information stored in IT applications present a problem; (6) hardware and software incompatibilities create new barriers to information exchange that are often hard to bridge; and (7) investment and maintenance costs of IT, in money, time, and annoyance, are still inhibitive to its general use in agriculture.

## IT from a KIS perspective

We can look at IT at three levels: (a) the program or software; (b) the project or service, including information suppliers, hardware, software, and clients; and (c) the complete IT system, including the support system (software development, project planning, investment, etc.), as well as the projects and services. We shall look at IT as a constituent part of a KIS. This perspective means that a software product is a form of communication among actors in a KIS (e.g., its developers and potential users), IT is only useful to the extent it enhances the KIS in improving the goodness-of-fit between knowledge and environment, the information provided must anticipate the client, client control over IT development and management are indispensable, moving forces are necessary to prevent incentives for default, and the introduction of IT into a KIS means task

differentiation and new interfaces and therefore requires new linkage mechanisms and other forms of integration.

## Issues arising

We started this article by assuming that the knowledge on which decisions about experiments and investments in IT have been based is inadequate and that the KIS conceptual framework provides a promising alternative. We have presented the outlines of the conceptual framework. We must now raise some of the issues that arise out of imposing KIS thinking on IT. In doing so, we use earlier ideas developed by C. Leeuwis of our department, who is presently working on a Ph.D. on the use of IT in agricultural extension. The issues raised, in turn, provide challenges that the articles in this volume try to address.

*Managing new interfaces.* Knowledge management primarily involves managing interfaces between system components. The introduction of IT creates new interfaces at all levels: between newly emerging institutions (software bureaus, network exploitation firms) and existing institutions at the multi-institutional level; between system analysts and programmers or between subject matter specialists and system analysts at the institutional level; and between user and machine, or between artificial and human intelligence at the individual level.

*Automating knowledge and information processes.* The 'stuff' of a KIS are the knowledge-related processes that take place in 'upstream' or 'downstream' transformation chains. Which of these processes can IT applications usefully support, and at which points in the transformation chains? How does this automation relate to the qualities of other conventional media, such as farm journals? What applications can be expected in such professions as extension?

*Technology development.* Which different approaches towards software and/or application development exist and what are the consequences of these approaches with regard to their usefulness in knowledge and information systems? What role should users play in such technology development?

*New incentives for default.* Can new default options be expected as result of IT introduction? How can they be managed? Can IT applications avoid exacerbating existing incentives for default (e.g., the KIS serving those who need it least)?

*Societal consequences.* What are consequences of IT introduction on the position of users (e.g., extension workers, farmers)? How is the quality of their labor affected? Does IT contribute to 'capitalization' of knowledge and information? Can users organize themselves to counter adverse consequences? What juridical problems arise from the use of IT?

*Vertical networks.* Electronic networks provide interesting new linkage possibilities between institutions, especially because of information from different sources and varying quality (i.e., scientific knowledge and experiential knowledge) can be included and exchanged. What are advantages and disadvantages of vertical IT

networks? To what extent can such networks support existing, and/or create new, vertical social networks? How useful is IT with respect to different knowledge-related processes in vertical transformation chains? What institutional arrangements and tasks are required in order to support vertical networks?

*Horizontal networks.* Horizontal networks play crucial roles in allowing individuals to exchange, synthesize, evaluate, and otherwise process information. Can electronic networks support existing and/or create new horizontal social networks? How useful are they with respect to different knowledge-related processes? What institutional arrangements and tasks are required in order to support horizontal networks?

*Decision support.* IT is often presented as a powerful tool for decision support. In reality, however, interesting problems occur and many questions remain to be answered, often related to actual human decision-making. Are computer-based tools for decision-making consistent with human decision-making? How can computer-based decision support systems anticipate human information needs? To what extent do the increased number of interfaces involved, and the very fact that electronic systems seek to overcome time and space, hamper anticipation?

*Bottom-up or top-down.* Most IT applications are based on interactive procedures. Can IT facilitate bottom-up flows of information (as compared to conventional media)? Or do IT applications slowly incorporate users in inescapable webs of top-down control? Can IT applications effectively support knowledge management information systems?

*KIS fit.* How can IT (programs, projects/services, and support units) best be fitted into an existing institutional KIS, both in terms of design and introduction process? How do IT applications affect KIS performance: under what conditions does the KIS become more effective and efficient? To what extent do IT applications decrease the client orientation, flexibility, and situation specificity of a KIS, or, on the contrary, increase the use of outside information?

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# Equivocations on knowledge systems theory: an actor-oriented critique

C. Leeuwis, N. Long, and M. Villarreal

*Knowledge systems theory, in our view, tends to obscure rather than illuminate an understanding of the fundamentals of knowledge processes in society. This tendency occurs primarily because both the theory, and the methodologies that are derived from it, fail to recognize that knowledge processes are social processes, and thereby that knowledge itself has to be envisaged as a social construction. As a result of this omission, knowledge systems theory and methodology can only deal poorly with issues of power and social conflict, and, at the same time, tend to make use of several inappropriate teleological and reifying notions. According to our view, the understanding of knowledge processes will benefit greatly from a more actor-oriented perspective. In such an approach, emphasis is accorded to human agency and the concept of multiple knowledge networks. Central purposes of actor-oriented methodologies then, are to clarify how actors attempt to create space for their own 'projects' and to determine which elements contribute or impede the successful creation of such space for maneuver.*

There is presently a lively debate at the Agricultural University of Wageningen between agricultural extension scientists on the one hand, and rural sociologists and anthropologists on the other, concerning the usefulness of knowledge systems theory[1]. The former argue that knowledge systems theory is a useful model for analyzing knowledge processes in agriculture and for diagnosing the problems of knowledge dissemination/transformation in situations of agricultural change and development. The latter (to which we belong) contend that such and approach fails to grasp the essential dynamics and complexities of knowledge processes and recommends instead the development of a theoretical approach based on an 'actor-oriented' rather than a 'systems' perspective.

While acknowledging at the outset that knowledge systems theory has recently been subject to some significant improvements, such as the greater emphasis placed on inductive reasoning, the shift from 'hard' to 'soft' systems thinking, and

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the development of a more explicit and elaborated methodology, it is our view that there remains a number of important theoretical and practical problems that need serious scrutiny. The purpose of this article, then, is to discuss some of these and to re-emphasize our call for a more actor-oriented approach to the study of knowledge processes in society (see also Arce & Long, 1987; Long, 1989a, 1989b; Villarreal, 1990).

## The nature of knowledge and information

Röling and Engel (this volume) argue that knowledge is something that "occurs between the ears" and therefore cannot therefore be transmitted directly; only information can be transmitted. Information then is the "sensory input which improves the goodness-of-fit between knowledge and the real world".

At first sight such a view might seem intuitively valid. However, it raises a number of contentious issues which it is necessary to elucidate briefly. In the first place, describing knowledge in this way tends to over-emphasize the individual-cognitive elements at the expense of processes of social and cultural production. The latter entail inter-subjectivities and shared understandings among people, which are central to an understanding of the nature of knowledge. Secondly, the characterization of information as a sensory input or flow of data that helps one test and adjust one's knowledge of the 'real world' is grounded in a kind of objective realism whereby information and the real world are assumed to be 'out there', while knowledge is essentially an internal mental construct. The difficulty with this position is, of course, that people can only interpret and assign meaning to sensory input on the basis of an existing body of knowledge and experience they have actively developed over time. This point is partly recognized by Röling and Engel (this volume) when they stress the importance of what they call "anticipation" on "the receiver's ability to interpret"; but this calls into question the very distinction they wish to make between information and knowledge. Both are in fact elements of a single interpretive process, since information has no meaning if it cannot be internalized, and by being internalized, it becomes part of a stock of knowledge. It is not helpful therefore to dichotomize the two.

This leads to a third related point, namely, that if the so called 'real world' does not exist apart from the sets of subjective perceptions and evaluations of particular social actors, then clearly we are dealing with 'multiple realities' and potentially conflicting social and normative interests. An analysis of these processes revolves around the issue of whose interpretations or models (e.g., those of agricultural scientists, politicians, farmers, or extensionists) prevail over others and under what conditions. Hence knowledge processes are embedded in social processes that involve aspects of power, authority, and legitimation; and they are as likely to reflect and contribute to conflict among social groups as they are to lead to the establishment of common perceptions and interests.

**The centrality of power and social conflict**

Issues relating to power and social conflict, we believe, are poorly dealt with in knowledge systems theory and methodology. At the theoretical level, Röling and Engel (this volume) hypothesize that "an optimal KIS [knowledge and information system] performance requires a balance between the intervention power of specialized institutions and the countervailing power of users". They also assert that a KIS needs to be endowed with adequate resources, but where these should come from and how they should be distributed among the various parties (e.g., government development agencies, farmers' organizations, and research institutes) to ensure a sound performance is not made clear. Thus there is no adequate understanding of how power differences affect the interactions between the elements (or 'subsystems') of the system. Indeed the matter is avoided by defining 'optimal performance' in terms of assumed system goals that entail a balance of forces that regulates information flow and promotes the coherence of the system.

Furthermore, neither the soft systems methodology (SSM) (Checkland, 1981) nor the rapid appraisal of agricultural knowledge systems (RAAKS) method (Engel & Seegers, 1989) provide satisfactory answers as to how to choose between the evidently differing goals and interests of the actors in the system. It is simply assumed in SSM and RAAKS that participants and researchers will be able, through a joint process of learning, to arrive at some new 'systematic' interpretation or model of reality that can then be compared and evaluated with the views originally held by the different actors, in order to design new intervention strategies. Implicit in all such procedures and theoretical tenets is the assumption that the relations between intervenors (whether researchers or extensionists) and clients will take place in an atmosphere of optimism and harmonic participation, whereas we know by experience that the process is unlikely to be so smooth and unproblematic, since differences of interests, resources, and perceptions will always intrude. For systems analysts, there are two practical solutions to this problem. Either one defines the system boundaries in such a way as to maximize the possibility that mutual agreements can be reached: this implies identifying homogeneous target groups or specific institutions concerned with knowledge dissemination/utilization, and thus excluding other actors or more informal social arrangements, or one adopts a view of this situation that is acceptable to the most powerful participants. From a scientific and enlightened policy point of view, neither of these solutions, of course, is satisfactory.

Summarizing the broad sweep of our argument so far, we can say that it is not enough to regard knowledge or information as a body of individual cognitive constructions, or made up of items of data that can simply be transferred from one person or organization to another. Instead, paraphrasing Long (1989b), we must adopt a more dynamic view that envisages knowledge as a social construction that is jointly created through encounters between "knowing and active subjects" (Knorr-Cetina, 1981) or, what we call, social actors (individuals or

groups). This social production of knowledge arises from a 'fusion of horizons' since, as we emphasized earlier, the absorption of new information or cognitive frames can only occur on the basis of existing stocks of knowledge and experience. Knowledge arises out of, and is continuously being reshaped by, the accumulated social experiences and culturally acquired dispositions of the actors involved. It is, therefore, crucially associated with the idea of human 'agency', which we discuss below.

We also suggested that power differentials and conflicts over social meaning are central to an understanding of knowledge processes. A systems perspective, it seems, fails to grasp the theoretical significance of these social processes for analyzing knowledge issues. It also evades making explicit the crucial value decisions made by researchers or intervenors when applying such systems models.

**The problem of teleology and reification: the issue of 'agency'**

Checkland (1981) and Röling (1989a) explicitly attribute an underlying 'purpose' or 'mission' to the systems they write about. In their most recent definition of knowledge systems Röling and Engel (this volume) seem to accept Checkland's view that such a mission is not necessarily an empirical reality. They do maintain, however, that it is useful to promote the idea of such a shared mission or common purpose in the process of developing appropriate interventions.

While we accept that a systems perspective is a construct aimed at simplifying and ordering the chaos of 'reality' in order to be able to comprehend and deal with it, in our opinion attributing a purpose to a system, either in an empirical or normative or instrumental sense, obscures rather than illuminates certain fundamental social processes. As we have argued earlier, knowledge processes can only be properly understood only if one recognizes their socially-constructed and emergent character. Furthermore, knowledge is a social construction that is only made meaningful when the agency of actors is accorded a central place in the analysis: "agency ..... attributes to the actor (individual or social group) the capacity to process social experience and to devise ways of coping with life, even under the most extreme conditions of coercion. ..... Agency - which we recognize when particular actions make a difference to a pre-existing state of affairs or course of events - is composed of social relations and can only become effective through them" (Long, 1989b).

Given the fact that different social actors are likely to have different, if not conflicting, interests and values, agency is most clearly seen in the struggles that take place over strategic resources and in the attempts to create space for furthering their own cherished values or 'designs for living'.

This implies that it is not very fruitful to predetermine analytically the boundaries of a system (e.g., in terms of knowledge institutions or types of communication channels) without first fully exploring how various actors

conceptualize and move around their social fields. Such an enquiry would reveal how different actors develop and utilize different networks of social relations, define their goals differently, and adhere to contrasting cultural models of what constitutes effective social knowledge. These actor relationships and definitions are themselves subject to continuous change and renegotiation. Such changes go well beyond what a systems theorist might describe as 'system dynamics' (i.e., changes and fluctuations that can be measured against the parameters of the system), since we are not dealing with a unified system or a set of functionally or hierarchically ordered subsystems, but instead with a multiplicity of social networks and webs of meaning that only partially overlap and are often incompatible. This is what we imply by the notion of 'multiple realities'.

This critique of system models reveals the link between the problem of system teleology and system reification, which attributes to theoretical concepts a misplaced empirical concreteness. One of Röling and Engel's arguments, following Checkland, is that a knowledge information system has "'emergent properties' not shown by the set of individual actors" (Röling & Engel, this volume). While we would not dispute that social actions often have unintended consequences that go beyond the social interactions and purposes of the specific actors, the outcomes (e.g., the state of a particular commodity market, pattern of rural-urban migration, or stock of cultural resources) do not strictly speaking have 'a life of their own' - somehow beyond the reach of human agency. Hence, for the concept to be meaningful, emergent properties must in some way or other be seen as forming part of the constraining and enabling conditions of social action itself. That is they become part of the social strategies developed by people themselves. Thus we find it very difficult to imagine the kind of emergent properties that Röling and Engel are talking about. Our difficulty is compounded by the fact that they do not provide us with any concrete examples of what they precisely mean by emergent properties. We gain the impression that the authors confuse the concepts of 'system goals' and 'emergent properties' since the only property assigned to the system seems to be the realization of predefined goals to be achieved through proper management and coordination. The concept of emergent properties is, it seems, empty and thus superfluous in their model.

## Knowledge networks

Because of these difficulties of teleology and reification in systems analysis, we believe it more useful to develop the concept of multiple knowledge networks rather than systems[2] (see Long, 1989b). Social networks are flexible and changing sets of social relations between individual or institutional actors that involve material, social and symbolic exchange. Network analysis (see e.g., Mitchell, 1969; Granovetter, 1973) could, we think, be helpful for identifying the boundaries of epistemic communities, (i.e., those composed of persons who roughly share the

same sources and modes of knowledge) and for characterizing the structure and contents of particular communicator networks (Long & Roberts, 1984). Networks extend through time and space, and so particular interactions can be understood against the context of a 'network' or chain of previous and future interactions and in different spatial locations. Apart from the theoretical merits of network concepts and studies, the recognition of the social, historical, and spatial nature of such networks is critical for understanding knowledge issues and for designing and implementing appropriate interventions.

## The applied status of knowledge systems theory

Extension science is an applied science. This statement means that extension scientists aim to provide those concerned with the effective dissemination and use of agricultural information with adequate tools for intervening in the process to improve their performance. This activity, of course, has a legitimate goal, although one would need to decide on who precisely one wished to assist. The foregoing discussion, however, raises the question of the adequacy of systems theory for understanding knowledge processes and for designing instruments of intervention or application.

Theory should help researchers to understand and explain why people act the way they do, and methodologies for intervention should be derived from such an analysis. Hence, contrary to the opinion of some, there is no sharp dividing line between "knowledge for understanding" and "knowledge for action" (Scott & Shore, 1979). Röling (1989b) apparently agrees. He writes: "We use the systems approach to *understand and affect* the complex phenomena associated with knowledge and information in society" (our italics). Yet if, as we have argued earlier, knowledge systems theory tends to obscure rather than illuminate our understanding of the fundamentals of social action, then any tools of intervention that derive from it are also likely to fall short.

A puzzle remains, however, as to why the application of knowledge systems theory in the field of agricultural knowledge is attracting attention from practitioners. One reason might be that, despite Röling and Engel's insistence that a crucial element in their project is to increase the claim-making capacities and countervailing power of local groups, systems theory fits well with current interventionist thinking in planning and development aid circles (see Long & Van der Ploeg, 1989). It does this primarily because it organizes the data in terms of 'input-output' matrices, 'feedback loops' and 'institutional linkage' mechanisms which lend credence to the belief that it provides a sound diagnostic means for capturing the critical social elements, which can then be manipulated to produce desired results. Moreover, even participatory research methodologies that aim to get away from top-down strategies often continue to accord a central role to 'the experts', such as (in this case) 'linkage catalysts' or 'knowledge managers', whose

job is to know how to improve the performance of knowledge systems.

On the other hand, systems thinking has undoubtedly encouraged, through the promotion of a systems discourse, a more holistic analytical approach among practitioners. It has also assisted certain professional and local groups to further their own interests and plans for action. Thus, within the arena of agricultural development, different social actors have latched onto it, just as they did with other theoretical discourses, like those associated with the adoption of innovations and with 'target group' thinking. But it would take, we believe, an actor-oriented analysis to expose fully the strategic and ideological interests entailed in this search by practitioners and others for a new theoretical paradigm. It would also require an injection of actor-oriented thinking to produce a more appropriate theory of communicative interventions.

**The methodological implications of an actor-oriented perspective**

This leads to the last topic we wish to discuss, namely the need to develop an actor-oriented field methodology when exploring knowledge processes. Due to limits of space, we can only identify briefly some key issues.

One consequence of conceiving of people as active and knowledgeable (but not all-knowable) agents is that it would be inappropriate for a researcher to enter a situation with strongly preconceived ideas (other than the meta-idea of agency itself) of how people interact and why. An actor perspective implies that analysis must be grounded in a detailed ethnography of specific empirical contexts and thus requires, as a Mexican saying graphically expresses it, "plunging oneself into the garlic", so that one might savour the taste, digest it, carry it with one, and eventually come to understand specific actors' life-worlds[3], interests, and representations of the world around them (Torres, 1990).

This perspective entails a much more actor-oriented and interpretive approach to the study of social life than that proposed in Checkland's soft systems methodology. Checkland is principally interested in exploring problematic situations and the interpretations offered by the various participants in order to identify actors' 'taken-for-given sets of assumptions' that are considered relevant in the eyes of the model builder or would-be problem solver (Checkland & Davies, 1986). Yet such a conception fails to study the lived-in worlds of the participants and in fact contains no proper understanding of the agency of actors, other than, perhaps, that of the problem solver. It also fails to contextualize problematic situations and actor interests within the arena of broader historical and socio-political events.

The understanding of people's life-worlds and their strategic actions is crucial for analyzing how actors attempt to create space for their own projects (Long, 1989a). This is a critical problem for sociologists wishing to break out of the straitjacket of structural explanations of development; and equally important for

extension scientists engaged in developing new intervention strategies. Indeed, given the long catalogue of failures in institutional intervention, such a research question becomes highly pertinent.

In order to explore these processes we need to develop a comparative analysis of different types of situations wherein such struggles take place and to examine the elements that contribute to or impede the successful creation of space for manoeuvre. There already exists a number of actor-oriented methods of data collection and analysis that can facilitate the exploration of these and related dimensions (for an overview, see Long, 1989a). Many of these, we believe, could be fruitfully adapted to the study of knowledge processes.

Having indicated the kind of methodology entailed in actor-oriented research, it is important to reiterate again its possible practical and political implications. Researchers cannot, that is, avoid the question of whose space is being enlarged and what are the ramifications of this on other individuals and social groups. In fact an actor-oriented approach forces this on one in a way in which systems theory does not. Indeed we believe it is better to address this issue in an explicit manner (instead of hiding it away in soft systems methodology) on the basis of a thorough understanding of the 'projects' and agendas of the actors involved.

It is hoped that extension scientists and others interested in the understanding of knowledge processes will join us in developing further some of these insights derived from actor-oriented analysis, and that they will contribute to the realization of a more adequate theory and methodology of extension practice itself.

## Notes

[1] Here we have in mind knowledge systems theory as developed by colleagues of the Department of Extension Science, and reflected by the contribution of Röling and Engel in this volume.

[2] Speaking of "networks within systems", as Röling and Engel (this volume) do is, for the reasons outlined earlier not appropriate either.

[3] The concept of life-worlds derives from Schutz and implies simultaneously both action and meaning. It is a "lived-in and largely taken-for-granted world" (Schutz & Luckmann, 1973). It is constituted of various forms of social knowledge, intentions, and evaluative modes, and types of discourse and social action, through which actors attempt to order their worlds. Such life-worlds are the products of past experiences and personal and shared understandings, and are continuously reshaped by new encounters with people and things. Although the researcher attempts to come to understand the make-up of different life-worlds, they are essentially actor rather than observer defined.

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# The Queensland dairy AKIS: a systems approach to the management of research and extension

P.G.H. Van Beek

*This article applies a systems approach and concepts of knowledge processes to the dairy industry in Queensland. The resulting model of the Queensland dairy agricultural knowledge and information system (AKIS) is analyzed by using an interface matrix. This matrix links the analysis with traditional management of research and extension units. Furthermore, the model is compared with extension literature and with an 'overall picture' then in use by the relevant extension and research units. The approach led to various perspectives, new insights and different management decisions. The article discusses some limitations, but concludes that the approach has practical value for managers and that further work is justified.*

## Introduction

*AKIS and management.* Agricultural production systems face many new challenges. In Queensland, these include more complex marketing and post-farm processing, higher awareness of ecological impacts and the need for conservation of non-renewable resources, increased concerns about quality of products and public health, and more emphasis on multiple land use (QDPI, 1989). These challenges demand a higher level of integration of knowledge, information, and services than is required for on-farm problems. They also ask more attention for information flows between producers and functions such as marketing, processing, regulation, finance, private consultants, and agribusiness, in addition to the traditional links between producers, extension, and research.

Rapid developments in information technology (IT), though opening new opportunities, have added further complications as a result of increased access to many information sources. Furthermore, government budget cuts are putting additional stress on publicly funded groups in current AKIS.

Over the years, research and extension managers in the governmental Queens-

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land Dairy Primary Industries (QDPI) have steadily improved the internal efficiency and effectiveness of their units. However, the current challenges require additional external adjustments. AKIS concepts seem useful for this purpose. They appear to provide managers with an additional perspective for:

1. positioning of their own unit in the AKIS;
2. coordination with similar or client groups in the AKIS, especially with newer groups;
3. management of information flows within the AKIS as a whole;
4. assisting other groups to further develop their specific roles and connections in the AKIS.

The first two allow direct benefits to their own unit. The latter two imply better 'management' of the AKIS as a whole, to the direct benefit of the production system and with only indirect benefits to their own units. The latter perspective is relatively new to many managers. These adjustments could lead to different selection, allocation and management of existing resources, such as staff, operating budgets, information flows, outside relations, power balances and the manager's own time. No extra public resources are likely to become available.

*Limitations.* However, in practice managers have limited time to explore new perspectives or their implications. Furthermore, they accept limited risks and have limited freedom to implement them. Four conditions need to be met for the AKIS perspective to be of practical value: (a) it must be possible within a limited time to construct a comprehensive, locally relevant, and credible model of a particular AKIS, with which managers and key operatives can identify; (b) clear links must be established between such a model and traditional managerial functions, so that any suggested improvements can be implemented through changes in resource deployment; (c) such a model must relate to literature and experiences, or comparisons must be possible with similar circumstances, so that improvements can be recommended with confidence and the risks assessed; (d) power relationships must potentially become visible and part of the analysis, so that the likely reactions of power holders can be incorporated into action plans.

*Applications of AKIS concepts.* AKIS concepts were applied to the dairy industry in Queensland, with which the author was familiar (see Van Beek, 1989). This resulted in a 'model' of the Queensland dairy AKIS in the form of working specifications. The model was all encompassing, in contrast to the extension models traditionally used in QDPI, which link only research, extension and production.

Then an interface matrix of all groups identified as belonging to the AKIS was constructed as a tool for analysis. It provided an overview of all interfaces deemed relevant and allowed linking the AKIS concepts with management of extension and research units. The matrix further showed potential in locating sources of power and in illustrating dominant power connections, a likely basis for power analysis.

The model was constructed from the perspective and with the assistance of the

manager of the QDPI Dairy Field Services section (DFS), responsible for extension and research[1]. It contains all officers who deal directly with the dairy industry full-time. Specialists in other disciplines are located in other branches and serve the industry part-time. The author believes the DFS to have been successful, as defined by Bakert et al. (1986). Key people in the QDPI, the dairy factories, farmers, and its own staff saw it as meeting its objective of introducing innovation.

The DFS manager strongly identified with the model developed, as it confirmed an overall picture which he had developed during the process of forming the DFS prior to the study. The model provided additional insights because it allowed a different perspective. The model was also compared with some of the extension literature (Röling, 1988a) which allowed further insights. In discussions about the value and relevance of this systems approach to his situation, the DFS manager indicated the strengths, potentials, and weaknesses, as seen from his perspective.

In addition to the exploratory and first study reported in this article, the AKIS principles and the matrix were subsequently applied to Queensland field crops and Queensland ornamental industries, which were expected to have less successful AKIS. The three were compared as was the management of related QDPI resources. The comparison supports the hypothesis that (resource) management of QDPI units is likely to have substantial and sometimes unintentional effects on the relevant AKIS as a whole, in addition to pursued internal effects. QDPI Managers may have to consider themselves as ex-officio AKIS managers in addition to their QDPI management role due to their influence on the AKIS.

In a third study, (Frank, Hass, & Van Beek, in preparation), more participatory methods were used to develop a locally relevant AKIS model. These methods involved key persons within an AKIS in the modelling process. Their participation increases the credibility and acceptability of the models and of the subsequent suggestions for change. Such acceptance is seen as necessary for successful change when power is spread throughout the system.

*This article.* This article describes the methods used in constructing the dairy AKIS model and the matrix. It describes links between analysis of the matrix and traditional management functions. It highlights some results and discusses some strengths and weaknesses. The article concludes that the conditions for a practical contribution of AKIS concepts can be met and that further studies are justified.

## Methods and definitions

*Data collection method.* Data collection consisted out of series of interviews with the DFS manager. One interview of two hours was required to introduce the concepts to him and to gain his commitment. During the second interview of one

morning, the working definitions and elements were determined and the matrix was compiled. A third morning was spent discussing the findings and their implications, and the strengths and limitations of the approach.

This method was chosen for its simplicity, as the main focus was on testing and developing the systems methodology. The data are believed to be reliable because of the DFS manager's intimate knowledge of the Queensland dairy industry (see Note 1).

*The systems methodology.* The systems methodology consisted of five steps:

1. define the processes and structures which are the focus of the study, establish the purpose of the study and identify the point of view from which it is conducted;
2. identify the system;
3. develop a matrix of connections;
4. select characteristics for analysis to be used;
5. analyze for ideas on how to change the management of time, staff, budgets, information flows and power.

*Processes and structure.* The focus of the study are the processes and structures through which knowledge and information are generated, exchanged, and used in the dairy industry in Queensland. Elsewhere in these proceedings, the conceptual framework which underpins this focus has been described (Röling & Engel, this volume). The fact that knowledge systems are managed or designed for optimum synergy and performance distinguishes them from 'natural' systems which evolved without planning or deliberate influence (Havelock 1986a). In this context 'managed' does not mean centrally controlled, but the deliberate use of direct or indirect influence.

The purpose of study is to describe the Queensland dairy AKIS as a model and to use this model to test for the four conditions mentioned earlier. The point of view clarifies from whose perspective the system will be described. Different perspectives can lead to different descriptions of the same system. In this study, the point of view is that of the DFS manager, who occupied the most senior position in the AKIS. Although by default, his was the location for overall AKIS management and was believed to be seen as such by many key people in the dairy industry at the time of study.

*Identifying the system.* Human activity systems have seven features (after Havelock, 1986b): (1) a purpose; (2) elements (also called components or sub-entities or subsystems); (3) boundaries; (4) connections; (5) an internal processing routine; (6) input; and (7) output.

The purpose is the reason for the system's existence, be it a natural, a guide or a designed one. Elements are the basic units or building blocks, with the understanding that each element is a full system in its own right. Conversely, each system can simultaneously be an element in many larger systems, called super-systems. What constitutes supersystems, systems, and elements depends on the level of aggregation at which the study is carried out. In this study, the elements

are formed by groups of people defined below, while the principal supersystem is the dairy production system in Queensland. Other supersystems influence the elements as well, sometimes leading to conflicts, and the relevant ones need to be identified. Elements within are distinguished from those outside by vital attributes, the common characteristics which make these elements part of the system and identify the system as a whole (Engel, 1987).

External boundaries are the separations between systems, and are determined amongst other things by the vital attributes of relevance to the study. They can include geographic and industrial aspects. Internal boundaries are the separations between elements and are determined by different attributes, which distinguish between elements. What are relevant boundaries depends on the purpose of the study. The internal boundaries in this study are formed by sets of skills and knowledge related to certain roles, such as production, research or processing.

Elements are linked to other elements by interactions or connections. Connections can be strong and close, as between nearby elements, or weak and distant, as between elements in different systems. The strength of the connection is not necessarily an indication of its importance to the purposes of the system. Connections can also be detrimental to the purposes of the system. This study distinguishes between a connection from one element to another and the reverse connection. Together they form the link between two elements.

The importance of a connection depends on the aspect under study. The interactions of interest to this study are exchanges of information related to dairy production and the use of power and influence. It is immaterial whether communication is for its own sake, as between an extension officer and producers, or is a byproduct of other interactions, such as buying farm inputs. Elements have connections with many other elements, directly or indirectly. Thus an element becomes part of one or more networks formed by the dominant connections. The sum of the networks within the boundaries can be regarded as forming the structure of a system. It is immaterial to the system whether connections and thus networks are official or non-official, formal or informal.

The connections of 'inside' elements with 'outside' elements form the links between the system and its supersystems. Some of these provide the system with various inputs from the outside world. These are transformed through an internal processing routine into a number of outputs, which go back to the outside world, often through different outside connections.

In this article a connection contains the collective real and potential communications from one element or group to another, e.g., from extension officers to farmers. Many different communication or extension methods can be used in a connection. The combinations of methods used in one connection are often different from those used in the reverse connection, e.g., from farmers to extension officers and its reverse. This causes the need to distinguish between the reverse connections within a link.

The number of potential connections grows almost exponentially ($n^2 - n$) with

increasing numbers of elements, e.g., there are 90 potential connections between 10 elements. This becomes a difficulty for overviewing and analysis of a complete AKIS.

*The matrix of connections.* Röling (1988a) suggests a matrix as one of at least eight possible methods to overcome this problem of overview and for empirical AKIS analysis, e.g., to locate malfunctions in the AKIS. A matrix is formed by listing all elements in both the horizontal lines (X-axis) and the vertical columns (Y-axis). The squares (x,y) denote the connection (e.g., in Table 1 '3,10' denotes the connection from 3 (agri-businesses) to 10 (extension), while '10,3' denotes the reverse. The x denotes the activities within the element or subsystem itself. Some of these have been subject of much research, e.g., diffusion theories (Rogers, 1983) would be placed in field '1,1'.

The matrix itself is an empty shell and is only useful in the analysis of relevant aspects or characteristics of the connections. Amongst these can be frequency of use, level of importance to some processes (while often being of little consequence to other processes), costs of maintenance, whether the communications occur naturally or require deliberate action, whether the connection allows clear passage of information or distorts or reduces information.

The exchange of worthwhile information is inextricably interwoven with power and influence (Holt & Schoorl, 1985; Röling, 1988b). Connections thus carry messages related to influence or power as well as information related to knowledge. In this respect, some connections can be harmful to the AKIS as a whole if overused. This can be indicated on the matrix, which can then become the arena for power analysis (e.g., as per Cobb, 1984).

## Results

*Specification.* Applying the methodology to the case resulted, first of all, in working specifications for the study and the AKIS:

1. the system under study is the Queensland dairy AKIS;
2. the focus of the study is on the use of connections, and on the communication methods used in these;
3. the point of view of the study is that of the manager of the AKIS;
4. the purpose of the study is to provide case material for testing the four conditions mentioned.

The Queensland dairy AKIS is restricted to dairy, defined as "the production of milk and milk products". The system includes in principle all animals which can be milked.

The principal supersystem is the Queensland dairy production system, then consisting of some 2,500 farmers along the coast and in near coastal inland, from Southport to Cairns, 3,000 km to the north. These farmers milked some 250,000 cows and supplied to about 20 factories. Other supersystems are the QDPI as a

major administrative, funding, and political system, and the complete AKIS in Queensland, as a major source of new information.

External boundaries are dairy and the state of Queensland, but only with regards to outputs. Inputs are seen as coming from where-ever useful information can be sourced. Internal boundaries are differences in specialist skills or knowledge, such as research skills, knowledge about dairy farming, teaching, or extension skills. These allow people to fulfil a specialist role within the AKIS. Internal boundaries are administrative indications only. They do not imply that people in these elements are restricted to processes requiring those skills. All people in the AKIS use, exchange, and generate new knowledge and information about dairy production in Queensland in their daily work, but with different emphases.

The level of aggregation and analysis (or the hierarchy; Checkland, 1981) is one step above studying the internal working of elements within a boundary. The systems purpose was defined by the DFS manager as: "to contribute to the generation, exchange and use of knowledge required to increase the efficiency in the Queensland dairy production system, while taking into account certain intervening variables". Intervening variables at the time were the need for long term sustainable use of non-renewable resources, market requirements, sustainable lifestyles, public health, and public veterinary health.

The vital attribute to determine inclusion or exclusion is engagement in activities or decisions which directly effect the Queensland dairy AKIS. This includes people who allocate resources to the AKIS, but excludes people who are merely interested. Three further attributes found necessary during the study are: (a) the ability to influence the procedures or power balances in the AKIS; (b) a degree of independence to operate within the AKIS; and (c) some dependence on, or importance to the AKIS.

*The Queensland dairy AKIS elements.* Applying these working specifications to the Queensland dairy industry led to the identification of ten elements:

1. producers of milk from cows;
2. factories processing milk;
3. agribusinesses;
4. teaching organizations;
5. a QDPI artificial insemination and herd recording unit;
6. the QDPI library with access to interstate and overseas information;
7. specialist officers spread throughout QDPI;
8. the QDPI hierarchy with its powers to allocate resources and exercise influence;
9. the DFS research unit; and
10. the DFS extension unit. A number of potential elements were dismissed.

Owners of dairy goats lack influence in the AKIS, while owners of housecows are neither important to, nor depending on the AKIS. A dairy technical support section within QDPI lacks independence in operating within the AKIS. Industry

organizations were seen as methods of communication, rather than as independent elements. The ten elements form the matrix in Table 1. The matrix has 90 connections.

In this study only those connections in which the DFS section was directly involved or those which its manager could directly influence were considered for further analysis. The potential importance to the AKIS manager of the other connections (marked '-' in Table 1), and of the internal processes (marked 'X'), only became evident during the third round of discussions.

Table 1: Connections in the Queensland dairy AKIS which the QDPI Dairy Field Services section can influence or is involved in.

| | PROD | FACT | AG-B | TEACH | AI+HR | LIBR | SPEC | HIERA | RESEA | EXTEN |
|---|---|---|---|---|---|---|---|---|---|---|
| PROD | X | - | - | 3,C | 2,B | 3,C | 2,A | 2,A | 2,A* | 1,A |
| FACT | - | X | - | - | 3,C | 3,C | 3,B | 2,A | 2,A | 1,A |
| AG-B | - | - | X | - | - | - | 3,D | 3,D | 3,C | 2,B |
| TEACH | - | - | - | X | 3,B | - | 3,B | - | 2,A | 2,C |
| AI+HR | 1,A | 1,A | 2,B | 3,B | X | - | - | - | 1,A | 1,A |
| LIBR | - | 3,C | 3,C | 3,A | - | X | 2,A | - | - | 3,A |
| SPEC | 2,A | 2,A | 3,C | 2,B | 2,A | - | X | - | 1,A | 1,A |
| HIERA | 2,A | 2,A | 3,D | - | - | - | - | X | 1,A* | 2,A |
| RESEA | 2,A | 2,A | 3,B | 2,A | 2,A | 1,A | 2,A | 2,A | X | 2,A |
| EXTEN | 1,A | 1,A | 2,A | 3,B | 2,A | 3,B | 1,A | 2,A | 2,A | X |

1 = frequently used; A = very important;
2 = occasionally used; B = some importance;
3 = not used; C = potentially important;
D = not important;
X = internal process;
- = not involved and beyond influence;
* = potentially harmful.

*Selecting of characteristics for analysis.* This study initially looked at two aspects of connections: the potential importance to the AKIS as a whole, and the actual level of use, both as seen by the DFS manager. He further established whether his unit: (a) was involved in the connection; (b) had an influence on it; or (c) was beyond his influence. Two connections were seen to be potentially harmful (marked '*' in the Table) to the Queensland dairy AKIS as a whole if overused in power exchanges (e.g., '8,9': the QDPI hierarchy - the DFS research unit).

Any important connection which was seen as not functioning or as functioning below perceived optimum shows as '3A' (e.g., '6,4', '6,10'). A connection estimated as '3C' (potentially useful, e.g., '7,3') indicates opportunities, while any marked '1' (frequently used) with 'B' or 'D' (some or no importance) could indicate overuse and thus potential areas for savings.

The manager then identified connections in which one or more of his units were directly involved. The DFS Section is directly involved in 28 connections ('1A', '1B', '1C' and '2A', '2B' and '2C') and could be involved in another five ('3A', '3B' and '3C'). It can influence 26 connections, while three are regarded as not important. Eleven connections involving the section are regarded as very important ('A') and 17 of some importance ('B'). Each one of these 28 connections needs supervision and occasional checking on the quality of its contents.

Connections can be linked into chains for further analysis. The chain producers-extension-research ('1,10' and '10,9') had been the subject of extensive study and consultation prior to this study (Dairy Husbandry and Animal Breeding branch, 1988). Other chains (e.g., extension-agribusiness-producers; '10,3' and '3,1', and extension-factories-producers '10,2' and '2,1') were being explored at the time. The latter chain later led to extensive cooperation with, and funding of extension, by processors. The chain producers-hierarchy-research ('1,8' and '8,9') was cause for concern from the manager's point of view, as it can potentially exerting undue influence, when used too much.

*Communication methods used within connections.* A total of 23 extension and communication methods were used in the connections. 17 methods were used regularly: loose leaved books; pamphlets; chance meetings; visits to farms; shops and offices; phone calls; a newsletter; scientific papers; routine reports; workshops; seminars; field days; attending meetings of two industry organizations and boards of factories; and working in various committees and task groups. Seven methods were used infrequently: radio; television; access to computer databases; newspapers; audio and video tapes.

The main methods were described and evaluated briefly, using a format designed for the particular need of the DFS manager. It specified: (a) the connections in which the method was used; (b) its main function(s) in knowledge processes and decision-making; (c) its strengths and side benefits; (d) its cost in terms of money, time, equipment and special skills; (e) any negative consequences and weaknesses; (f) consequences of failure or too much success; (g) the required motivation for use of the method by the receiver; (h) the mechanism which triggers the use of the method by the sender (which can be a management tool for the AKIS manager); (i) any consequences of default if the sender fails to use the method (such as failing to produce the next edition of a newsletter); and (j) how action is recorded (which can be used for monitoring purposes).

The major methods used in each one of the connections in which the DFS was actually or potentially involved were listed in a table. This indicated: the trigger to use the method; its cost in terms of high, medium, or low cost in money and time;

and specific comments. The table highlighted which methods are single or multiple purpose (e.g., field days, seminars, and the newsletter).

The table illustrated the dominant influence of certain connections or chains of connections in terms of cost. In the connection 'extension to producers' ('10,1') a substantial number of high cost methods are used, as it is the traditional area of activity of extension officers. Extension to teaching has no methods, but could be served by including teaching organizations in the send list of the newsletter.

*Comparison with the literature.* The Queensland dairy AKIS was compared with Röling's 12 pathologies (1988a). The Queensland dairy AKIS suffers from three of these:

1. cross-purposes or conflicts between supersystems are caused by the requirements for promotion of research and extension staff, which are based largely on documented and preferably published papers;
2. progressive farmer control is evident from the frequency of use of methods involving progressive farmers. Analysis of power relationships further showed a strong link between progressive farmers and the government and hierarchy;
3. wrong orientation could be a problem, depending on one's view. The AKIS serves progressive large producers very well, but does not serve small farmers, who are forced to leave, nor owners of dairy goats or house cows. This trade-off is believed to be a deliberate choice.

*The effects of systems thinking on previous decisions.* The manager had been under instruction and had a personal desire to establish the DFS section as an 'excellent' unit for research and extension in the Queensland dairy industry. To this end, he had used an unspecified 'overall picture' of the QDPI involvement in the dairy industry. This was meant to assist in breaking down the barriers between extension and research. It was a new and not uniformly welcomed perspective. Decisions taken by the manager and others within this 'overall picture' were:

- four regional surveys of dairy production systems (Dairy Husbandry and Animal Breeding branch, 1988);
- an extensive survey of farmer needs;
- the planned relocation of extension officers, where possible, to research stations;
- the placing of both extension and research officers in one administrative unit, which will be developing one set of operational goals each for southern, central, and north Queensland and which operates from one budget;
- consolidation of all relevant research findings and extension messages into one series of publications, which is for sale as one single loose-leaved publication;
- seeking funds from dairy industry sources on an integrated basis;
- coordination of the DFS's research unit with research units at the Queensland agricultural college and the university of Queensland;
- development of a focal role for DFS in planned coordination of all activities

related to knowledge of dairy in Queensland (only coordination by chance took place at the time, to the perceived detriment of efficiency and effectiveness of the Dairy production system).

Implementing these decisions had involved changes in the management of budgets, staff, facilities, monitoring of performance, and allocation of the manager's own time. This had caused considerable resistance. People from many elements had felt that their personal interests were threatened and had used power and influence to resist the changes.

## Discussion

*Effects of a wider perspective.* The manager identified readily with the systems approach. The value of his 'overall picture' could be enhanced considerably by applying the systems approach, which is openly derived and debatable, but methodically and rigorously applied. Moreover, the resulting Queensland dairy AKIS model provides a comprehensive overview of all elements and connections, while it avoids getting trapped in discussing details about the information passed through the connections. Such a wide overview had previously been missing. The Queensland dairy AKIS model thus formalized and widened the 'overall picture'.

The wider perspective led to a plan to re-allocate supervisory responsibilities. At the time, the responsibility for overviewing every connection rested with the DFS manager, who was under continuous and heavy pressure for time. Analysis of Table 1 and others not shown indicated sets of connections which could be delegated to four other officers in accordance with the main role of their units. This would allow the DFS manager time to concentrate on establishing missing connections. The model supported the changes made previously and provided a framework for coherence between decisions, which until then had taken and implemented independently. It also provided arguments for adhering to these changes and not revert back under pressure.

The wider perspective of systems and supersystems helped to understand and reduce some conflicts by explaining these as conflicts between requirements of supersystems, rather than seeing them as conflicts between individuals. Furthermore, the matrix promised to provide a structure for informed debate (Checkland, 1984). One purpose of such a debate was the channelling of power and influence towards more supportive applications, rather than resistance.

*Links with managerial functions.* One link between AKIS analysis and management of resources other than the manager's time is through re-allocation of staff time. Potentially important, but underused connections may indicate areas to which the AKIS manager could profitably allocate more time or other resources. Initiation of communications in these connections need not involve his own units on a permanent basis to benefit the AKIS as a whole.

A second link with management of especially extension resources is through

analysis of the extension methods used in the main connections in which his units participate. A large number of extension methods can be used in each connection, while some extension methods can be used in many connections simultaneously at little extra cost. Extension methods differ in characteristics as mentioned before. Extension managers have some choice in the mix of methods they employ. A change in methods has effects on budgets, staff selection, training and management, and investment in equipment. Placing the currently used extension methods in the context of the whole Queensland dairy AKIS confirmed decisions to develop multipurpose methods (newsletter, seminars, and large workshops) and to allocate time and funds towards these, away from direct contact through individual visits. This required certain new skills in staff. These new skills however still needed to be included in the reward system.

Different methods can also require different capital equipment which provides links with investment decisions. Also, investments in IT such as computers and equipment which allow direct access to computer databases by all elements, are likely to lead to profound changes in the frequency of use of connections. This can enhance the role of element such as factories in exchange processes, when they want to develop an independent advisory service to their milk suppliers.

A third link with management would be through analysis of skills, equipment and goals of elements involved in the same main roles, e.g., research, and to subsequently develop better coordination and complementarity. This was planned by the manager for the research unit and could have a substantial effect on investment decisions.

*Perceived strengths.* The discussions with the AKIS manager further highlighted particular strengths and needs, where the use of an AKIS model can be uniquely beneficial, as well as limitations which need to be kept in mind. The holistic view embedded in the AKIS and the 'overall picture' highlights the dependence of all elements and individuals on the success of the AKIS as a whole for their ultimate individual success. This may help to break down barriers between people.

There is a need for, but also an absence of, a planned and regular monitoring of the DFS section's and the AKIS effectiveness and efficiency. The recording base for such a 'management information system' about the section and about the Queensland dairy AKIS could be designed around the matrix without much extra cost, as all public service activities are already recorded somewhere. Strategic management skills of the QDPI managers need to be developed, if they are to work within wider frameworks. The AKIS methods can be useful in this training. However, role descriptions, decision-making freedom, performance standards, and moral and legal support need to be reconsidered and confirmed, if AKIS management is to become an official part of the duties of QDPI managers.

*Limitations.* The absence of a dairy goat industry illustrates that an AKIS model based only on what exists cannot incorporate what could be, such as a small but potentially profitable new industry. Information about such potentials needs to come from outside, in the form of questions, suggestions, or challenges. Hence

there is likely to be a need for input by an outside analyst into the design or review of an AKIS. Discussions about desirable changes highlighted the need to incorporate power aspects into analytical processes. Analysis of the existing power distribution suggested that a new dairy goat industry might best be served by an independent AKIS. The incidence in the Queensland dairy AKIS of progressive farmer control (through political influence and the dominating values within other elements), would prevent any substantial re-allocation of resources towards the development of a new industry within the existing AKIS framework.

An AKIS itself must be seen as being part of a larger system of AKIS. The Queensland dairy AKIS concentrates on only one economic activity or enterprise. However, on many dairy farms, the dairy enterprise interacts economically and physically with other enterprises. These other enterprises are served by other units within QDPI, and coordination between several AKIS is thus of obvious importance to producers.

While an AKIS is a powerful way of seeing, it can also lead to 'not seeing'. Some important side effects of being successful remained invisible from the Queensland dairy AKIS perspective. One was the displacement of small dairy farmers, who can no longer keep up with the continuous developments, but have nowhere else to go. The Queensland dairy AKIS has nothing to offer producers who are likely to be forced out of the industry in the next few years.

Furthermore, the Queensland dairy AKIS focuses on one aspect only, the production aspect. While the systems approach can focus on other aspects, the production focus can become so familiar as to be taken for granted without regular strong challenge. The definition of elements may preclude such a challenge. The process of defining working specifications of elements is thus very important. It needs to be reviewed regularly, if the model is to remain actual and relevant to current challenges. If for instance the AKIS had been defined as science oriented instead of production oriented, connections from producers to researchers would be discouraged as interfering with science, rather than encouraged, as orienting scientific goals towards production.

## Conclusions

The AKIS approach has been applied to a successful section of the QDPI and compared with existing management. The concepts were introduced to a practicing manager within limited time. It required considerable preparation by the analyst to bridge the gap between theoretical concepts and the actual situation. A meaningful and locally relevant AKIS model could be constructed with which the manager could identify. An interface matrix depicting connections proved useful as an analytical tool.

An informal perspective of an 'overall picture' had been very useful in guiding DFS redevelopment. The AKIS model strengthened and widened this perspec-

tive. The matrix, with an overview and analysis of extension methods, provides further links with the management of staff, budgets and investments. It re-enforced previously made decisions and the model provided a framework for them. The model will be used in role re-negotiation and delegation of certain supervisory responsibilities, which were not seen as in need of attention before. A locally relevant AKIS model also appears to offer guidance to the setting up of monitoring of the AKIS and the DFS.

The model has been successfully linked with some of the existing literature and so provides new insights and confidence in the suggestions for change. The model has been of substantial assistance in illustrating power relations within the AKIS and in understanding one consequence of these relations, the lack of a dairy goat AKIS. The distinction between systems and supersystems has helped to explain and reduce conflicts as being caused by conflicting demands from competing supersystems.

The approach has a number of limitations. These are not seen as major obstacles, provided the model is not seen or used as the one and only way to look at situations, and provided the model and the working specifications leading to the model are regularly challenged.

As the four conditions for practical value of the AKIS perspective are met, the study has justified further application of the systems approach to other QDPI sections.

## Note

[1] Mr R. Humphreys, whose contribution the author wishes to acknowledge. The fact that his perspective was used in defining the dairy AKIS does, of course, lead to a different result than the use of the perspective of a producer or a factory manager would have done.

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# Moving forces: external pressure and the dynamics of technology systems

D. Kaimowitz

*Knowledge and information systems (KIS) institutions must receive strong and focused external pressure to function synergetically over sustained periods. This external pressure should be exercised by other elements in the system. Without such pressure, institutions and personnel act to fulfil their own social and political needs more than those of their clients, and their effectiveness is inevitably reduced. This article is concerned with the 'moving forces' that instill public agricultural knowledge systems with particular dynamics. The article's objectives are to predict under what circumstances external pressures will occur and their likely outcomes, and to advice KIS managers on how they can be managed. The first section reviews the evolution of the concept of external pressure as a moving force in the dynamics of technology systems. The next four sections examine the roles of policy makers, foreign agencies, farmers, and the private sector, respectively, in pressuring KIS institutions. The sixth section explores how institutions behave without external pressure. A final section looks at what all this implies for KIS managers' 'room to maneuver'.*

## The evolution of the concept of external pressure

Prior to the mid 1960s, social scientists saw technological change as exogenous, produced through random research efforts aimed at improving overall social productivity. Research and extension management, to the extent they were viewed at all, were discussed independently of their context. Two theories, contingency theory in business and the theory of induced institutional innovation in economics, helped change this view. Contingency theory (Lawrence & Lorsch, 1969) stressed the importance of an organization's environment in determining how it should be managed. Using this approach, Lane, Beddows, and Lawrence (1981) examined how the political context influenced the management of large U.S. research and development programs in health and communications. The theory of induced institutional innovation (Hayami & Ruttan, 1971) argued that the

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direction of technological change in agriculture is influenced by national resource endowment and market forces through the interaction among farmers, researchers and administrators in the political arena (Ruttan, 1983).

In the late 1970s, induced institutional innovation gave way to more explicit political economy models of how and when different interest groups organize themselves to influence research and extension priorities (De Janvry & LeVeen, 1983; Guttman, 1978; Huffman & McNulty, 1985; Piñeiro & Trigo, 1983). Heaver's work (1982) on the interaction between bureaucratic politics and external incentives helped to explain how different actors within research or extension institutions were likely to respond to external influences. Soon after, Burmeister (1985) developed the concept of "directed technical innovation" and showed that national governments could act as strong, rather autonomous, forces in the technical change process. Sims and Leonard (1989) pulled the previous literature together in one comprehensive theory for the specific case of agricultural technology in developing countries. They coined the term "default incentives" to describe the behavior researchers and extension workers would exhibit in the absence of pressures from outside their institutions. Whenever default incentives apply, research efforts are unlikely to be relevant to farmers' needs, particularly those of resource poor farmers. Adoption will probably be poor, as will the integration between research and technology transfer activities.

In a separate article, this author has synthesized Sims and Leonard's conclusions and built upon them to develop further hypotheses (Kaimowitz et al., 1989). Researchers from eight different countries working on the research-technology transfer linkages project of the International Service for National Agricultural Research (ISNAR) then carried out case studies which examined the hypotheses' validity. This work, and other examples collected by the project, form the basis for the remainder of this article.

## National policy makers

Generally, national policy makers intervene forcefully in technology issues only in exceptional circumstances, such as disease outbreaks, major crop shortfalls, rapidly rising food imports, rural unrest, a highly publicized international breakthrough in technology, or a radical change in government. They exert more consistent pressures only in certain cases, where one or a few crops play a dominant role in society (e.g., rice in Asia or sugar in the Caribbean). Chile and the Dominican Republic provide us with two typical examples of national political interventions.

In Chile the Pinochet government came to power in 1973 determined to reduce the role of the public sector and the politicization of certain public services. It abolished the public extension system and privatized most technical assistance tied to supervised credit. Soon after, the public sector agricultural research service

(INIA) was told to either prove it could have a significant impact on production (particularly for exports or import substitution) or else face major budget cuts. INIA rose to the challenge by creating Technology Transfer Groups. These are specialized groups of 10 to 20 producers, organized by INIA technology transfer workers, to obtain research results, share technological experiences, and give input to INIA's research program. INIA's target group was the country's 30,000 largest producers, who, while only comprising 25 percent of the farmers, produce 70 percent of the agricultural output. By concentrating on these farmers, INIA felt they could have the quickest impact on national production and gain the support of a constituency with substantial influence in the national government.

Estimating the program's impact on national production is difficult. Nevertheless, the yields and production of agricultural exports and import substituting goods rose rapidly, and most observers credit INIA for at least part of this increase. Undoubtedly, the program improved the relations between research and technology transfer activities for large producers (Goldsworthy & Kaimowitz, 1988).

Of all the crops in the Dominican Republic, the agricultural KIS supporting rice, the country's principal staple and the focus of major agrarian political struggles, has been the most successful and had the strongest inter-agency links. It is no coincidence that the central rice research station was created in 1963, soon after the assassination of the dictator Trujillo and the Cuban Revolution, by a government worried about rising urban food prices and rural unrest. The rice technology institutions made their next significant advances in the mid-1970s, when the government was preoccupied with rice and had just confiscated most of the rice lands, created rice cooperatives, and broken the power of the rice processors and merchants. In that period inter-agency coordination for seed multiplication and distribution improved and a national rice training center (CENACA) and separate rice development agency were created with strong links to research. Rice yields more than doubled between the early 1960s and the mid-1970s. Some, though not all, of this change can be attributed to national government pressure on the KIS. The international availability of new 'green revolution' rice varieties and strong long-term support for rice research from Taiwan were other important factors (Indarte, 1989).

Other examples analyzed in the Linkage project's case studies include: the case of the Tongil rice varieties developed under presidential leadership to achieve rice self-sufficiency in South Korea after U.S. food aid was withdrawn (Burmeister, 1985); the Masagana 99 rice production program, comprising research, extension, mass media, storage, and credit components, launched in 1973 by Philippine government when facing crop failure (Sison, 1985); and the promotion of cowpeas in Senegal in 1985, when the government unexpectedly found itself without sufficient seed to supply the, politically important, peanut farmers (Bingen et al., 1988).

These cases have common features: some event or events triggers the direct

intervention of high level Ministry officials or national policy makers. In response, these actors define clear specific goals which they expect the KIS to accomplish, and: (1) provide additional resources; (2) identify and overcome gaps of bureaucratic bottlenecks in the system; (3) give recognition to achievers and blame laggards; and (4) force all the related agencies to be, or at least appear to be, full team players in a common effort.

In most cases studied, pressure from policy makers led to greater system synergy and improved institutional performance. Nevertheless, there are a number of important caveats.

First, policy makers do not always adequately understand the problems they wish to see solved. Thus they may demand results which are not feasible or cost-effective, overlook potential dangers or secondary effects, and place undue emphasis on the symptoms of problems, rather than underlying causes. In South Korea (Burmeister, 1985), new varieties were pushed through the system before being adequately tested. This action led to devastating losses when these varieties performed poorly in the face of rice blast and frost. Researchers had warned of these problems, but policy makers insisted upon quick results.

Second, the effects of political pressure on technology development are often short-lived. The rice program in the Philippines failed to maintain its momentum over the long-term. Cowpea success in Senegal was even shorter. Serious institutional pathologies emerged after only one year.

Third, policy pressures for increasing production may lead to greater inequality. It is usually easier to achieve rapid results by concentrating on larger farmers and favorable agro-ecological regions. This point comes out clearest in the Chile case.

Fourth, pressure from national policy makers is not a viable means of improving the day-to-day management of national research and technology transfer institutions or dealing with the wide variety of unexciting, but necessary, technological issues that must receive sustained attention.

### Foreign agencies

This term includes multilateral and bilateral aid agencies, international agricultural research centers (IARCs), and externally sponsored non-governmental organizations, although most of the following discussion focuses on aid agencies. Their ability to provide substantial individual incentives and their emphasis on constant review, monitoring, and evaluation make them particularly powerful actors in determining whether KIS institutions act synergetically and show high performance. Until recently, most foreign agencies regarded research and technology transfer as separate systems. This approach is now changing, and they are making improved links between the two a precondition for further funding.

In several cases studied, foreign agency pressure increased the synergy among agricultural KIS institutions. Typical examples stem from the World Bank's

Training and Visit (T&V) system of extension, which has helped to establish formal links between research and extension in many countries. In Bangladesh (Abedin & Chowdury, 1989) it played a role in creating several mechanisms to link researchers, extension workers, and farmers through the extension & research (E&R) Project. These mechanisms included: regional and district technical committees; internal review workshops; innovative farmers' workshops; monthly extension-research training of extension workers. The project provided an official mandate for promoting links between research and extension and had adequate financial support, manpower, and transport facilities. For about five years, the project positively affected KIS synergy. It fine-tuned and disseminated various national research recommendations, identified numerous farmer innovations, improved upon them, and incorporated them into extension recommendations. Later, however, the links became weaker.

Similar stories have been documented for T & V in Sri Lanka (Seegers, 1988), the Ghana Grain Development Project (Annor-Frempong, 1988), the PROGET-TAPS research and technology transfer project in Guatemala (Ortiz et al., 1989) and a Dutch technology project in Colombia (Engel, 1990).

Donor pressure, exercised through project design, control over funds, the use of material incentives, consultancy reports and at times intellectual leadership, resulted in increased intra- and inter-institutional links and higher institutional output. In some cases research became more relevant and applied. Higher access to resources explains only part of the results. Making strong system links a clear objective and assigning specific resources to develop them, constant monitoring of performance, and flexible resource allocation were also important.

The clearest weakness of foreign agency pressure is the difficulty in sustaining activities organized as projects. KIS synergy and output tended deteriorate when the funding ended. Second, foreign agencies often neglected the problem of weak national constituencies for the technological activities they support. They liked to develop general institutional models and replicate them widely. The clearest example is the rather unsuccessful attempt to reproduce the U.S. land-grant university model, which failed largely because of its inability to duplicate the pressures that farmers organizations and government place on universities (Sims & Leonard, 1989). Third, in some countries competition between foreign agencies has negatively affected synergy within the national system. National institutions associated with a donor may be reluctant to share their access to donor resources or may feel less dependent on other national agencies to carry out their mandate. Lastly, donor pressures may force leaders of institutions to indulge in 'window-dressing'. For example, if improvement in research-technology transfer links is a precondition for external financing, committees may be constituted and documents published to create the illusion this is under way; but such maneuvers may bear little relation to the real situation (Wijeratne, 1988).

**Farmers and their organizations**

"There is considerable evidence to suggest that the strength and character of farmers' organizations are the single most important determinants of KIS institution effectiveness. The importance of farmers' organization is that they directly represent the users of agricultural research. To the extent that they are effective in transmitting the needs of their members, they will demand relevant research, press for integration of research and technology transfer, and, as a consequence, promote adoption to a greater degree than do any other actors in the political or bureaucratic system. The managers of research stations and extension organizations frequently regard the interventions of farmers' organizations as technically ill-informed, short-sighted, and generally a nuisance. Yet these organizations are vital in keeping research and extension on their toes, exerting pressure on them to integrate, and providing political support for better funding and policies for agriculture as a whole" (Sims & Leonard, 1989).

Rogers et al. (1976) cites "a high degree of user control over the research utilization process" as one of eight factors which made the U.S. extension system successful. Farmer pressure implies that farmers have some power to ensure their preferences are considered. This power may come from funding research or extension institutions, membership in decision-making bodies, or participation in other forums where farmers can express their needs and research or technology transfer institutions feel obliged to consider them. Colombia and Israel provide two typical examples of farmer pressure.

The Colombian Rice Growers Federation (Fedearroz) has helped, for over thirty years, to define technological constraints and seek out opportunities to overcome them. It has accepted some technological responsibilities, including, at different times: seed importation, multiplication and distribution, rice extension, training and materials production and adaptive research. Fedearroz has financed public rice research, seconded agronomists to the public rice research program, and made farmers' concerns known to rice researchers in several institutions. It has consciously and successfully sought to bring together the different KIS institutions working on rice, particularly regarding new varieties. These efforts helped to rapidly improve rice yields in the 1960s and 1970s. Currently the system is involved in a major effort to reduce production costs (Agudelo & Kaimowitz, 1989).

Practically all farm settlements in Israel are affiliated to the Agricultural Centre. It advises the national committee which makes agricultural research policy. "Israeli farmers also sit on the boards of the para-statal, regional R&D authorities. Farmer representatives often hold a university degree or have actively participated in regional research activities, and thus have an understanding of research problems" (Blum, 1988). About half of the money for agricultural research comes from farmers, either through a value-added levy or through rural, regional councils and farmers' organizations. "The latter two sources finance

regional field trials, over which regional farmers' representatives have the controlling voice" (Blum, 1988). The distribution of funds between research projects financed by the value-added levy is decided in some 30 Branch Directorates, one-third of whose members are farmer representatives (Blum, 1988).

Pressure on KIS institutions is stronger when farmers are: affluent; politically influential; educated; motivated to invest; already users of research-generated technologies; and able to exercise monopoly power to reap the rewards of technological change. Homogeneous production systems, concentration of production in particular regions, and production of crops of national political or economic importance also favor producer pressure (Piñeiro & Trigo, 1983).

Since farmers' livelihoods depend on the technology they use, pressure for technological services may be easier to sustain, where it exists, than that of policy makers or donors. Like other external actors, however, farmers' organizations tend to concentrate on more immediate and obvious problems and to seek short-term solutions. The main criticism of farmer pressure is that it may bias agricultural research and technology transfer activities away from less organized (and generally poorer) farmers and away from ecological and consumer concerns.

### The private sector

Private companies influence public sector performance directly and indirectly. Examples of direct influence are representation on public advisory boards, funding of public research projects, direct contact with researchers and technology transfer workers, and private (or public) delivery of publicly (or privately) developed technologies. An example of indirect influence is the implicit competition that takes place when private and public sector agencies are involved in similar activities. The degree of private sector involvement and its influence on research and technology transfer depends on potential market size and on government regulations and incentives.

An important aspect of private sector pressures on an agricultural KIS is the influence exerted by large plantations and processors, particularly those with monopoly power. These concerns are usually in a position to finance technological activities and to make full use of new technologies: sometimes they develop and deliver technologies themselves, sometimes they contract out these activities to the public sector or a private company. Two examples from the Philippines and Costa Rica illustrate private sector pressure.

When the Ciba-Geigy company learned that researchers at the University of the Philippines Los Banos (UPLB) had obtained promising results from applying the pesticide Ridomil on corn seeds to prevent downy mildew, it provided funds to complete the research. The company remained active as the research proceeded and produced and delivered the chemical and information about it. Ridomil's continued use can be credited largely to the company's sustained promotional ef-

forts (Bernardo, 1989).

Macademias of Costa Rica, a company that began to grow and process macademia nuts for export in the mid-1970s, has maintained close informal relations with the few researchers working on macademia nuts and with agronomists providing technical assistance to macademia nuts producers. In recent years a national macademia nuts research and technology transfer program was formulated. This program brought together public and private sector efforts concerning macademia nuts. Macademias of Costa Rica played a subtle, but key role through its owners' membership on governing boards, and by providing valuable information to program members. Thanks to strong external demand, public/private sector coordination in credit and technology, and the activities of Macademias of Costa Rica, macademia nut production has risen very rapidly (Coles, 1990).

The biggest concern with private sector pressure, as with pressure from large farmers, is the possibility that it will bias public activities away from the social needs of small farmers, urban consumers, the environment, and occupational health and safety.

**Low external pressure**

What happens when there is little external pressure? Resources decline for technology development and delivery. The institutions lose their focus, 'spin their wheels', and often undergo frequent modifications. There are few results. Two examples tell the story.

Maize is one of Costa Rica's basic foodstuffs. Resources for maize research and extension have always been rather limited and have tended to decline. Until recently maize producers were unorganized. National policy currently favors importing basic foodstuffs rather than subsidizing their production. Maize research concentrates on breeding, not necessarily because that is most needed, but because the staff is available. Relations between researchers, extension workers and farmers are limited. There are no clear goals and few incentives for greater efforts. The research and extension division have undergone multiple structural changes, but little has happened on the ground. None of the varieties produced have been widely adopted. Yields are stagnant (Palmieri, 1989).

The second story comes from Huila, Colombia. In 1976 the province of Huila produced one-third of the beans in Colombia, where beans are an important food crop. Most of Huila's 10,000 bean producers grow various crops. They tend to be small and poorly organized. Beans have never been politically important. Various donor projects have come and gone. Researchers and technology transfer workers have conducted nine different diagnoses of the technological constraints on the region's bean production, often completely ignoring the previous studies. There has been rapid turn-over both of personnel and programs, and, except for during

brief periods of project funding, few resources to conduct research. Relations between the few researchers working on beans and technology transfer workers have been weak and occasionally hostile. Today, after 30 years of research and extension work, bean producers in Huila use the same varieties as in the early 1960s. Yields have been stagnant for at least ten years. The percentage of national bean production coming from the region has dropped to less than one quarter (Urrego, 1989).

## 'Room to maneuver'

The previous discussion portrays external pressure as an independent and exogenous variable which drives the actions of agricultural research and technology transfer institutions. This section briefly discusses the options available to research and technology transfer managers, their 'room to maneuver'.

If external pressure already exists, managers can work to sustain it and minimize its negative effects. They can communicate with those exerting pressure and try to clarify what is and is not feasible. Strategic planning can be used to take the initiative, and not only respond to external pressures. If activities are institutionalized, they may be more immune to fluctuations in external pressure. Managers can allocate their existing resources to attract additional resources and to make high profile endeavors more likely to succeed (Martinez, 1988).

If there is little external pressure, managers can try to provoke it. They can seek to catch policy makers' or donors' attention. In some countries, research or technology transfer organizations have fomented farmers' organizations or actively sought joint ventures with private companies.

Trying to proceed without external pressure probably is not a viable alternative. This author, at least, has been unable to identify highly successful situations without identifiable external pressure, in part because, unless external actors are interested enough in technological institutions to pressure them, they are unlikely to provide the resources these institutions need to operate effectively. Without external pressure, the best managers can realistically hope for may be localized achievements, not high performing, synergetic knowledge and information systems with a great impact on production and rural livelihoods.

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# Knowledge management in agriculture: building upon diversity

P.G.H. Engel

*Knowledge increasingly has become a vital resource. Within our communities, institutions, and organizations, practical insights are needed for optimizing its use. Knowledge management needs to become an object of study. This article deals with two issues. First, using both knowledge systems concepts and tools, and insights gained from comparative research, it explores the vital qualities of agricultural knowledge systems. These qualities, like the multiplicity and relative autonomy of actors, the level of integration reached through linkage mechanisms, and the coordination needed to overcome default situations, might provide leverage points for effective knowledge management. Second, it probes into a more specific definition of the tasks and areas of attention of the knowledge manager. Knowledge management can focus on various levels of a system (e.g., the individual, organizational, or system level) and can make use of a variety of instruments and skills.*

## Vital qualities of agricultural knowledge and information systems

An effective agricultural knowledge and information system (AKIS) makes available the necessary intermediate outputs (e.g., technologies, software, expert systems, trained professionals, and information) necessary to continuously innovate and develop agriculture. These knowledge products constitute the 'state of the art' in agricultural knowledge and information. AKIS performance can be measured in terms of its contribution to sustained agricultural adaptation and innovation. The definition of the type of innovation desired, and the direction of change it implies, are the outcome of a political process. They seldom are the responsibility of the actors in the AKIS alone. Societal objectives (clean drinking water, fresh air, healthy forests, rural employment, an attractive landscape) play an increasingly important role, where formerly on-farm productivity was the main yardstick. Optimum performance depends upon the political, administrative, technical, and economical environment of the system. International and national

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agricultural trade and price policies, rules and regulations, and environmental, educational, and research policies, need to provide incentives for, rather than impediments against, achievement of the type of innovation desired. Resources provided should enable the system to perform its tasks adequately.

*Multiplicity and relative autonomy of actors.* AKIS actors are many: farmers' organizations, cooperatives, specialized services, and groups or study clubs; agro-based industries; public and private research, extension, and training institutions; agricultural press and information services; agricultural policy units; and formal and informal networks of many kinds. More recently, environmental and consumer groups claim an increasingly important role. The multiplicity found within agricultural knowledge and information systems has its roots in two simultaneous processes:

1. functional specialization; and
2. system segmentation.

Functional specialization refers to the division of labor among actors, such as policy makers, research institutes, extension agencies, education and farmers' organizations. Each process occupies its 'niche' on the science-practice continuum, and develops a relative advantage based on it.

System segmentation refers to the process by which certain categories of producers are singled out, or single themselves out, because of common elements in their situations (e.g., for targeting sales), shared interests (e.g., tomato marketing), or a common strategy (e.g., biological pest control). Other actors may then target their services and support to such a category. The multiplistic character of agricultural knowledge systems is invigorated by the relative autonomy that characterizes the actors. Each acts according to a particular strategy and operational agenda and uses resources, intellectual and otherwise, to achieve long- and short-term objectives. AKIS performance, therefore, has to be envisaged as the combined outcome of the policies and actions of many, not necessarily cooperating, actors.

*Diversity in sources and types of knowledge and information.* Since all actors are at the same time sources and users of knowledge and information on agriculture, the multiplicity described above translates itself in a large diversity in sources and types of knowledge and information. Producers no longer rely solely upon their own practical know-how and research-based technical knowledge. Marketing knowledge and information provided through cooperative auctions or private advisory services, play increasingly important roles. Also, policy-related knowledge and information, produced by EEC or national policy bodies, increasingly determine farm results. Similar comments can be made for extensionists. Recent research suggests that exposure to, and integration of, many different types of knowledge and information, through active involvement in a number of different networks, plus ample availability of information of all sorts, are crucial to an extensionists' effectiveness in modern agriculture (Engel, 1989).

*Integration.* To successfully make available 'state of the art' knowledge and

information among its actors, a continuous circulation, or rather 'alternating current' of knowledge products has to take place within the AKIS. Evidence (Röling, 1988; Engel, 1990) suggests that the effective AKIS exhibits high levels of integration with strong links among core actors. Moss Kanter (1983) and Wissema and Euser (1988) stress the importance of cooperation and integration of efforts for industrial innovation. Specific arrangements for organizing links are called linkage mechanisms (Kaimowitz et al., 1989). In more complex systems, linkage mechanisms become more sophisticated and diverse. A certain redundancy in both formal and informal linkage mechanisms is sometimes reported as having a positive impact on integration (Grooters, 1990). The current of knowledge (half) products leads to chains of product transformations, when each actor works the products received into specific new ones, anticipating the demands of his/her particular clientele. The circulation itself may be based on informal transactions, barter (e.g., informal know-how trading), or sales (e.g., patents, licensing, consultancy), or may involve regulated transfers (e.g., pre-competitive cooperation, project groups, meetings) depending upon the relationship among the parties, the expected benefits, and the knowledge products involved. Within the highly differentiated AKIS, both vertical and horizontal integration require attention. A network, in fact, is a number of individuals within the system that exhibit a high level of integration. This point explains why in situations where vertical integration, and thus system segmentation, is dominant, informal networks often exist to bridge some of the gaps (e.g., industrial know-how trading) (Carter, 1989).

*Coordination.* Reasons why certain systems exhibit high levels of integration, while the state of others can best be characterized as 'entropy', is the object of various international studies (e.g., Kaimowitz et al., 1989). One line of explanation singles out incentives. Wissema and Euser (1988) speak of creating "win-win situations" as a condition for successful cooperation in industrial innovation. Without such incentives, the system leaps into 'default', where ideas and initiatives are suffocated and innovativeness is stifled (Moss Kanter, 1983). Sims and Leonard (1989) suggest four possible parties that hold the key to positive incentives in the AKIS: national policy makers; farmers' organizations; agro-industry; and financial donors. The strong influence of agricultural producers on the Dutch AKIS is well known. In Europe, other strong candidates include the EEC, and environmentalist and consumer groups. Secondly, an increasing amount of evidence suggests that networks of individuals play a pivotal role for maintaining the current of knowledge (half) products, and for sustaining innovation (e.g., Carter, 1989; Wissema & Euser, 1988). Field research in The Netherlands and Colombia corroborates the importance of both formal and informal networks in producing intermediate outputs within the AKIS (Engel, 1990; Grooters, 1990).

## Knowledge management for sustained agricultural innovation

*Knowledge management: walking the tightrope.* We have identified multiplicity and diversity as inherent qualities of agricultural knowledge and information systems, and recognized them as related to the vitality of the system. Also, they relate to the adaptability of the AKIS to the demands of modern agriculture. Multiple systems, capable of handling knowledge and information from a diversity of sources and types, are potentially well equipped to make rapid adjustments to unexpected changes in demands and circumstances. Also, they relate naturally to a multi-functional, sustainable agriculture that does not solely stress productivity values, but also societal values of a less quantifiable nature: clean drinking water, fresh air, healthy forests, rural employment, and an attractive landscape.

At the same time, we have argued that strength in innovation does not stem from multiplicity and diversity alone, but also needs a degree of integration and coordination. At the right place, at the right time, conditions must be created and links activated to make the system work. To characterize the state in which AKIS actors begin to reinforce each other's contributions to sustained innovation, the term 'synergy' has been introduced, as opposed to entropy, or inertness (Röling, 1988). Synergy does not imply the non-existence of segmentation, nor the absence of conflict amongst system actors, nor does it refer to a low level of system-environment interaction. On the contrary, as we have shown above, segmentation, conflicts of interest, and environmental pressures are natural attributes of the AKIS. Synergy refers to the existence of a successful balance between adequate multiplicity and diversity, on the one hand, and effective integration and coordination, on the other. Establishing such a balance can be taken as the overall objective for knowledge management.

*Multiple actors, multiple interventions.* In the AKIS, management interventions are made by many different individuals, at various levels of aggregation. Generally, not one single management unit can be identified, nor one central manager. Components will have their own managers and responsible strategists. Certain segments or functional units may show some degree of unified management, but that does not, generally, hold for the system as a whole. Multiplicity in systems is reflected in a large variety of managers and management styles. Also, knowledge management takes place at different levels of aggregation. First, at the individual level, farmers, extensionists, and researchers can be considered knowledge managers 'avant la lettre'. Second, we can look at knowledge management within networks of individuals. Thirdly, we may focus on the management of knowledge and information within an organization or institution. And finally, we can consider the management of the AKIS as a whole. In the following paragraphs some of the main issues related to knowledge management at each level are briefly outlined.

**Knowledge management at four different levels**

*Individual knowledge management.* Farmers are not recipients and reproducers, but also are creative managers and integrators of knowledge and information from a large number of sources, including their own practical experience and that of their friends and colleagues. Farm related communication patterns reflect diversity (Schiefer, this volume), and different groups of farmers develop significantly different management styles in the process (Bolhuis & Van der Ploeg, 1985). Extensionists create and defend a surprising degree of autonomy in handling knowledge and information, against centralist tendencies to standardize their behavior and messages (Wagemans, 1987; Engel, 1989).

Individual competencies include skills in defining problems and information needs; acquiring, selecting and processing information; validating sources; storage and retrieval; exchanging information; and, finally, learning skills, that is, the ability to draw relevant conclusions and lessons from the information, and to incorporate these into a permanent knowledge base or rationality. This rationality is of an adaptive kind, firmly rooted in personal experiences, efforts, reflection, and learning in everyday life while managing one's work (Nitsch, this volume). Support for individual knowledge management requires recognition of the differential effect of different styles of farm management and of different communication patterns, while providing opportunities for individual improvement of skills. Moreover, in handling such diversity of sources and types of information as farmers and extensionists do, "it is not a matter of doing everything right, rather, it is a matter of getting the right things done" (Nitsch, 1990).

*Knowledge management in networks.* A knowledge network is defined as a number of individuals who share knowledge and exchange information concerning a specific field of interest, or knowledge domain. Knowledge networks may exist within organizations, or across organizations and institutions. They produce certain benefits for their members or sponsors, and exhibit different levels of integration and formal regulation. The rules that govern knowledge sharing and information exchange in networks are only partially known. Reciprocity is often stressed as a critical success factor in information barter. Rogers and Kincaid (1981) emphasized the "strength of weak ties".

The rules of information barter versus commodity barter have yet to be explored exhaustively. Yet, it is clear that "informal know-how trading is a robust institution that is well adapted to the special requirements of informational exchange" (Carter, 1989). Most participants of effective knowledge networks share a common rationality, that is, their knowledge base is similar to such a degree, that interpretation of each others' information becomes easy and fast. Also, informal networks generally are embedded in long-standing social relationships, mutual understanding and trust being essential to facilitate the sharing of knowledge and information. Networks can be spontaneous and totally informal, or can be designed to serve a purpose (c.f. Von Hippel, 1987).

Ongoing field research shows ample evidence of the use of ad hoc task groups within the Ministry of Agriculture of The Netherlands, as a tool, either to integrate different types of knowledge from various sources at different levels into one product, be it a research proposal, a policy statement, an extension bulletin, or for the sake of information sharing itself (Engel, in prep.). R&D projects within large organizations are another case in point. In agriculture, certain farmers participate in informal networks with extensionists, suppliers of services, researchers, and policy makers, more than others (e.g., Grooters, 1990). Increasingly, evidence shows that networks which are successful in developing and disseminating new technologies, or other knowledge products, such as the Dutch study club networks in horticulture, exhibit high degrees of user control.

*Knowledge management at the agency/organization level.* At the organization level, knowledge management is concerned with the monitoring and adjustment of the current of knowledge (half) products, and those knowledge related processes vital to the organization's success. Internally, knowledge management tasks may include:

1. monitoring and evaluation of the circulation of essential knowledge (half) products;
2. development of a corporate language and culture concerning the generation and use of vital knowledge and information;
3. appraisal and adjustment of internal communication, or linkage mechanisms and, where necessary, the design of new links;
4. mapping, organization, and management of the systems' knowledge base, including the development and use of a company thesaurus, reporting systems, in-service training programs, information systems, and other instruments;
5. formation of knowledge networks or task forces on strategic issues, filling (expected) gaps in the organization's knowledge base;
6. appraisal and, if necessary, modification of incentive structures; and
7. review and allocation of resources to alleviate existing bottlenecks.

Managerial decisions, or influence, may also have to be extended to the structural arrangements within the organization, and their consequences for knowledge and information flows and linkage management. A regular and thorough appraisal of (potential) blockages to system performance, might include the identification of 'fatal gaps' in functional calibration (McDermott, 1987), or tracing other structural 'AKIS disorders' (Röling, 1989).

Externally, the knowledge manager is concerned with the management of interfaces between the primary organization and external sources and users of knowledge and information. This requires communication skills and skills for handling social relationships and informal networks; awareness of the organization's external image, and its reliability as source and user of knowledge and information; awareness of the possibilities to influence, rather than control, the activities of other actors of the AKIS; and abilities to monitor and optimize the

actual use and effectiveness of information exchange relationships (when does "the well run dry"?). At the same time, it requires the ability to assess one's information needs, and those of others. Lastly, as knowledge and information become commercial 'goods', the manager must find ways and means to assess, negotiate, and regulate transactions of knowledge and information between (staff of) the primary organization and others.

*Knowledge system management.* At this level, knowledge management aims at optimizing overall system performance. It concerns interactions between autonomous or decentralized (sub)systems. Unified management is, generally, impossible. Instead, the focus is placed on enhancing synergy among actors. Ongoing research (Engel, in preparation) suggests the following areas merit particular attention from knowledge managers at the (sub)system level (see also Röling, 1989; Verkaik & Dijkveld Stol, 1989):

a. developing a shared culture, policy, and purpose;
b. development and maintenance of a shared language and thesaurus, facilitating exchange of experiences and information;
c. avoiding reverse incentives, such as unspannable social distances among actors blocking formal and informal communication;
d. enhancing links and institutional articulations at strategic interfaces;
e. enhancing the use of informal networks (e.g., the support of electronic media);
f. linking and/or integration of existing computer-based information systems within the AKIS;
g. monitoring functional calibration, enhancing strategic cooperation among key actors;
h. segmenting the area of concern into useful knowledge domains, around traditional and nontraditional user groups;
i. enhancing user control, through political, market, or technical coordinating mechanisms;
j. strengthening system responsiveness to societal objectives, environmental influences, market opportunities;
k. avoiding system isolation from external sources of knowledge and information, or from nontraditional target groups;
l. strategic investment in physical infrastructure, human resources and programs, and financial flexibility in funding;
m. identification of key system segments, balancing resource allocations according to performance requirements;
n. developing AKIS management information systems, their design, operation, potential, and limitations.

## A final note: who walks the tightrope?

Knowledge management is the task of many and represents an ideal opportunity to 'pass the buck'. Agricultural knowledge systems in disarray, all over the world, speak for themselves. Resource squeeze, decentralization, privatization, and commercialization (phenomena that in many ways are hardly understood) affect traditional ways of generating, sharing, and using knowledge and information in agriculture. Where does the buck stop? Knowledge management has become one of the major development challenges for the nineties. Moreover, no one single or inflexible approach can do the trick. Such simplicity is not compatible with natural and social diversity, nor with human creativity and its demands. Building upon diversity, trying to do some things right, might be the best motto for many years to come.

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# Reorganizing the Dutch agricultural extension service: the IKC in focus

J.T.M. Bos, M.D.C. Proost, and D. Kuiper

*Recently, the Dutch government has reorganized its agricultural extension service. A new structure was designed, which implied a rearrangement of positions and tasks. Furthermore, it was agreed upon that in the future farmers would be charged for the services provided. This article summarizes this reorganization, which was effectuated at the beginning of 1990. It will especially focus on a new institution that is supposed to play a major role in the Dutch agricultural knowledge and information system: the Information and Knowledge Center (IKC). The article consists of three parts. First, a brief overview of the situation before the changes is given, including the motives behind the changes. In the second part, the new structure is presented and the IKC is highlighted, focussing on its position and tasks in the system. Finally, some of the first experiences with the new structure are reported.*

## Before the changes

Farm management is a complex process. To allow careful decision-making much information on the biological, technical, economical, political, and social aspects of agriculture has to be acquired and processed (Nitsch, this volume). The mass media (such as specialist farming journals) keep farmers well informed on a number of important topics. They provide current information (e.g., on market prices and trends, social events, courses), background features (e.g., on political, social, or environmental issues), or might introduce farmers to agricultural innovations (Kuiper & Van Woerkum, 1991). Although information delivered by mass media may satisfy part of farmer's requirements, when specific questions arise, when problems need to be solved and important decisions are about to be made, direct communication with people one trust (such as colleagues and professional advisers) remains indispensable (see e.g., Fearne & Ritson, 1989)[1].

Information from colleagues is highly valued by most farmers. For this reason many formal and informal contacts among farmers exist, which allows e.g., direct

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exchange of practical experiences. In addition, most farmers have established extensive contacts with commercial representatives from trade and industry, like cooperatives and input suppliers (Nederhof et al., 1990). Their advisory services are given in addition to the sales activities, and mainly concentrate on specific technical aspects of farming, such as the use of compound feed or pesticides.

When farmers need independent farm management advice that takes more aspects into consideration, and examines the farm as a whole, many turn to the government extension service. It provided, beside distinct farm management advice, a more educational type of agricultural extension (e.g., by supervising farmers study clubs and organizing excursions) (DLV, 1990).

Farm visits, direct contact with farmers to answer questions and solve specific problems, were under the task of 26 Regional Advisory Offices (Wielinga, 1988). Each of these offices served a special sector (e.g., horticulture) within a distinct territory. An office was staffed with extension officers, branch experts, subject-matter specialists, and a regional director. The extension officers were often generalists and provided the actual extension (mostly through farm visits) free of charge. Their main tasks were to improve the entrepreneurial qualities of the farmer, to give advice on technical problems, to explain government policy, and to promote the dissemination of research findings (Blokker & De Jong, 1985).

In their daily routine the extension officers were supervised by a branch expert. When extension officers needed information on a specific technical issue they could turn to the subject-matter specialists for assistance. It was their responsibility to keep up to date with the latest research findings and technical developments in their field through regular contacts with the research liaison officers of the National Advisory Offices.

These liaison officers were supposed to play a very important role in the Dutch AKIS. Their tasks were threefold: to pass the problems related to agricultural production on to the research organizations, to make research results available to the subject-matter specialists and branch experts, and to support the departments of the Ministry of Agriculture in policy development. The research liaison offices were therefore located at the different research institutes, according to their specific disciplines or branches.

When we look at farmers' opinions on their contacts with the extension service, market research reveals that for most branches farmers were satisfied with the extension received (Van Overveld, 1987; Van Gestel, 1985). This should not surprise us, as research shows that most extension officers tend to be very perceptive to what farmers think of their performance. Their opinion is often given more weight than the opinions of the branch expert or regional director (Bos & Burgers, 1982).

"Why should a government want to change an extension system that is appreciated by the farming community and has proven to be successful?" one might ask. There are some valid reasons for doing so. First of all, the government wanted to reduce its apparatus. Budget constraints made it impossible to maintain

its financial support at the usual level. Instead of opting for a serious cutback in the services provided, the government decided to partially charge the farming community for the extension it received. In return farmers would enhance their influence on the extension given, which was believed to stimulate the market orientation of the service (see also Röling & Engel, this volume; Kaimowitz, this volume).

The discussions that followed this decision made it clear that, given the interwoveness of tasks within the existing system, it was only possible to privatize part of the extension service when this was accompanied by a complete reorganization and restructuration, which made it feasible to improve the efficiency of the system and establish a better delineation of tasks and responsibilities.

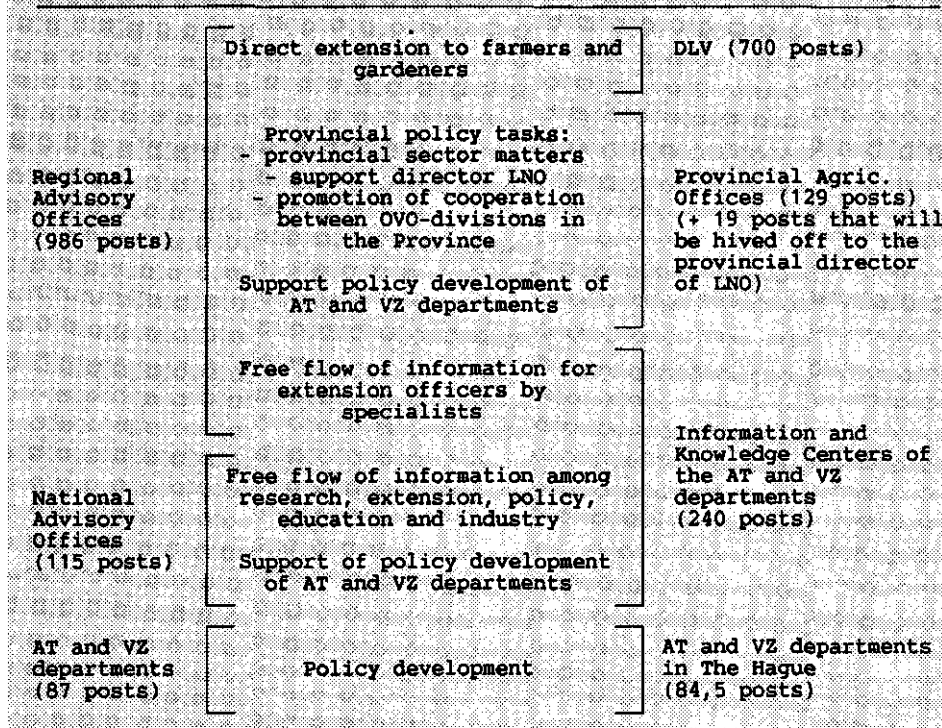
## The changes

*The new framework.* The reorganization and restructuration lead to the framework diagrammed in Figure 1. The 'first line' extension was hived off to a new institution: the Agricultural Extension Service (Dienst Landbouw Voorlichting: DLV), which will be privatized in 1993. That year, farmers will start to pay part of the services received, a process that will be completed in 2003, when government funding will be brought back to 50 percent. DLV will employ about 700 extension workers, organized in 61 so called 'extension teams', which are stationed in 26 team offices. The teams are of service to a specific agricultural sector. In doing so, a variety of tools and techniques (such as leaflets, computerized information systems, demonstration farms, group meetings, study groups, and intensive individual consultation) is used. Each team is supported by an advisory committee of farmers, who are appointed by the local branches of farmers unions and farmer-owned service organizations (Meijering & Ovinge, 1991).

When we compare the old regional extension offices to the new DLV teams, we see that most of the extension officers remained. But many of the subject-matter specialists and branch experts are now stationed at the two Information and Knowledge Centers (IKC), which were designed to collect, translate, and transfer information to all actors involved in the Dutch agricultural knowledge and information system (AKIS).

Both, the IKC for Animal Husbandry and Dairying and the IKC for Arable Farming and Horticulture, are divided into several divisions (such as Pig Production, Floriculture, or Fruit Growing). It is the task of these divisions to collect information from all sides, on aspects important to the sector, and to translate and combine information into packages, tailored to fit the needs of other parties in the system. Establishing good contacts with research is of vital importance. The IKC-divisions are therefore mostly located near the national experimental stations to enable intensive contacts.

Figure 1: The reshuffle of tasks and established staffing posts as a result of the reorganization of AT and VZ




AT = Arable farming and Horticulture;
VZ = Animal husbandry and Dairying;
DLV = Agricultural Extension Service;
LNO = Agriculture, Nature, and Outdoor recreation;
OVO = Research, Extension, Education.

In all, the IKC are believed to play a central role in the AKIS, functioning like 'a spider in a knowledge and information web'.

National policy development remained in The Hague, at the Ministry of Agriculture, Nature Resource Management, and Fisheries. However, at the provincial level a new body was created: a Provincial Office for Agricultural Affairs (Consulentschap voor de Landbouw: CL) for each of the 12 provinces. Subject-matter specialists, branch experts, and officials from the former extension offices were employed as staff members. It is the task of a CL to stimulate agricultural development within its province. To perform this task a CL will supply the

parties involved in these developments with information on national policies, and transfer information from the provincial level to the policy makers in The Hague, through the provincial directors for Agriculture, Nature and Outdoor recreation (LNO). It is essential for a successful task performance of a CL to have excellent contacts with organizations for education and training, regional branches of farmers organizations, research institutes, etc. There are many contacts, both through representations on boards and in information transfer.

This last restructuration, the creation of the CL, holds an essential change with the former situation: diffusion of technical and economical information is separated from the dissemination of information on government regulation. Different bodies are now responsible for these aspects relevant to farm management. Extension officers have no longer to operate as 'advocates' of government's interests. CL personnel will take care of this task.

All in all, it meant an extensive reshuffling of tasks and people. In essence the following changes are the most important:

1. privatization of extension, no longer free of charge;
2. more influence through farmers representatives on the extension service;
3. specialists integrated in extension teams and in IKC;
4. creation of CL at provincial level: decoupling of advice on farm management and the provision of information on government policy;
5. IKC as a new organization for the transfer of information and knowledge.

We will now take a closer look at the two Information and Knowledge Centers, which are believed to take a central position in the new framework.

*The Information and Knowledge Centers.* The idea behind IKC creation is that gathering information from different sources, and combining, integrating, and 'translating' this information to make it useful for others, is a rather complex process which can only be done efficiently by specialists who, on the one hand, have a lot of contacts with 'information producers', and on the other, know what is going on in the agricultural field. With the IKC, an institution is established where a variety of information is brought together, to be used, not only for extension purposes, but also to support government policy formulation. Furthermore, it is expected that the IKC will play an important role in influencing research directions. Because of their many contacts with extension organizations in the agricultural field, they can foresee research programs that are needed, where 'knowledge gaps' are to be expected, and what problems to anticipate.

In the years to come the IKC will have to acquire a central position in the Dutch AKIS, gathering information from all sides, combining it with other relevant information, making the translation to serve a specific target population, and, finally, making the results of the process available. The IKC will develop all kinds of 'information products', such as handbooks and brochures, but also coaching programs, software programs, policy papers, or even education programs for agricultural schools and training centers. In future, information technology (IT) will be of great use to IKC activities. One of IKC tasks is to

develop, in close cooperation with DLV, so called 'extension support systems' (ESS). Furthermore, using IT might be valuable to build databases to make information acquired by IKC directly available to other parties in de Dutch AKIS.

These products will find their way to a variety of clients, like extension organizations; besides the DLV, one can think of private advisors, extension divisions of private or cooperative firms, and the socio-economical extension service (which is provided by the farmers' unions). Other clients include the policy departments of the Ministry of Agriculture, Nature Resource Management, and Fisheries, and the research and education centers throughout the country.

The IKC will operate as independent organizations, and will work with their clients on a contract basis. This to assure that IKC-personnel work systematically and more client oriented. The joint projects with other actors in the Dutch AKIS will be set up around certain themes (e.g., the reduction of slurry production in animal husbandry).

The government decided not to privatize this 'second line' type of extension, in contrast to its 'first line' extension service (DLV). There are valid considerations for not privatizing the IKC. The IKC will produce information packages for all sorts of clients, including the Ministry of Agriculture, Nature Resource Management and Fisheries. And, as the government needs a loyal organization which collects various data and produces important information that can be used for policy formulation, privatization was not a feasible option. A more important argument was that according to government policy the Dutch AKIS should remain an 'open system', in order to guarantee every actor unobstructed access to the available information and knowledge. The system has always been very open, resulting in an active exchange of information among actors (Verkaik & Dijkveld Stol, 1989). Some recent developments, however, threaten to undermine this openness. Knowledge is getting more and more important as a means of production (besides land, capital, and labor). Consequently, agricultural information becomes more and more a commodity. As a result, private funding for research is growing (in 1988, it made up for around 15 percent of most research institutes budgets). There are indications that information and knowledge are privatized and shut off for others, developments that can also be observed outside agriculture. It is expected that the IKC can keep the information flows open and 'running', servicing all clients and keeping information available to everyone. It is believed that this openness is a precondition for innovation. This role of the IKC can only be assured with an independent financial basis through government funding.

## First experiences

It is still too early to draw solid conclusions on the outcome of the whole reorganization operation. Still, some remarks can be made.

For the DLV (the privatized extension service) most tasks have remained as they were before the reorganization. But the structure in which the extension workers have to function, changed considerably. Formerly, they were used to work from their private addresses. In the new situation, they have to cooperate with their colleagues in a team, with work schedules and control on their presence and activities. Another important change is that an extension agent no longer works for 'his' farmers; the team member whose skills fit a specific request for assistance best, will serve the client. It seems that after the first objections the new changes have been accepted, and are seen as a challenge, although the young seem more willing to adapt than senior staff.

At the moment the extension services provided by DLV are still free of charge, but this will soon change. It is difficult to foresee how extension agents will react. Anyway, they have to be prepared for a different attitude towards the client. Time and information will mean money, which was not so much the case before. Furthermore, extension workers are still paid as if they were civil servants. Differences in salary with private extension advisors are evident, and might in future create problems when salary raises and more differentiation are claimed for.

DLV management is working on the development of service packages that can be 'sold' to the farmers, and seems to face a dilemma; either to offer a broad spectrum of services, or to specialize. Specialization might be the best option in order to compete with private advisors.

In 2003, after the privatization is completed, the government will still be paying half of DLV expenses, in exchange for which DLV will provide farmers with extension products on subjects with a common interest (e.g., environmental issues). As these services will be paid from public means, they are available for farmers free of charge. Furthermore, in future years the government will establish influence on DLV policy through the occupation of 50 percent of DLV Board membership. This might create some tensions between DLV management in its strategy towards independence and government representatives aiming at public goals.

The Provincial Offices for Agricultural Affairs (the CL) seem to do quite well in the new structure (changes on this level were also less drastic than e.g., for the DLV). CL are supposed to 'translate' government policy to the provincial level. So far, it has been noticed that they do not really reach the farmers in an effective way. Although in group or mass meetings the latest information on government policy is transferred, the CL seem to fail in creating acceptance for restrictive government policy on farmer level. To reach such goals, a more intensive contact with the target groups is needed. At this moment specialists and experts are supposed to use 15 percent of their time to extension activities. It might be advisable for the future to enlarge this substantially.

The IKC are still in a transition process, searching for an identity within the AKIS. Concentrating mainly on DLV, the research institutions, and the Ministry,

and only slowly broadening its span to service other actors, like private advisers and industry, they have started to offer the first information products. It is too early to anticipate on the outcomes of expectations on the role and function of this 'spider in the web'. Yet, it is observed that their position within the AKIS is very vulnerable. By creating the IKC the number of interfaces among organizations and institutions has been enlarged. It needs extra time and manpower to maintain these interfaces. At the moment, good professional contacts often derive from good informal contacts between two persons (e.g., because they worked together in the former structure). This can be very useful in an initial phase, but should be consolidated in a more permanent way.

Relations between DLV and IKC are being evaluated in order to find out how information is exchanged, and if the specialists fulfil their tasks towards the extension agents. Preliminary results show that in some sectors better results have been achieved than in others, and that the people concerned are very willing to improve information flows. The relations between IKC and the education and training centers need further development. Until now, most attention was paid to the contacts with the extension services (especially DLV). In future, the IKC will also have to create interest from other clients for their information packages. This client orientation involves a change in 'culture' of the organization, which has already been acknowledged.

Government funding guarantees the IKC a solid financial basis, but also means that their independence is not accepted as such by everyone. They risk to be seen as government bodies, with the implication that other actors within the system might see them as institutions implementing agricultural policy. This aspect will need careful attention in the near future. A choice has to be made about the identity of the organization: an independent actor among other actors in the network, or a service organization for the policy departments of the government.

Ongoing research has already indicated that it is almost impossible for the IKC to control all the information flows from research to farmer. Since 1988 research institutes have to earn part of their income out of the market. This means that they will actively look for opportunities to do research for private organizations (such as agricultural industries). Since these clients also 'buy' the publication rights on the results, they withdraw (or exclude) the information from the 'public circuit'.

This are some of the issues which are discussed at this moment in order to create the position for the IKC as intended.

## Note

[1] Although these conversations often are triggered by the mass media. One of the most important characteristics of mass media is their 'agenda setting' function: "the press may not be successful in telling people what to think, but it is cunningly successful in telling people what to

think about" (Cohen, 1963).

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# Knowledge management by farmers' organizations: the French experience

M. Le Gouis

*The purpose of this article is to address some of the problems encountered when trying to develop and manage an agricultural knowledge and information system (KIS) based on farmers' organization initiative. What strategies, in such an 'upstream' approach, might lead to knowledge acquisition and management that benefit the farming community? In France, the questions and challenges have been met by farmers' organizations during the past twenty years. This article provides some insights gained. First, consideration will be given to knowledge generation and dissemination from a farmers' organizations perspective, using a typology of knowledge and a classification of strategies. A second part will focus on KIS management by farmers' organizations, with particular reference to the French experience during the past twenty years.*

Since 1966, the departmental Chambers of Agriculture, farmers' unions (with their young farmers sections), agricultural cooperatives, and other 'mutuel' associations have joint forces to promote an agricultural KIS well adapted to the needs of French farmers. These needs are essentially twofold:

1. to improve the competitive position of French farmers, especially within the EEC;
2. to keep a reasonably high percentage of the active population in agriculture.

Specific difficulties in finding the right solution were due to the fact that farmers' organizations tried to reconcile two objectives: they wanted a more efficient KIS, and at the same time wanted acquisition of valuable information by the majority of farmers. Underlying these objectives (efficiency combined with solidarity) was the urge to take an active part in the development of the agricultural economy as a whole. Farmers' organizations struggled to acquire more autonomy and control over the management of knowledge instruments, substituting government leadership in this field. At the same time, they worked out an arrangement with government in order to obtain sufficient resources through a system of compulsory levies on agricultural products, so called 'commodity surcharges'.

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French farmers' organizations had to develop two different, and complementary policies: one to deal with acquisition; and the other to deal with the management of acquired information and knowledge. The system that evolved could still be improved. Yet, it can demonstrate the steps and pitfalls of such an endeavor. Also, it illustrates the time factor and the dynamics involved in the privatization of the KIS. The latter was not the result of budgetary restrictions initiated by the government, but the desired outcome of farmers' organizations efforts to take charge of what was no longer called "vulgarisation": the downstream flow of information, but "agricultural development": an upstream attempt at directing knowledge instruments towards farmers' needs and expectations.

Such a fundamental change was only possible with government agreement and support. The system has weathered many storms and is now matured, with its strong and weak points.

## A farmers' organizations perspective on knowledge generation and dissemination.

*Three types of knowledge.* It seems useful to first establish the main kinds of knowledge most farmers need, as each type raises specific problems of acquisition. Then, alternative or successive acquisition strategies will be outlined, which underpin the policy choices to be made. Finally, a brief description of the French system of knowledge acquisition will be given as an example of a farmer-oriented policy and its implications.

*Technical know-how.* For farmers' organizations, generation of technical know-how implies at least some ability to tune research to farmers' needs. This is particularly important for applied research and its practical outcomes, as they help farmers solve such daily problems as the choice between varieties, breeds, methods of cultivation, types of building, or equipment.

Farmers' organizations might even feel they need to establish a network of agricultural testing centers, experiment stations or applied research institutes, that is complementary to government or private research. The general idea is to maintain public and private knowledge sources, and to develop own means of knowledge generation in order to supplement, compare, and adapt data to what is felt to be in the best interest of the farming community (as viewed by their own representatives).

Subsequently, the need to transfer the acquired knowledge to farmers will arise. Farmers' organizations, therefore, need to establish a corps of technical advisers. They could service as an interface between applied research and farmers, and must be highly qualified and supported to play their expected role in the up and down stream flow of information.

That such an approach to generation and dissemination of technical know-how of farmers' organizations often leads to serious problems should not come as a

surprise. Autonomy in this field requires substantial resources. Furthermore, the important question of how funds should be divided among applied research, advisory work, and training of farmers and advisers will be raised. A related question is if funds should be spend according to the percentage each agricultural sector contributes.

*Marketing know-how.* Marketing know-how is viewed by farmers' organization as an essential in order to obtain bargaining power on the markets, and as a means to adapt farm products to consumers needs. An important objective is to keep a substantial share of the value added by farmers on the farm (see Blokker, this volume). Farmers' organizations have established many types of marketing associations, especially cooperatives, which provide farmers with market information. Often their agents support farmers to produce according to specifications that allow profit making, and help to discover cost reductions (e.g., on supplies, equipment, credit, insurance).

But this knowledge generation and dissemination also entails some problems. Sometimes, farmers feel that their own cooperatives treat them just like a private concern would, and claim they have little opportunity to exercise responsibility, and limited access to marketing know-how. Hence, some (of the better) farmers tend to return to individual marketing of their goods and services, or might be selected by private firms as privileged clients.

In all, knowledge is needed by farmers on how to obtain and maintain a reasonable share of the value added to their production. This is particularly true when farmers' organizations want to maintain a substantial farming community, with young farmers replacing those retiring.

*Management know-how.* Successful farming depends not only on technical or marketing know-how, but mainly on the ability of farmers to sustain the viability of their farm over a long period. Acquisition of this management know-how is viewed by farmers' organizations as a life-long, continuous process, starting with basic school education and including early initiation to accounting and sound management practices. Also, it requires agents that are especially trained to help farmers make major decisions (e.g., changing farm orientations, enter into diversifying activities, or looking for non-farm income).

Of the three types mentioned, acquisition of management know-how is the most difficult to organize efficiently. Often it is developed by farm management schools and institutes, and taught to farmers by special courses and through personal advice. Still, it remains difficult to apply management know-how to individual cases, considering the great diversity. This mostly causes for individual advice or consulting, at relatively high costs as this is given more and more on a 'charge-for-service' basis. The general trend is toward a selective approach that often supports better and larger farmers more efficiently than others.

*Strategies to generate and disseminate agricultural knowledge.* Three major strategies for the generation and dissemination of agricultural knowledge have been selected for review: (a) downward transfer; (b) self-supported developments;

(c) assisted self-reliance.

*1. downward transfer.* This strategy is an extension to public education. In most cases, the generation and disseminating of knowledge is a responsibility of government agencies, in consultation with farmers' organizations. The main objective is efficient and rapid diffusion of (mostly technical) research findings. Knowledge is accumulated in various public research institutions, and disseminated by a corps of civil servants, known as extension agents or agricultural advisors. Ultimately, the information flow is directed at farmers, with their needs assessed in various committees with joint participation. Costs are often covered by public funds, usually earmarked in the Ministry of Agriculture's budget. However, in the non-technical fields, government action is limited. Here, most of the initiative is taken by the private sector. Firms and cooperatives provide market information and farm products specifications to their clients or members. Management know-how is often considered as an undifferentiated area that does not call for specific government action, and is left to business schools and private consultants.

This downward transfer of knowledge seems to be the prevailing strategy in most countries, at least until 10 or 20 years ago. It is simple to conceive, and well adapted to conditions where: (a) large number of farmers have received little formal education and farmers' organizations are weak or non-existent; or (b) the active farming community is reduced to a limited number of well educated and usually prosperous farmers, quite capable of acquiring (and paying for) the information they need.

But the strategy is not well adapted to intermediate situations where farmers are still numerous, reasonably well educated and organized, and conscious of hazards involved (in terms of declining rural opportunities for young farmers, and decreasing economic and political power).

*2. self supported developments.* In the latter situations there are two incentives for the farming community to switch to self-supported knowledge generation and dissemination. First, farmers' organizations might want to supply or substitute government efforts in this field. Second, the government might be forced to look for alternative funding of applied research and advisory services, due to budgetary restrictions. The main objective is to redress the trend towards downward with upward information flows in the technical, marketing, and management domains. Farmers' organizations should be able to compel adjustment of research programs and advisory services to their needs, and could, therefore, decide to organize their own research and extension. Such a switch is usually achieved gradually, and related to the ability of farmers' organizations to collect resources.

Furthermore, there are limits to what farmers' organizations can finance, and often problems in allocating scarce resources arise. In fact, in France there are but few (and only local) examples where a given group of farmers was able to entirely self-finance its knowledge acquisition (e.g., the sugar-beet, oil seeds, and grain growers).

Resources are usually collected on the basis of a levy on farmers' production.

The corresponding increase in their production costs might be difficult to compensate, with imports from countries where knowledge acquisition is financed by the taxpayer. Moreover, it is almost impossible to collect farmers' levies on a purely voluntary basis. But any compulsory system implies a relationship with the government. Fund collection raises also the problem of selecting the farmers that are supposed to pay, and those who are supposed to benefit. In years of fierce competition it will be increasingly difficult to make the necessary adjustments in fund raising and services returned. Consequently, an entirely self-supported system is hardly realistic. Over time, a compromise is needed.

*3. assisted self-reliance.* 'Assisted self-reliance' is a term introduced as compromise between self-reliance and public support. The apparent contradiction between both can be solved when:

a. public assistance remains marginal and complementary (knowledge generation and dissemination should remain a main task of farmers' organizations);
b. acquisition of more basic knowledge receives substantial public support (investments in knowledge procurement with long-term return scales justify public financial and technical assistance);
c. external assistance compensates areas with poor natural conditions and aptitudes or many low educated farmers.

The assisted self-reliance strategy is likely to be more promising, and yet more demanding, than others. Its flexibility seems well adapted to a great variety of situations. However, to establish the right balance between the roles played by farmers' organizations and public agencies remains difficult. The farming community should be made responsible, but without affirmative action the liberal approach will favor the best informed and competitive farmers. Equity in access to knowledge is not easy to achieve.

## The French strategy

At present, the French system of knowledge generation and dissemination is inspired by the third strategy, the 'assisted self-reliance'. Shortly after World War II, agricultural research and extension were largely in the hands of the government. In order to promote productivity and improve food supply, research institutions were providing technical knowledge to a corps of extension agents, employed by the state and supervised by the Ministry of Agriculture. But soon, some farmers' initiative emerged. Farmer groups, with the purpose to test (in liaison with government agents and researchers) new techniques on individual farms, appeared in the Parisian Basin area. Furthermore, some of the farmers' unions decided to collect funds to establish applied research institutes for each major commodity or type of farming.

From the beginning, government authorities encouraged these developments on the part of progressive farmers toward self-reliance. Not so much for budget-

ary reasons, but in order to enable them to profit from their favorable position in the new established European Common Market.

A major step was made in 1966, when the National Fund for Agricultural Development (FNDA) was established. Incorporated under private law and headed by a farmers' representative, an association was established to manage this fund and give advice to the government about agricultural development. This national association, called ANDA, constitutes for 50 percent of representatives from the Ministries of Agriculture and Treasury, and for the 50 percent of representatives from the major farmers' organizations at the national level: Chambers of Agriculture; farmers' unions; and the cooperative movement. The levies to finance the fund, collected through commodity surcharges, came initially from the grain growers, and have been progressively extended to most other commodities. Yet, about 75 percent of the fund is still contributed by the wealthier areas and farmers, while about the same percentage is used to support the smaller and less prosperous farms throughout the country.

Agricultural knowledge is obtained by farmers through training and advice, within the framework of three to five years programs of local farmers' organizations. Such programs cover a wide range of subjects and are implemented by local agents, most of them hired by Chambers of Agriculture and cooperatives. Local resources are important but vary considerably from one area to another. The national contribution by ANDA compensates to some extent for the insufficient capacity of relatively disadvantaged areas to self-support services. On the other hand, ANDA also supports research, like technical branch institutes for applied research, the national institute for farm management, and national networks for training and information developed by marketing cooperatives.

All these activities, local and national, call for efficient relations with other partners in France's complex agricultural knowledge and information system (KIS). For instance, all of the (farmer owned and managed) technical branch research institutes maintain direct contacts with government institutions for basic research (INRA). But such coordination tasks are time-consuming, and not always as efficient as they should be. It is difficult, for instance, to reach a sufficient degree of personnel mobility among the various functions in teaching, research, and extension.

It can be stated, however, that the prime objective (to provide equal access to agricultural knowledge for the majority of farmers, whether in poor or rich areas, whether with high or low level of initial schooling or training) was realized to a considerable degree. Differences still exist, but a general move toward self-reliance in agricultural development has been made, without disregarding assistance of government or private industry in research, experimentation, and extension.

**Challenges and experiences**

In this section I want to explore some aspects that are important when a farmers' organization gains influence on a knowledge and information system (KIS).

*Objectives.* First of all, management of a KIS calls for clear and agreed-upon objectives. The main objective of ANDA could be stated as: "to make reliable agricultural information readily accessible to all farmers". This implies some transfer of resources from wealthier to poorer branches or areas. Furthermore, special attention goes to young farmers in general, and adult farmers during crucial and vulnerable periods of rapid adjustment to new demands. Special efforts are being made to compensate for the low level of initial schooling of some farmers by organizing attractive professional training sessions. For instance, to help a dairy farmer to leave his farm for a short, two or three days training session a replacement service at reasonable cost can be provided. Special training is also required for advisers to help them adjust messages to the needs and capacity of various publics. This does not compensate, of course, for existing discrepancies in operation size, nor for the differences in individual management skill.

*Charging farmers for services received.* Lately, there is a growing need to charge farmers for extension services. Still, a diversified approach to charge rates is required, taking factors such as age, location, and economic situation into consideration. A fee can only be charged when a substantial benefit results directly from the service given. Special efforts are required to prevent wealthier and better farmers from monopolizing the best technicians available.

*Decentralization.* In order to find the solution best adapted to local conditions, especially when conflicting situations arise, another principle is favored: "decisions should be made as close as possible to the farmers involved, after an open debate with professionals". Farmers' leaders should, therefore, be given the appropriate training. Furthermore, important information is circulated among them, presenting case studies that show how others have solved similar problems.

*Farmers' demands.* Knowledge and information systems are quite complex and need constant adjustment. Resources are decreasing, and as farmers become fewer but better educated and trained, they tend to become more demanding for the latest and most sophisticated types of information. An approach that involves all important factors in decision-making at farm level requires combined use of socio-economic and technical advice. Different options are often tested on small computer equipment, with the help of a general adviser familiar with IT. ANDA has established a "national network for experimentation and demonstration" (RNED), that provides access to technical and economic references in six different domains: grains; dairy; meat; fruit; vegetables; and wine.

*Evaluation.* Evaluation is probably the most difficult management task. With a very decentralized system, the collection and summarization of data presents a real challenge. Often, districts use different terms to refer to similar experiences and engage in different types of linkages with the other components (such as

public and industrial research) to manage their local system. Much remains to be done to overcome this lack of uniformity needed for administration at the national level.

## Conclusion

With respect to the objectives stated earlier, the conclusion that it will still take some time before access to agricultural knowledge becomes equally shared among farmers throughout the country seems valid. To some extend the quality of services will remain dependent of local resources and competence of service personnel. But, however imperfect, a KIS that allows farmers' organizations to play an important role clearly offers important advantages. Farmers, through their spokesmen, are better able to reason out their own (technical as well as socio-economical) problems, and to take initiative in finding appropriate solutions. Although not all the answers depend on farmers' organizations initiative alone, these organizations have now acquired KIS management experience, and are able to work in liaison with other institutions (such as government and industry research institutes). They gained insight in media use (not only to disseminate technical information, but also to make their ideas known to a wider audience) and how to present results obtained through a combination of private and public resources. In all: they contribute considerably to the synergy of the French agricultural knowledge and information system.

# Strategic investment in IT with a view to integrating the marketing column

K.J. Blokker

*Integrated chain management (ICM) is becoming increasingly important in agriculture. This article examines a number of related aspects. It deals primarily with the likely consequences for agribusiness in general, and for agricultural cooperatives in particular. It is divided into seven parts. The first looks at the changes in cooperative agriculture that provoke the need for ICM. The second part covers the question how agricultural cooperatives would position themselves in the emerging chains. This brings us, in the next part, to the role that information exchange plays for ICM. Part four discusses the current situation of agricultural automated networks, and gives some forecasts of the number of farmers and market gardeners that will join such networks in the near future. Part five states the importance of networks for agricultural cooperatives, followed by an examination of a number of critical success factors for chain networks (part six). Finally, in the seventh part, an attempt is made to indicate some of the consequences of these developments for information technology (IT).*

## Cooperative agriculture in a changing market

The Dutch farmer faces major adjustments. Some reasons for this are: (a) the EEC agricultural policy; (b) 'Europe '92'; (c) the pronounced concern for the environment; (d) a rapidly developing dichotomy between intensive, large-scale farms and extensive, small-scale ones; and (e) new technologies (biotechnology, informatics), resulting in changes in methods of production. Related is the transition from a seller's to a buyer's market; the farmer has to become more market-orientated, and has to produce for critical, mainly European consumers, while major demographic factors (e.g., the decrease in population and ageing) reduce the market.

Within this context the farmer must try to obtain the largest possible share of the 'consumer's guilder' and generate more added value per unit of primary product, directly or indirectly. In this, integrated chain management (ICM) can

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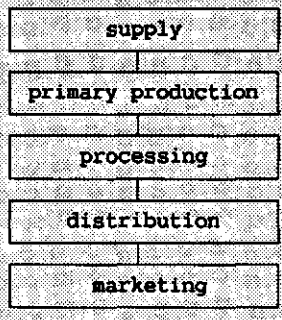
play an important role.

A somewhat comprehensive description of ICM might be: "the management of production, transport, storage, processing, and packing activities from the supply of raw materials to the farmer up to consumer marketing". In broad terms, a chain can be depicted as follows (Figure 1).

Figure 1: A chain.




Three (related) factors make it essential that the stages of the production chain are coordinated efficiently:

1. consumer demands, such as increasing emphasis on health (e.g., products without traces of 'poisons'), increasing demand for 'convenience' (e.g., ready-to-cook or ready-to-microwave food), increasing demand for variety (resulting in a large number of market/product combinations), and increasing environmental awareness;
2. demands by retail trade (such as reliability of promised quality, optimal price/quality ratio, delivery speed and reliability);
3. legal aspects (e.g., agricultural products must be traceable, for example, through animal registration).

There is a tendency to shift responsibilities to the previous link in the chain: the retail trade places the onus for incoming inspection on the processing and distribution stages, who try to pass on responsibility to farmers and their suppliers.

## The positioning of cooperatives in the chain

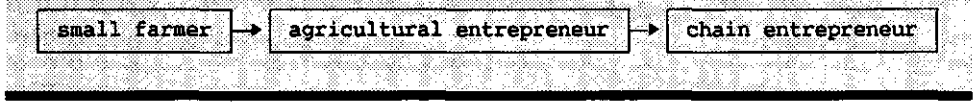
Cooperatives are associations set-up and run by farmers. Their original purpose was to provide better economic conditions for farmers through joint purchase of

inputs and/or sale of products. Farmers' reasons for joining cooperatives are illustrated by the name of one of the first Dutch cooperatives: "Enlightened self-interest".

It will be clear that one of the factors determining farmers' incomes is good chain management. Bearing in mind that the best economic results are usually achieved closest to the consumer (processing, distribution, and retail trade), the obvious question that arises is whether cooperatives should position themselves more forcefully at these stages.

The Cebeco Trade Council Group, a large conglomerate of agricultural cooperatives, has answered this question in the affirmative, and has consequently obtained a role in the processing and distribution stages. This acquisition process is far from finished. In the process, the farmers of a cooperative gain power at several stages in the chain. As a result, they capture a larger proportion of the consumer's guilder and hold a stronger position in the management of the chain. Such a development path could be described by Figure 2.

Figure 2: A farmer's development path.




**The part played by chain communication**

ICM can only be successful when there is sufficient exchange of information between the various stages in the chain. Chain communication is a critical factor for success. The poultry sector provides a good example.

Poultry slaughterhouses have contracts with retail trade to provide, within a given period, a certain range of butcher's meat, linked to a schedule with fixed maximums and minimums, with the final order being decided on at the last minute. Under these circumstances quality control and logistics are extremely important. The slaughterhouse would, therefore, like to have the following information from its suppliers (the fattening farms): number and breed of chickens they are fattening; weight increase; methods of feeding and types of feed; use of medicines. This means that the fattening farms must regularly exchange information with the slaughterhouse to find out in good time how many birds can be supplied, when, and in what weight classes and quality. It is illustrative in this context to note that slaughterhouses pay their fattening farms on a flexible basis: the farms receive a bonus for correct estimations on average weight

and quality.

In turn, the fattening farms want to receive particular breeds of chicken, free from disease (such as salmonella). This information has to be passed on to the hatcheries, which have to notify the breeding farms. Furthermore, information must also be exchanged between the fattening farms and the feed suppliers, to select the right feed and estimate needed quantities.

**Agricultural networks**

The last few years have shown a marked increase in the number of farmers that communicate through automated networks (especially videotex systems). By the end of 1989 some 1,500 farmers were estimated to be communicating through a videotex system. The Cebeco Trade Council Group is a particularly large user: it communicates with some 1,200 farmers in this manner.

What are the forecasts for the number of farmers that will be linked to such a network in the near future? In Table 1, I hazard a number of sector-related forecasts.

Table 1: Forecasts for number of linked farmers on January 1st 1993.

| | pessimistic | optimistic |
|---|---|---|
| cattle | 3,750 | 7,500 |
| pigs | 1,250 | 2,500 |
| arable farming | 2,500 | 5,000 |
| glass houses | 2,800 | 4,600 |
| TOTAL | 10,300 | 19,600 |

Assuming that there are 60,000 - 70,000 thriving agricultural enterprises, this means that at a minimum around 1/6, and at a maximum 1/3 of these enterprises will be connected.

The rate at which this innovative process spreads is determined by a large number of factors. One of the main factors is undoubtedly the importance that agribusiness attaches to these networks. If manifest economic benefits can be derived, agribusiness will contribute by lowering the financial barriers that exist for the farmer, and by assuring that sufficient emphasis is placed on effective support. This process is now undoubtedly beginning to accelerate. It is therefore important that the advantages of automated networks for agribusiness are considered.

**The importance of automated networks for agribusiness**

I will illustrate the importance of such networks by showing the functions they fulfil for the regional cooperatives in the Cebeco Trade Council Group. I will also take a brief look at the growth path for networks.

At the moment the Cebeco Trade Council Group uses networks as a commercial instrument, a tool for strengthening relations with the farmers. They are used for disseminating all kinds of advice, for advertising, for electronic ordering, etc. This involves message traffic: texts go to and from the farmer via an electronic postbox. A number of important experiences are:

1. the success of a network depends on its acceptance by the farmer: a cooperative must provide information that is up-to-date, clear and concise, and tailored to the needs of the market. The information supplied must add value for the farmer;
2. this usually requires organizational changes, such as the recruitment of an editor/coordinator and improvement of the technical and commercial provision of information;
3. a great deal of time is required to develop a network that functions satisfactory.
4. the results are not quantifiable, but it would seem reasonable to assume that networks: reinforce an image; offer more opportunities for establishing contacts, in particular for reaching the large, modern enterprises; improve the internal provision of information (field staff are better informed and become more aware of the importance of conveying important commercial information); make a genuine contribution to sales.

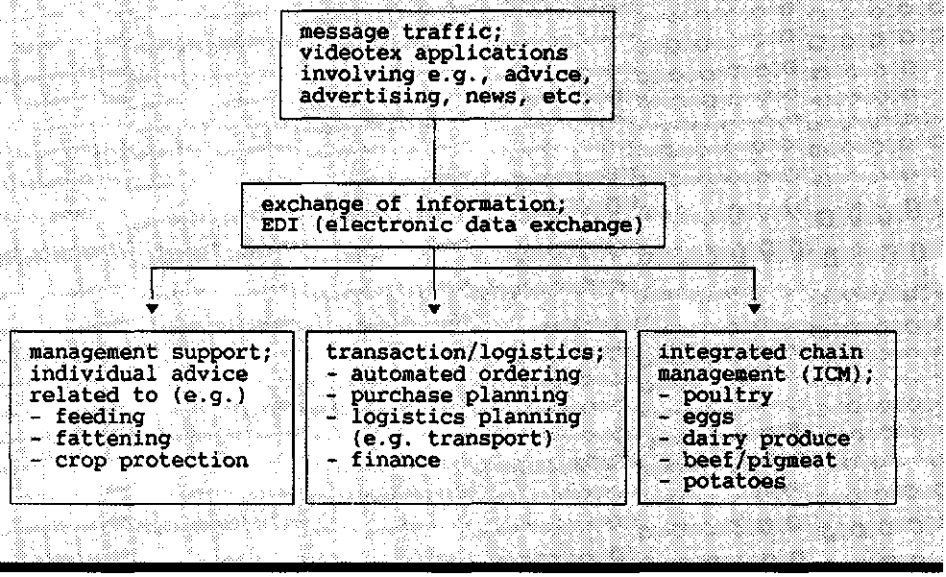
The use of automated networks must be viewed in relation to a cooperative's marketing strategy. The question of how much information should be provided in the package is crucial. The possibilities are:

1. the 'product only' strategy (little or no information is provided);
2. the 'product+' strategy (information is clearly product related, with the objective of enabling the farmer to increase his yield by means of the product, e.g., what is sold is not feed, but yield);
3. the 'product++' strategy (in addition to product related advice, management support is given).

As a result of the squeeze on margins and farmers willingness to pay for good advice, the following trends can be observed among cooperatives: the use of the 'just enough' principle (the information is limited to what is strictly needed to promote sales; the product+ strategy); management support provided by advisors will either be hived off or made available at a charge (the product++ strategy). Experience in other economic sectors has shown that networks can considerably save costs in transactions and logistics. Examples include: automated ordering by the farmer (orders, order confirmation, and transport orders); automated invoicing; purchasing and distribution planning for compound feed ingredients.

Therefore, it will be obvious that electronic networks are capable of supporting the necessary chain communication. It is interesting to consider the growth path followed in developing advanced networks (Figure 3).

Figure 3: Growth path for electronic networks.

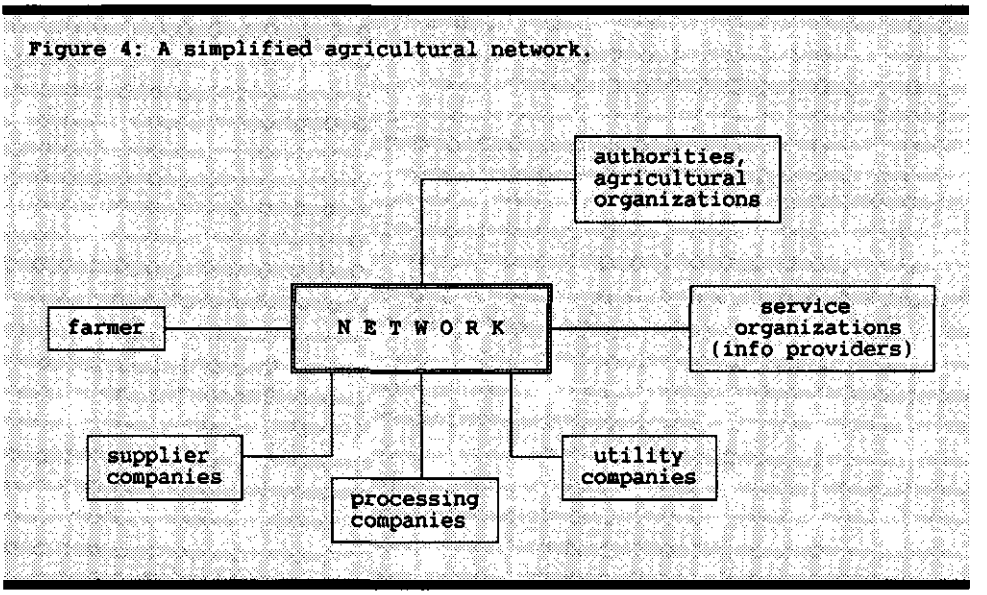



It is of great importance that cost savings and quality improvement should be achieved primarily by EDI applications. They require major technical and organizational investments. It is not surprising, therefore, that the government is trying to stimulate precisely this type of network.

## Critical success factors for chain networks

It is essential that all actors involved in agricultural production can communicate with each other about the information each requires on the conditions each stipulates. First of all, let me give a simple example of such an agricultural network (Figure 4). Two important conditions must be satisfied before this situation can be achieved: technical compatibility and organizational cooperation.

*Compatibility.* From a technical point of view, compatibility is the principal success factor. It means that computers can (ultimately) communicate directly with one another. Standardization is essential, and relates to two levels: (a) the communication system (e.g., Open Systems Interconnected standard) - a standard




network of paths along which communication is possible; and (b) applications - to ensure that data is exchanged and stored or processed without human intervention, a great amount of standardization is required (such as data definition).

Activities should be aimed at identifying promising applications (feasibility studies), followed by pilot projects. Standardization with regard to applications involves a great deal of time and money. Utility companies can enable 'non-standardized computers' to communicate with one another by acting as 'interpreters'.

*Cooperation*. Standardization calls for accordance between the different stages in agricultural production. This is easier said than done. Nevertheless, developments in other sectors have shown how essential cooperation is (e.g., transport, banks, retail trade, insurance). The current situation may be compared with the "prisoner's dilemma": if actors cooperate, the risks are great for all concerned (rivals acquire strategic information), whereas nobody stands to gain from an individualistic attitude.

The answer may lie in dissimilar rates: some parties (pioneers) in the chain develop new applications, while their competitors bide their time and, once the applications have proven their worth, move in. Since considerable investment costs are involved, it is important that sound financial agreements between parties are made beforehand. The government can play an important part in this through 'IT stimulation funds'.

**Consequences for IT**

Having dealt with ICM and how it relates to information exchange, we will now look briefly at the consequences that this development is likely to have for IT. A number of issues for which IT can possibly be helpful will be raised.

*An integrated communication plan.* Developments in chain communication will result in a different role for agricultural cooperatives and the farmer. As a consequence, the latter will have to develop towards a 'chain entrepreneur'. The relationship between a farmer and his cooperative will therefore also change: at the financial level farmers will more often become shareholders instead of members of an association: the distance between the cooperative and its farmers threatens to become wider.

Despite increases in scale, regional cooperatives in particular do their best to keep this distance to a minimum. This places stringent demands on the communication between the cooperative and its members. It is a vital condition for a dynamic cooperative sector to maintain the involvement of its members. Consequently, a comprehensive cooperative communications plan is required, with the objective of securing acceptance for the policy formulated, but at the same time designed to reflect the needs of farmers, so policy can be adjusted if necessary.

*Towards a discontinuous model for diffusion of innovations.* The theory of diffusion of innovations is in need of some adjustment. For example, until now it has always been assumed that, following a hesitant initial phase, innovations gradually spread at an increasing rate; later the curve flattens. Agricultural research (as well as studies in other economic sectors) shows that diffusion does not always proceed so evenly, but on the contrary often goes in fits and starts. There are many reasons for this. One is that not enough account is taken of the policy pursued by agribusiness (e.g., this is what happened with the introduction of the milk tank).

Diffusion theories were founded on relatively simple innovations in which only the farmer's interests have been taken into account, whereas in the case of agricultural information exchange, in particular within economic chains, we are dealing with a complex of innovations and interests. Innovations that manifest themselves both at the technical and at the organizational level.

Finally, too little attention is paid to the fact that today's innovations are dynamic ones. We can see for example, particularly throughout the informatics sector, that developed products and services have a limited through-put time. We are talking about innovations that are constantly being renewed. Extensive research into factors affecting the spread of innovations and the way in which this process develops could provide interesting clues for policy makers.

*The management of knowledge and information systems.* It will be obvious from the foregoing that IT can drastically affect the way in which a knowledge and information system (KIS) functions. We only need to think of the possibilities that

networks offer for reducing the gaps between research and practice. We can also see that more and more information is becoming available, information that acquired its added value for the farmer precisely from the fact that it is bundled and processed. This places demanding requirements on the management of this type of knowledge. It is a possible area of contribution for IT.

It is probably good to note here that experience with chain communication shows that information exchange seems to hold a more powerful motive to engage in IT than access to information alone. Where management computers and other automated decision-support for farmers have only diffused very slowly and have, so far, no clear economic advantages, automated information exchange for logistics and quality control seems more promising.

*Information provision.* Major changes are taking place in the exchange of agricultural information. We need only look at the privatization of a large proportion of agricultural information (see also Bos et al., this volume). Of course, IT also greatly affects information. For example, an increasing amount of advice is becoming available through data banks, and decisions are being taken by farmers on the basis of data registered and processed in management systems. As a result the role of the information provider is changing. More than ever, he has to become the farmer's partner in business matters. It would appear that the mix of factors, the increase of scale in the primary sector, and appearing powerful management tools, is creating the scope for a new interpretation of the role of information provider. In our view this role can best be described as 'agricultural business advisor'.

*The micro level.* Many aspects relating to information exchange and the accompanying use of automation will have repercussions for the methods used to provide information. We would like to draw attention to what is sometimes referred to as 'making IT user-friendly'. This involves such elements as the layout of screens, comprehensible and concise texts, the effective use of graphics aids, appropriate color gradations, help options with management systems, etc.

With networks we have reached the stage of IT that provides a mix between personal information and mass media information, sometimes referred to as individualized mass media information. In our view, this gives the communication expert an important opportunity to integrate and further develop his knowledge in both areas.

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# Agricultural information: the farmers' point of view

A. Fearne

*The British agricultural industry is well supplied with information from both government and private sector sources. Recent developments, such as investment in information technology (IT), changes in the structure of farming, and the shift in the way the public sector delivers and promotes information suggest that, in the future, the information dissemination network may well change. In order to gain a better understanding of the potential impact of these developments it is essential to consider the farmers' point of view. For this purpose some empirical research into the provision and use of information on farms in England was recently conducted by the Department of Agricultural Economics and Food Marketing at Newcastle University. This paper presents some of its findings, with a special focus on IT. It is in three parts. The first looks at the various ways farmers obtain agricultural information, and gives some insights gained by earlier studies. The second part presents some of the research findings. The final part provides some conclusions, regarding the future role of IT as an aid to farm management.*

## How agricultural information reaches the farmer

The ways in which agricultural information is disseminated can be categorized into three broad groups: personal communication; group activities; and mass media.

*Personal Communication.* The spoken word is perhaps the most powerful means of communication, particularly when delivered in person. There are basically four groups of people involved in communicating information personally to farmers: state advisors, private consultants, commercial representatives (including merchants), and other farmers. The advisors from ADAS (Agricultural Development and Advisory Service, a government body) tend to be regarded by farmers as "the men from the Ministry" - a source of objective advice though erring on the side of caution (Read, 1985). Until recently, state advisors and private consultants

D. Kuiper & N.G. Röling (Eds.). (1991). *The edited proceedings of the European Seminar on Knowledge Management and Information Technology.* Agricultural University, Department of Extension Science, Wageningen, The Netherlands.

have worked together in a complementary fashion "...the former to create awareness and the private consultant to provide the specialist service to the individual client." (Dancey, 1983). However, as ADAS focuses increasingly, due to diminishing governmental funding, on selling advisory packages to the individual farmer rather than servicing the industry as a whole, the complementarity of the two groups will decline as the competition increases.

The most frequently used information sources are merchants and commercial representatives. It is estimated (Dexter, 1983) that the larger companies in the agricultural input industry together employ around 20,000 commercial representatives. While most of them are treated by farmers with suspicion, a successful product and a reputable company name can often make a commercial representative a highly valued source of information and advice. In recent years the declining fortunes of the farming industry have been reflected by a reduction in the number of commercial representatives 'on the road'. The regular farm visit is being replaced by a telephone call and companies are relying increasingly on mailshots as their first point of contact, with direct personal communication now left mainly with the merchants.

Although farmers themselves are less preoccupied with the dissemination of agricultural information, they often play an important role, especially in the crucial stages of on-farm decision-making.

*Group Activities.* In recent years ADAS and the Agricultural Training Board (ATB), have established many discussion groups, partly in recognition of the need to reach isolated farmers (Whitby & Saunders, 1985) and partly as a result of budgetary constraints. Although discussion groups have proven to be cost-effective, the benefits to farmers are limited to the extent that they are generally only attended by more progressive farmers and their success is largely dependent on the sociological characteristics of the group members and the commitment of the advisor involved (ADAS, 1982a). Other group activities include agricultural shows, the services provided by co-operative societies, and farm demonstrations. The latter represent a highly valued way of getting reliable information, particularly for arable farmers, for whom the visual inspection of new crop varieties or crops treated with new chemicals enables personal (and therefore commercially unbiased) assessment (ADAS, 1982b).

*Mass media.* The mass media includes those communication channels which transmit information by various mechanical means to a large population (Read, 1985). Published material used most by farmers include the farming press, advisory publications from government bodies such as ADAS, and promotional literature from commercial companies.

Broadcast information benefits from being instant, easily understood and generally requiring little time to 'consume'. Its disadvantages are that the information is not as permanent as the written word, the services are impersonal, and it requires a certain degree of discipline from the farmer in that he must be prepared (or able) to 'tune-in' at the right time (Thomson, 1975).

Agricultural IT covers the use of computers, videotex, and message services. A considerable amount of research has been carried out on the application of IT in the agricultural sector (eg., Houseman, 1985, 1988; Angell; 1986) and the use of computers on the farm (eg., Westlake, 1984; Offer, 1985; Agar, 1985). Perhaps the most significant finding is that the uptake of IT by farmers remains extremely limited. Following a period of rapid progress in the late Seventies and early Eighties, agricultural IT is currently going through a period of consolidation (Houseman, 1988). There are currently some 7,000 micro-computers and over 2,000 videotex terminals on farms in Britain, with 35 agricultural software houses, of which only nine provide a full range of software (Houseman, 1988).

The videotex service used most widely by farmers in Britain is Prestel, a viewdata service which provides weather forecasts from the meteorological office and up-to-the-minute price information and market reports supplied by the relevant commodity organization (for example, the Meat and Livestock Commission (MLC) provides information on fatstock markets). The main advantage of videotex is the ability to communicate information as it happens twenty four hours a day. However, experience suggests that farmers remain unconvinced of its cost-effectiveness and their ability to cope with the technology (Houseman, 1985). Its greatest use is therefore likely to remain as a means of communication within the industry but outside the farming community, with specialist advisors and the media being the main users (Read, 1988).

Some organizations, like ADAS and the Potato Marketing Board (PMB), use telephone information services (TIS) to disseminate pre-recorded information. The advantages of TIS are that information providers can make information available to a large number of farmers and can respond quickly to a changing situation. In addition, the farmer is not constrained to seek out the information at a particular time and, having paid for the call, the farmer is more likely to listen to the message (Thomson, 1976).

## Farmers' attitudes towards agricultural information; some recent findings

Despite the considerable literature on the use of agricultural information and on-farm decision-making there is a distinct lack of published material based on objective data or empirical research. For this reason a study, sponsored by the Royal Agricultural Society of England and British Petroleum, was carried out during the spring and summer of 1988 (Fearne & Ritson, 1989). The first part of the study involved a series of group discussions with farmers held across the country, with the objective of establishing the main areas of importance and the key hypotheses which were subsequently tested in a survey of 900 farmers in England.

*The group discussions.* The groups focused on two main areas. The first concerned the dissemination of agricultural information amongst farmers, and the

second covered how this information is evaluated and used in the decision-making process on the farm. Each group consisted of between eight and twelve farmers, with discussions lasting for between an hour and half and two hours.

*The dissemination of valuable information.* The use of consultants was widespread throughout the groups. The most common source of independent consultancy advice was ADAS, whose main attribute was the absence of commercial bias. While some farmers used private consultants solely for accounting purposes, the most common use was for problem-solving, where expert advice was highly valued. Commercial representatives were viewed as a useful source of local news and a means of finding out what other farmers are doing, but, although representatives from reputable companies were generally respected and welcome, their commercial advice was rarely taken at face value, under the suspicion that their advice would be biased by company policy. The apparent reduction in the number of commercial representatives visiting farms was welcomed throughout the groups.

Furthermore, most farmers valued the experience of other farmers. They look to their successful neighbors for advice, and seek to learn from the mistakes others make. While for many this is only an occasional or coincidental event, for others, primarily the livestock farmers, it is not (for them the auction market provides the ideal forum for the dissemination of information relating to personal experiences).

Discussion groups were highly regarded and most farmers found the time to attend a handful during the course of a year. They were seen as being aimed at the 'grass roots' farmers and benefitted from being extremely specialized and usually of a technical nature.

Agricultural shows were seen largely as social events, although some farmers did admit to having 'discovered' a new variety of cereals or a new piece of machinery during a visit to the Royal Show and many welcomed the opportunity to talk directly to manufacturers. Direct purchases were usually restricted to small items. While substantial purchases were occasionally instigated by a visit to a show, further research was always undertaken before a final decision was made.

All groups were agreed that most of the general or market information was provided by the free farming papers. However, considerable frustration was expressed at the degree of repetition from one paper to the next and their reliance on sensationalism which, while entertaining, usually resulted in the information reported not being taken seriously. There was also a feeling that much of the technical information reported was commercially biased, given that these papers are wholly financed from their advertising revenues. While benefitting from a clear and simple style with short and succinct articles that were easy to read, these papers were rarely read assiduously, with the majority agreeing that a quick scan was generally sufficient.

The use of specialist (i.e., enterprise specific) journals was widespread throughout the groups. These were the journals that farmers consulted for

technical information relating to production rather than marketing. Their attributes lay in their high technical content, a general lack of advertising and scant coverage of political issues. Ironically, the main criticism of these specialist journals was that they are often "too technical and too difficult to read", a comment which merely confirms that information needs and the methods of communication required clearly differ throughout the farming population.

Commercial circulars, advertising chemicals, machinery etc, were widely condemned and rarely consulted, with two significant exceptions: some farmers did acknowledge that they would read and possibly follow up circulars but only if they happened to be looking for a particular product or item of machinery at the time; other farmers stated that if the circular carried a reputable or respected name, then it had a greater chance of being read. For example, some dairy farmers pointed out that ICI literature was usually read, as this company had earned their respect.

Of the other mass media mentioned the radio was most highly valued, largely due to the tendency for radio programs to provide a great deal of up-to-date information in a relatively short time period.

When asked to comment on the use of computers on the farm most farmers felt that their businesses were not large enough to justify either the initial cost or the necessary 'user time'. Others saw them merely as "glorified filing cabinets" and a number confessed a fear of the unknown. The use of computers by those with experience was limited to accounts and records. Perhaps surprisingly, the young farmers were no more familiar with the use of computers than the others.

Each of the groups had one or two farmers with experience of Prestel, all of whom found its main attribute that of up-to-the-minute price reporting, which many found particularly useful as a negotiating aid when purchasing inputs. Ironically, the main reason put forward by others for not investing in this technology was that they could not see the need for such up-to-date price information at additional cost to that which is freely available from alternative sources. As one dairy farmer put it: "all the time five or six weeklies and Radio Four provide the information; I can't see the alternative technology taking off".

Both the intensive and general livestock groups mentioned the MLC telephone service as a useful source of price information. A number of beef and sheep producers noted that knowledge of local auction market prices was particularly useful prior to marketing their own animals.

*Information evaluation and decision-making.* The groups found it difficult to pin-point precisely how they decided to treat the abundance of information received. One farmer likened the process of evaluation to a jigsaw puzzle: "you put little bits together to make one", while another simply said: "every so often something sticks". In many ways these sentiments sum up the consensus view that information and advice in the agricultural sector tends to be 'processed' like building blocks with one source being verified against another. Very rarely did farmers make 'instant' or spontaneous decisions based on a single source of

information or advice. As one livestock farmer explained: "information is drip-feed, slow".

All were agreed that information that was farm-specific was much more highly valued than information of a general nature. Generally, advice which was paid for was considered likely to be more reliable and commercially unbiased than that offered free of charge. It was also felt that, generally speaking, the most reliable information is based on actual experience and that however much information was provided a farmer had to try things for himself on his own farm.

Market information was clearly an influential factor affecting marketing decisions. Livestock farmers, for example, spoke of a tendency to hold stock back from the market when price trends indicated lower returns. However, longer term decisions relating to buildings and machinery, crop varieties, or animal breeds were, on the whole, much more influenced by word of mouth and personal contact than by media sources. As one arable farmer explained: "I feel somewhat disturbed about changing a system that has evolved over a period of time because of a free magazine telling me so."

Overall, the groups confirmed the traditional image of farmers being largely conservative, responding cautiously to new ideas and advice and relying heavily on personal experience and that of other farmers. There appeared a general reluctance to experiment, yet concern that others might be doing better.

*The survey: some questions on IT answered.* The survey took the form of a postal questionnaire, sent to 2,000 farmers selected from the British Telecom database. From the initial sample, over 900 questionnaires were returned representing a response rate of 45 percent. The results of the survey are published in "Communications in Agriculture" (Fearne & Ritson, 1989). For the purpose of this paper, discussion of the survey's findings will be limited to the use of IT.

Only 12 percent of respondents used a computer on the farm. This proportion was higher for the largest farms, of whom almost one quarter used a computer, and among the younger farmers and those with agricultural diplomas or degrees. The importance of enterprise size was also confirmed by the fact that almost one third of those with two or more full-time employees used a computer on the farm. Almost two thirds of those with a computer used it for accounting purposes. This percentage was even higher in the North East and East Anglia, where dairy and arable farms predominated in the sample. It was also higher for the larger farms. The most common reason for not using a computer was that the size of the farm did not justify it. This reason was more often mentioned by the older farmers, of whom 60 percent felt their farm to be too small, compared to 38 percent of the younger farmers. Almost 30 percent of respondents felt that a computer was inappropriate for their farming system. Surprisingly few respondents cited cost (15 percent) or complexity (13 percent) as reasons for not using a computer.

Less than one quarter of respondents used off-farm computing services (such as accounting services). The proportion of respondents using these services was higher for farm managers (31 percent), dairy farmers (46 percent), bigger farms

(30 percent), and for those who had attended an agricultural college (37 percent), but significantly smaller for the older group (6 percent) and the beef and sheep producers (4 percent). Interestingly, there appeared to be a relationship between involvement on the farm and the use of off-farm computing, with 80 percent of those least involved personally on the farm using accounting services compared to only 25 percent of those spending all their working time on the farm.

Of all respondents 92 percent had never used Prestel. Of those who had, information on market prices and the weather were sought by over 80 percent. Not surprisingly, the interest in weather information was fairly uniform across farm types and region, but information on market prices was less important to dairy farmers, of whom 42 percent were interested in information on input prices compared to 27 percent of all respondents. Needless to say, the small number of respondents with experience of Prestel reduces the significance of this particular question.

## Conclusions; a future role for IT?

The use by farmers of IT remains distinctly limited, both in terms of user numbers, type of farmers using IT, and the way in which IT is used (with farm accounts as the prominent application). Evidence suggests that while farmers on the whole acknowledge the usefulness of computer services provided by private and commercial consultants and other advisory bodies, they are still to be convinced of the value of incorporating IT directly on the farm. Judging from the reaction of the group of young farmers interviewed, this wider adoption of on-farm computer technology might not come about before the turn of the century, when the next generation of farmers will be better trained to make use of the technology. In the mean time attempts to establish the widespread application of IT at the farm level should proceed with a greater understanding of farmers needs and their incremental approach to decision-making. Farmers are (and clearly recognize themselves as being) individuals with specific information requirements. If IT is to become more widely used by farmers as a routine aid to decision-making, then the 'hard sell' approach of enthusiasts and salespeople must be replaced by a more acutely defined 'market led' approach, in which the agricultural market for IT is more clearly segmented. Just as farmers need to be persuaded of the potential benefits of using IT, so the software houses need to show a greater awareness of farmers' requirements, and a greater understanding of the adoption process.

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# Computers and the nature of farm management

U. Nitsch

*The introduction of computer-based information systems to be used by farmers, as in many other fields, is preceded mostly by great expectations. Some persons even tend to think that eventually the computer might take over farm management. This article tries to make an assessment of the validity of such expectations. Based upon a study among Swedish farmers, it examines the nature of farmers' decision-making. The latter is based upon an adaptive rationality, as opposed to the normative models of formal rationality used by scientists. Essential to this rationality are coordination skills: the ability of farmers to arrange the many interacting factors important to the totality of a farm in a satisfactory way. What the farmer needs in this complex situation is personal communication and tacit knowledge, knowledge that cannot be reduced to facts and rules. Consequently computer-based information systems can be useful tools only in some aspects of farm management, but they will never replace farmers' decision-making. To understand the possibilities of the computer as a tool in farm management, a distinction between interpretation skills and application skills is necessary.*

There are many problems in farming which are easy to specify and define. For instance, if a crop is damaged by a pest, the problem can be defined easily. A precise question can be asked of a computer-based information system which delivers appropriate and useful information as a basis for decision-making. Most problems in farm management, however, are of a much more complex character. Management of a farm requires the ability to handle a multitude of biological, technical, economic, and social factors in a changing and largely unpredictable environment. In such complex problem situations, the mere delivery of factual information corresponding to specific questions is not enough to ensure appropriate management decisions. This statement does not mean that computer-based information systems are of no use in farm management. It means that we need to clarify what such systems actually can and cannot do for the farmer.

In a study conducted at the Department of Extension Education at the Swedish University of Agricultural Sciences, farmers were interviewed about their

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experiences using the following computer systems: a system for crop protection (Epipre), a system for dairy feeding recommendations, farm computers (personal computers), and a videotex system (Ekman & Nitsch, 1988). For each system, 25-40 farmers were interviewed on their farms. The farmers were selected to represent different backgrounds in terms of age, size of farm, and other characteristics relevant to the specific computer application. The aim was to capture as much of the variation in farmers' experiences with computer-based information systems as possible. This article summarizes the most important conclusions of the study.

## Farmers' motivation and rationality

The applicability of computer-based information systems in farming can only be assessed in terms of their contribution to farmers' management decision-making. To make such an assessment, we need to know how farmers actually make their decisions and manage their farms. In the literature on this subject, however, the authors usually begin with normative models of decision-making and farm management and assume that these activities will be improved by a fast delivery of computerized research-based information. From this point the researchers proceed to exhaustive presentations of the various technologies and computer programs that are available or under design.

The analysis of farmers' use of computers presented in this article has a different initiation point. It is based on the results from earlier empirical studies on the nature of farm management conducted at our department (Andersson & Axelsson 1988; Bernes & Johanson 1984; Landquist & Lundkvist 1983; Nitsch 1982, 1987). An important insight gained from these studies is that Swedish farmers' primary motivation in farming does not stem from making monetary profit. More basic to motivation are factors such as family appreciation, freedom in making decisions, room for creativity, pleasure of working outdoors, and working close to nature. These observations do not imply, of course, that Swedish farmers are not concerned about the economy of their farm operations. But money is seen as a means for maintaining the farming occupation rather than the other way around. This conclusion has important implications for the applicability of computer-based information systems in farm management. Often designers of such systems assume that maximizing monetary profit is a farmer's primary goal. Thereby, the system is separated from the thinking and motivation of most farmers who give priority in their management decisions to other aspects of living.

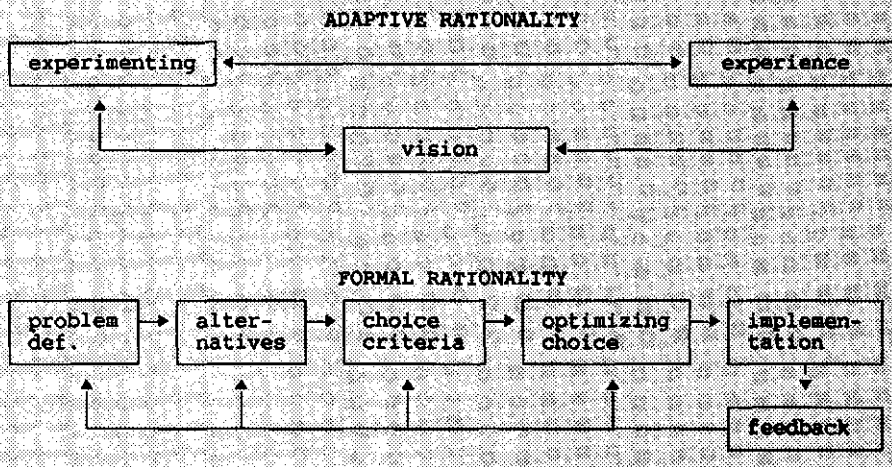
Our observations are made in accordance with empirical research on management in small manufacturing firms (Johannisson & Gustafsson 1984; Sørlie 1982). This research concludes that decision-making in small firms is not performed as a separate activity. Instead, it is integrated in the owner-managers' daily work activities. The owner-managers operate as living information systems, acting in a

continuous flow of information, and prefer personal communication with colleagues, employees, customers, and suppliers rather than impersonal communication. Their decisions seldom are based on formal analyses or calculations. Instead, decisions grow out of a synthesis of information and the owner-managers' own experiences and aspirations. They apply decisions an adaptive rationality that is different from the formal rationality usually recommended by researchers.

## The Nature of farm management

Adaptive rationality is pursued as a continuous interaction among visions, experiences, and experimentation. Managers have a vision of how they want their firm to develop. This vision reflects their personal needs and aspirations. They evaluate information against their vision and experiences and develop new experience by trying out new procedures and technologies. Formal rationality, on the other hand, represents an application of 'scientific method' to decision-making. It is thought of as a linear process that begins with the narrowing down of a complex reality to manageable problems, and is followed by a systematic collection of information, identification of alternatives for action, maximizing of choice among alternatives against explicit criteria, and, finally implementation and feedback (Figure 1).

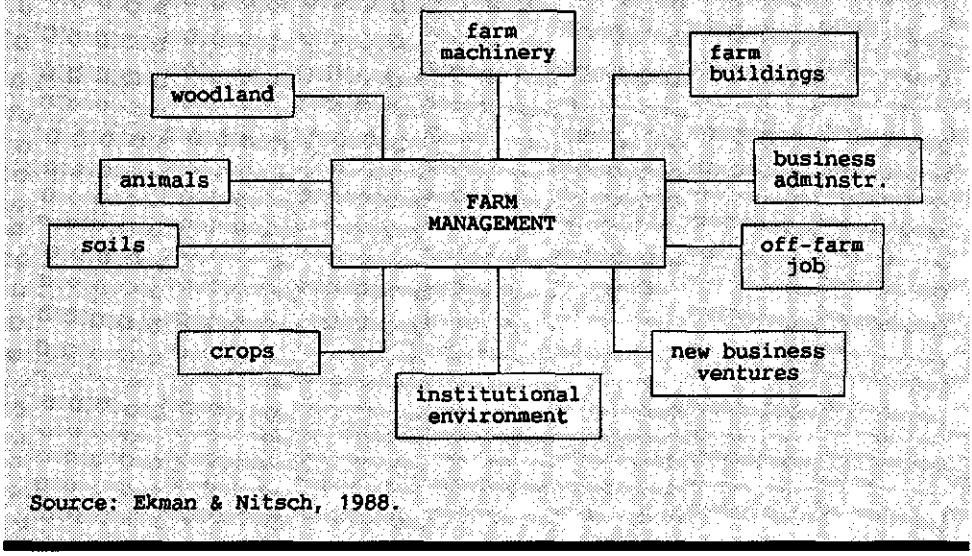
Figure 1: Small business managers apply an adaptive rationality rather than a formal rationality in their decision-making.




Source: Sørlie, 1982.

Our studies with farmers show that the rationality applied by them is also of an adaptive kind and is very similar to that applied by small business managers. The crucial element in this rationality has been defined as the farmers' coordination skills. The outcome of farming is influenced by weather and a variety of biological factors that are largely unpredictable or cannot be controlled fully. The institutional environment of legislation and market conditions also may offer surprises. Therefore, farm management is not a matter of doing everything correctly. Rather it is a matter of getting approximately the right things done under the specific prevailing conditions on a farm. It is not a matter of optimizing the parts, it is a matter of making a totality run in a satisfactory way (Figure 2).

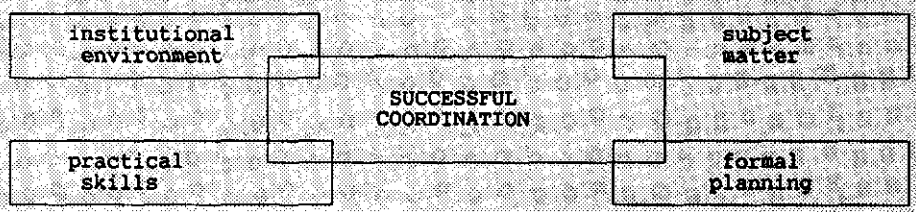
Figure 2: Many interacting factors must be coordinated in farm management.




Source: Ekman & Nitsch, 1988.

What is the nature of the coordination skills and how are they learned? Coordination skills require subject matter knowledge, skills in formal planning, practical skills, and skills in interacting with and adjusting to the institutional environment (Figure 3). But these skills are not sufficient. The crucial element in farm management is not found in any of these separate skills or knowledge areas, nor is it equal to their sum. The crucial element is how to apply them to the complexities of farming under the social, biological, economic, and technical conditions of a specific farm.

Figure 3: Successful coordination is the application of several areas of knowledge and skills




Source: Ekman & Nitsch, 1988.

**Will the computer take over decision-making?**

Some agricultural administrators and researchers seem to believe that the farmers' coordinating skills can be reproduced and replaced by computer-supported systems analysis. But there is no way to capture all aspects of a complex activity system, such as farming, in a computer program. We cannot expect to have exact information on all of these factors, nor do we know their exact relationships. In such a complex system there are many possible solutions, not just one correct answer (Suppe, 1988). The correct answer is often unique to the specific farming situation and can only be provided by the farmer. Farming is a human activity and a computer cannot equal the farmer's conceptualization. No matter how many factors are include in the models and how many simulations are run on computers, successful farm management remains dependent on the farmer's coordination competence, including the ability to interpret and apply computer output to specific conditions on a given farm, taking into account the existing priorities.

Coordination skills cannot be learned in a classroom. They can only be 'learned by doing' in the context in which they are applied (i.e., working with the machinery, livestock, soils, crops, finances) on the farm. They consist of a combination of experience, intuition, and practical know-how. The coordination skills represent a kind of knowledge that has been termed tacit knowledge: it cannot be reduced to facts and rules and cannot, therefore, be formalized and translated adequately into a computer program. It is maintained through what Schön (1983), in his analysis of professional knowledge, calls "reflection-in-action", and applied when a problem situation is characterized by complexity, uncertainty, instability, uniqueness, and value conflicts. This scenario often exists in farm management. In

such situations, professionals must rely on their own repertoire of experiences from various problem situations. They enter, as expressed by Schön, into a dialogue with the situation and there is no general set of rules to apply in this process.

**Personal communication remains indispensable**

At an OECD-meeting with directors of agricultural advisory services, two US extension administrators proposed that: "with the development of interactive software packages, the user will be able to feed-in data specific to [his] own enterprise and hence to obtain recommendations that [he] can act upon. The distinction between this form of advice and face-to-face consultancy will become progressively smaller, and since the latter will always remain expensive it is clear that farmers will slowly but surely come to accept that the computer provides the most effective route for obtaining much of the technical help [he] requires" (Bell & Bunny 1985).

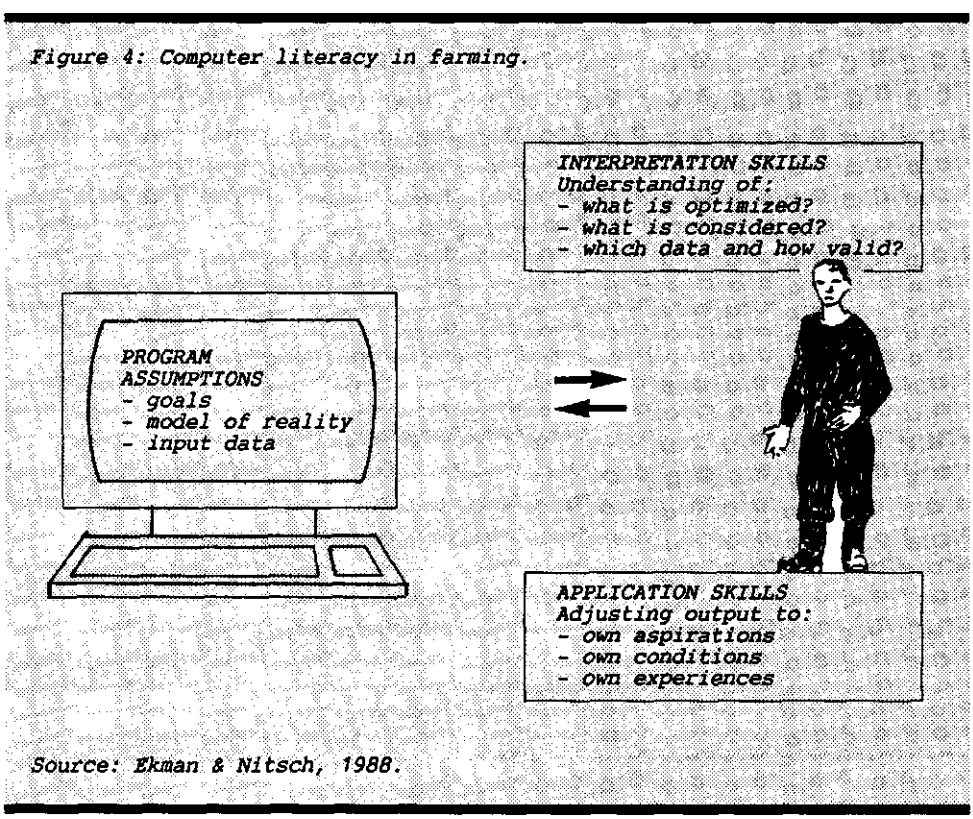
Our research on Swedish farmers' use of computer-based information and the previous analysis of the nature of farm management show that this proposition fundamentally is wrong. To be sure, computer-based information certainly will remain cheaper than face-to-face consultancy, but it will never replace the need for personal communication.

Computers operate on the basis of formal rationality. They do not understand what motivates the farmer and they have no insight and experience from the multi-dimensional complexities in farming. They never shared the work with a family and never felt the pride and joy of carrying on a family tradition. A computer-based information system can only provide factual information as a response to well-defined questions on trivial problems. But factual technical information that responds to an incorrectly defined problem is of little value. In situations in which it is important to adapt information to complex and unique conditions, when the situation is unclear and unstable, or when old experiences from the operation of the farm need to be changed; in all such instances, personal communication remains indispensable. As we have seen, such instances represent the normal state of affairs in farm management. In addition, there is another dimension in face-to-face communication that must not be neglected. The interest, support and empathy of a human adviser enhances inspiration, stimulates creativity, and energizes individuals. A computer-based information system does not offer a human relationship. I know from my own experience as an agricultural adviser that this human support is often tremendously important as a motivating force in the development of a farmer's management procedures and decision-making.

## Computer literacy in farming

As shown, computers cannot replace farmers' coordination skills. Still they can be helpful tools in supporting decision-making. To use them in such a way, farmers must be able to translate and adapt the computer output to their own unique farming reality. This ability is called 'computer literacy in farming'. In our research, we have conceptualized this ability as computer interpretation and application skills (Figure 4). The interpretation skills refer to farmers' awareness of the assumptions underlying the computer programs (i.e., assumptions about goals, reality, and input data). Assumptions about goals are implied in the activities the computer system is designed to optimize (e.g., profit, environmental protection, work safety). Assumptions about reality refer to the models of reality included in the computer systems (e.g., models of farmers' decision-making, dairy production models, models of crop growth). Such models are always simplifications, including some parts of reality and excluding others. Finally, assumptions about input data refer to the completeness and validity of the data processed in the systems.

*Figure 4: Computer literacy in farming.*




*Source: Ekman & Nitsch, 1988.*

It is not mean that farmers must have a complete understanding of the contents of all these assumptions. This assertion in fact, would be impossible since the assumptions are often not fully known by the system designers themselves. In complex systems, the designers often cannot even be identified (Weizenbaum, 1980). But in order to judge the applicability of computer output to a specific decision, farmers must be aware of the existence and the basic nature of the assumptions underlying the programs.

Interpretation skills are not sufficient to assure appropriate use of computers. For instance, as a researcher, I may have developed a good understanding of the assumptions underlying some computer programs. Still I would not be able to apply them appropriately in a farming situation, since I lack the experience of running a farm. To use computers as tools in decision-making, one also needs to know how to relate the computer output to one's own aspirations, experiences, and the conditions on the farm. This ability reflects what is called the application skills. With the increasing use of computers in farm management, computer interpretation and application skills will become an additional essential part of farmers' coordination skills.

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# From electronic to social interfaces: towards extension-based characterizations in relation to IT applications.

C. Leeuwis

*For extension scientists most information technology (IT) applications are no more and no less than media for communication between different actors. Although this seems a rather obvious statement, some of the consequences of such a simple assessment tend to be overlooked by people that try to encourage the use of IT in general, and in agriculture in particular. Therefore, in the first part of this article it will be argued why, from the extension science perspective, we cannot understand the use (or, often more appropriate, the non- or mis-use) of IT applications without examining this as an activity with a highly social character. It will be suggested in the second part, therefore, that the debate on IT in primary production needs considerable reformulation, if one wants to arrive at effective and efficient use of IT. Especially the relevance of existing classifications of IT applications and the meaning that is commonly assigned to the term 'user-interface' will be questioned.*

## The social character of using IT applications

The best introduction to the social dimensions of IT use is probably to ask the question: "who are (supposed to be) the users?". In agriculture, the farmers are usually referred to as 'the users'. But wouldn't it be equally valid (in the Dutch context) to argue that it is the government and the farmers organizations that want to *use* IT applications to improve the competitive position of certain segments of the Dutch 'knowledge intensive' agricultural sector; or that researchers and extension workers *use* IT applications to promote their (often scientific ) farming models; or that it is the agro-industry that want to *use* IT applications to integrate production columns, tie customers, and increase margins?

Thus, it is clear that IT applications have to be seen in the context of an often complex social setting. There are usually a variety of communication processes taking place in such a setting, some of which may be related to, or supported by

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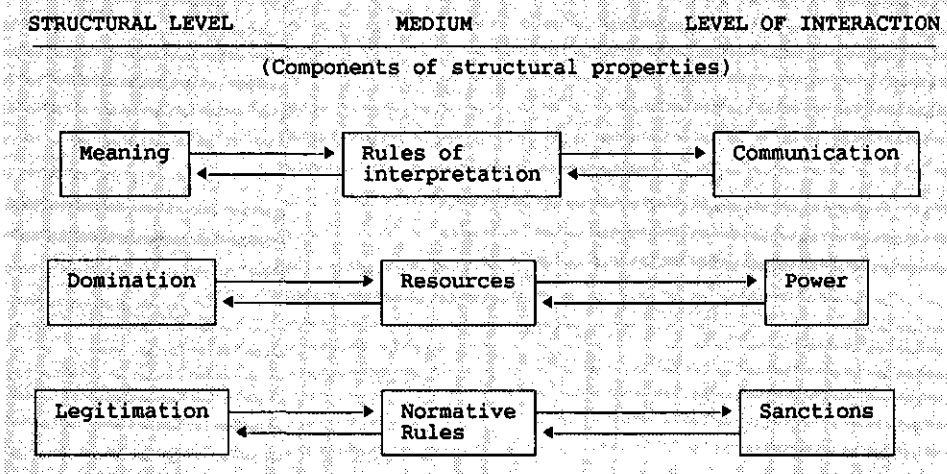
IT applications.

It is of crucial importance to recognize that in such communication processes, knowledge and information are socially constructed entities, and that mechanistic conceptualizations of knowledge and information (as implied by terminologies such as 'information flows' and 'knowledge transfer') are not very helpful if it comes to the understanding of knowledge processes (see Leeuwis, Long, & Villarreal, this volume). The relevance of this assertion will be illustrated by discussing agricultural extension (and IT applications for decision support in particular) in relation to some of the crucial properties of social interaction in general.

According to Giddens (1979), the structural properties that guide interaction can be conceptually divided into three components of equal value (meaning, domination, and legitimation). Actors make use of these components in the creation of their (inter)action via rules and resources that correspond with these components, as is illustrated in Figure 1.

Figure 1: Conceptualization of the relation between structural properties of social systems and human action.




Source: Munters et al., 1985.

The components mentioned above can only be distinguished analytically: "the communication of meaning in interaction does not take place separately from the operation of relations of power or outside the context of normative sanctions. All social practices involve these three elements" (Giddens, 1979). Apart from these three components of structural properties, we will also show the importance of

the concept of 'agency': a crucial characteristic of human action (Long, 1989a).

*Meaning.* The socially constructed nature of knowledge and information implies that social phenomena may be interpreted differently by different social actors. For farming, this holds true for both the 'agricultural content' of a certain phenomenon, and the 'relational content'. If we take, for example, the use of the concept 'cow' we can imagine that a researcher who is developing a management information system for dairy farmers, defines 'a cow' as: "a more or less efficient transformation factor between grass and milk". According to the life-world[1] of the researcher (as reflected in the computer program) a particular cow may be labelled 'non-efficient'. The perception of farmer X, however, is influenced by the fact that he shares a long history with a particular cow; thus the meaning might be more like: " ... that particular cow my father bought in 1980, and that, as a result of an unfortunate mastitis, has lost one of her quarters, so that she produces less than average at the moment. Yet, she is worth holding on to, since she is an easy calver that has produced seven of my best cows in the last ten years. Anyway, it is just not right to dispose of a cow like that." Under similar conditions farmer Y might assign yet another meaning to the cow, whereas farmer Z could agree largely with the researcher.

Similarly, at the relational level, the researcher might see the IT application as something that extension workers could use to advise farmers on which cows should be sent to the abattoir. Farmer X, however, might reject any interference of the extension worker on this point, while farmer Y would like to have a discussion with the extension worker on his own criteria in this respect, and farmer Z would just like to have and explore the program herself.

Given these differing interpretations it is very hard to asses who's meaning is 'correct'. Given the specific contexts and life-worlds that they are situated in all views have a certain validity. Nevertheless, it will be clear that such differing interpretations significantly affect the ways farmers, and others involved, respond to specific IT applications.

*Domination.* Extension workers and farmers often have different resources at their disposal. In the Irish context for example (Leeuwis, 1989), extension workers were the only channel through which farmers could apply for certain EEC grants and subsidies. For getting grants or loans it was in some cases also required to show a development plan approved by an extension worker. The criteria that such a plan should meet were in turn decided upon by (inter)national politics. The extension workers were evaluated by means of a quantitative assessment of the 'development achievements' of his or her clients. What was included in the term 'development' was defined in great detail by policy makers and managers of the extension service.

It is not surprising that this resource or power configuration did greatly influence both the information that was exchanged, and the ways it was acted upon. We can easily imagine that a totally different picture would emerge with a privatized extension service that is independent from the state, and for which

farmers pay a considerable amount of money.

In the context of IT applications for registration and comparison among cucumber growers in Holland, it appears that the distribution of decision-making power in both the development and implementation phases of the program, is of crucial importance for explaining the long-term viability of such applications. Where there was only limited involvement of cucumber growers in the decision-making on the variables that were to be included in the program, the variables that were of crucial interest to them were completely left out. Similarly, it appeared that, given the particular nature of enterprise comparisons, it is highly important that individual growers can influence and negotiate the composition of the small grower-groups that are supposed to facilitate these comparisons (Leeuwis & Arkensteijn, 1991).

*Legitimation.* Ideological issues too can have a great impact on social interaction. The normative models and ideas on farming that extension workers put forward can conflict seriously with those of farmers, as becomes very clear in so called 'less-developed' societies. In other cases, such as Holland, an 'entrepreneurial ideology' was widely internalized by the (surviving) farmers. Communication processes cannot be properly understood without taking this ideology into account. Furthermore, scientific models based on experimental research are often considered by farmers to have little practical validity. The same holds for market information or advice that is made available by agro-industries.

At the relational level, the idea that an extension worker is someone who knows things better than farmers might also be considered illegitimate by many farmers. Thus, various implicit legitimacy claims are often present in extension messages, and they may have repercussions for social interaction. For example, in relation to IT we can refer to a software package that analyzes feed and fodder costs for dairy farmers. The program provides farmers with actual results and (on the basis of scientific models) normative figures. Farmers, however, often do not aim to reach these figures at all. Instead, they often explicitly formulate their own goals in relation to them: for some variables they aim above the normative figures, for others below, and sometimes they merely 'agree' with them. And frequently, a number of normative figures are simply considered irrelevant. Thus, farmers appear to have their own models and ideas on farming, and many times these are, at least partly, of an ideological nature (see Roep, Van der Ploeg, & Leeuwis, 1991).

*Agency.* The rules and resources that people draw upon in interaction are, of course, subject to change. Giddens (1979) speaks of the "duality of structures": "structures are both medium and outcome of social practices". In other words: production and reproduction of structures take place simultaneously. This implies that people are seen as 'knowledgeable' agents, that have a certain space for maneuver. Agency then, according to Long: " ... attributes to the actor (individual or social group) the capacity to process social experience and to devise ways of coping with life, even under the most extreme conditions of coercion. Agency -

which we recognize when particular actions make a difference to a pre-existing state of affairs or course of events - is composed of social relations and can only become effective through them" (Long, 1989a).

In relation to farming, agency is clearly illustrated by the increasing body of literature on 'diversity in farming' that shows that (even under very similar conditions) one can often distinguish between different valid patterns of farm structuration, based on different farmer rationalities and strategies (see e.g., Bolhuis & Van der Ploeg, 1985; Leeuwis, 1989). This body of literature also makes clear that such differing farming patterns are related to types and sources of knowledge and information that are considered to be relevant. Turning back to the example of the feed and fodder costs program for dairy farmers, it was possible to identify several farming patterns, each with its own specific logic. There appeared to be systematic differences in the goals that were formulated on the basis of the normative figures between farmers adhering to a different 'style' of farming. Also the different styles were characterized by different attitudes towards (and from) available sources of knowledge and information (Roep, Van der Ploeg, & Leeuwis, 1991).

**Reformulating and redirecting the debate on IT**

In The Netherlands, the debate on the relation between farmers and IT applications tends to focus on the 'user-friendliness' of software packages, as well as on so called 'information needs' of farmers. It is assumed that, in order to be user-friendly, a software package needs a good 'user-interface'. The concept of user-interface refers to certain software characteristics that allow for effective and efficient use of the program. Thus, the user-interfaces discussion is centered around such issues as screen lay-out, colors, menu's, windows, and cognitive ergonomics. The content of the IT application, then, should be based on the information needs of farmers. In practice, these information needs are often derived from information models (see Leeuwis, Hamilton, & Moorman, this volume) and/or ideal-typical decision-making procedures.

Furthermore, the debate seems to have a highly 'technology-driven' character. What happens is that hard- and software industries and automation departments have the resources to come up with a continuous flow of 'new' hard- and software technologies. In the past decades we have been bombarded with programming languages, databases, spreadsheets, videotex, videodisc, expert systems, hypertext, pc's, modems, glassfiber cables, etc.. Every significant development in this field seems to cause anxiety in the agricultural society: "how can we integrate this development into our sector", and "how can we use this to strengthen our position". As a consequence, a search for possible users and 'information needs' is launched. A suitable user is readily embraced, and the process of gaining experience with the particular package can start.

This 'technology driven' development of IT applications is apparently linked to ideological and political interests of the actors and institutions involved; "we are living in the 'information age', and our export oriented and knowledge intensive agricultural sector should not 'miss the boat'". Besides, institutions subsidized by the state nowadays have to show a certain dynamism to justify their existence.

What becomes clear from this brief characterization of the IT debate is that social issues of meaning, domination, legitimation, and agency hardly play a role in de discussions, although it was made clear in the preceding paragraphs that social processes play an important role in (IT-mediated) communication (and could even explain the dynamics of the debate itself). The debate therefore completely ignores some of the crucial issues for both the explanation of IT (non) use in agriculture, and the development of appropriate IT interventions.

Below some suggestions will be made with regard to a possibly useful redirection and reformulation of the debate.

**Broadening the concept of user-interface**

The concept of user-interface, until now, has a merely psycho-technical meaning. Yet, the interface between farmers and computer software, as we have shown, cannot be properly understood from a combination of software-technical and/or cognitive psychological perspective. Software packages play a role at certain 'social interfaces'[2]; they imply, create, or reshape social interfaces. Thus the concept of 'user-interface' could be redefined into: the whole of subjectively appreciated relations (in time and space) between both a particular soft- and hardware package and the actors involved in its realization and use, and between the different actors themselves, in a specific context.

In this definition, relevant aspects of a 'user-interface' are, amongst others:

- the way in which actors (such as farmers, extension workers, information analysts, software specialists, researchers, agro-industries, and government agencies) are or have been involved in the development process of the application, and the meanings people attach to this:
- the institutional arrangements and organizational setting around the IT application, and their (perceived) consequences for the actors involved;
- the political, cultural, and economic implications that application use would have in the eyes of the actors involved;
- the software technical rules of interaction between the IT application and its users (which, as we have seen, cannot be equalized to 'farmers').

In this sense a user-interface is not something that allows for efficient and effective use of the possibilities of a particular package, but rather a set of social processes that do, or do not lead to development of effective and efficient properties and use of such a package. As any social process, user-interfaces can, to a certain extent, be influenced and/or managed by the actors involved. We will

return to this later.

By stressing the social character of IT applications, it becomes clear that it is very hard to make general normative statements about criteria IT applications should meet. There is an enormous variety of social settings in which IT-mediated communication can take place, and, as we have seen earlier, within each setting there are often many different interpretations and strategies related to it.

In extension science, the traditional solution for coping with this enormous diversity is segmentation into target groups, but this approach is rather problematic here. First of all, social situations tend to change fairly rapidly in present day agriculture, so any particular classification of farmers may soon become irrelevant and outdated. More important, however: different actors find different classifications relevant at a particular point in time. Classifications handled by policy makers or extension workers might be quite different from the classifications that farmers find relevant (see e.g., Roep, Van der Ploeg, & Leeuwis, 1991). Thus, any decision on a classification is inherently questionable. Furthermore, any classification tends to oversimplify reality, is insensitive to differences in contexts, and individual projects of actors.

We can conclude that IT applications in agriculture will, in general, have to anticipate on a variety of frameworks of meaning, (networks of) social relations, physical possibilities, etc.[3] Such an anticipation goes well beyond anticipation on information needs; in fact one can argue that information needs are not an independent category, but results of earlier mentioned frameworks of meaning, social relationships etc.

An implication of all this is that 'ready-made' IT applications will have to be developed in such a way that people can easily integrate them into their own social and physical context. A number of characteristics of present day IT applications and their user-interfaces seem to obstruct such adaptability, as the following observations show:

1. a number of applications have a very prescriptive nature. Such a design does not seem to take into account that there are different valid strategies to organize a farm. Also, such a design implicitly assumes that researchers' and extensionists' knowledge is superior to that of farmers, instead of recognizing that a joint creation and integration of knowledge from different life-worlds is essential. IT applications will have to facilitate such a "fusion of horizons" (Long, 1989b);
2. often extension workers are seen as the ones that should validate extension support systems (ESS). This negates the idea that ESS eventually have to anticipate farmers as well;
3. there is still a tendency to create black box applications that are hard to interpret by farmers. Furthermore, the flexibility of programs is often limited. These characteristics obstruct the possibilities for farmers to integrate the information produced with the relevant knowledge they already have;

4. the role that farmers play in development processes is merely that of 'guinea pigs'; farmers are used to test programs, but they hardly participate in decision-making on software development;
5. there is still a great emphasis on scientific knowledge and formal decision-making procedures. This does not adequately reflect the importance of non-scientific types of knowledge and actual decision-making practices;
6. a number of applications try to coordinate different fields of farm activity. It is thereby often assumed that the relations between different fields of activity in the model can be expressed as 'simple' arithmetic equations and/or if-then-else statements. This reflects an under-estimation of both the complexity of farming as a social activity and the farmers' coordination skills (see Nitsch, this volume);
7. many of the applications aim at support for 'vertical' communication; there is little attention for supporting 'horizontal' communication among farmers. This again shows an over-valuation of knowledge produced at research and extension levels. At the same time chances are missed to establish IT applications that would, more than likely, show considerably fewer inherent communication problems.

**Towards an extension based classification or characterization?**

If there is little possibility to make general statements on what criteria certain types of IT applications should meet, the question remains whether or not there are any classifications that remain useful. Classifications of IT applications are until now mostly centered around software characteristics. In agricultural circles, people refer to either the classification of development stages as formulated by Sol (1984) and Van de Herik (1988), or to concrete soft- and hardware packages (such as videotext, expert systems, hypertext, and MIS). As was outlined earlier, the use of such a classification reflects and stimulates 'technology driven development' that can be held responsible for many of present day failures and disappointments.

From an extension science standpoint there is a great need for classification on the basis of a communication paradigm. Given the social character of communication, this means in fact that we would have to classify social situations (instead of IT applications), and, on the basis of that, determine what criteria soft- and hardware should meet in order to provide a useful contribution to the actors involved. As we have shown such a classification cannot suffice by just identifying the actors that are involved in the interaction as, for example, Schiefer (this volume) has tried to do. The social nature of the relation will have to be taken into account as well.

Any possible rigid classification of social situations, however, is probably even more 'tricky' than a classification of target groups. Therefore it is wiser to just

define the important dimensions on which a social situation, on the basis of empirical analyses, can be characterized. The relevant dimensions can easily be derived from the theoretical model presented so far; meaning, domination, legitimation, and agency were already identified as crucial aspects of social interaction. In order to characterize a specific social situation on these dimensions a considerable amount of research will be necessary.

In order to focus such research, a fifth aspect is essential: the social activity that is supposed to be supported by IT-mediated communication. This statement is, of course, questionable; why would one start off with a preconceived idea about the communication that is to be supported by IT. Is it not more consistent with the argument so far, to claim that one can only identify activities that might be supported by IT on the basis of research? This might be true, but in practice it is hardly realistic to expect that anyone with decision power about the considerable resources needed to carry out such research, will actually decide to allocate them without at least the beginning of an idea about the role IT can play. Such an idea will usually originate from one (or more) of the actors involved (e.g., farmers, extensionists, or researchers) and does therefore inherently have a certain social validity.

How such a procedure for characterization of social situations might look like and fit in with development processes related to IT applications in agriculture, is discussed in more detail in the article of Leeuwis, Hamilton, and Moorman (this volume).

## Notes

[1] A life-world, according to Schutz, is a "lived-in and largely taken-for-granted world" (Schutz & Luckmann, 1973). "It is constituted of various forms of social knowledge, intentions, and evaluative modes, and types of discourse and social action, through which actors attempt to order their worlds. Such life-worlds are the products of past experiences and personal and shared understandings, and are continuously reshaped by new encounters with people and things." (Leeuwis, Long, & Villarreal, this volume).

[2] Long (1989a) defines a social interface as: "a critical point of intersection or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found."

[3] Because of practical and financial reasons it is probably only possible to deliver 'ready-made' IT applications in agriculture; in many other branches it is very common to develop 'tailor-made' IT applications for one specific enterprise.

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# Systems supporting the use of local knowledge

G. Schiefer

*The collection, processing, and communication of information are basic processes of major concern in present technological developments. New information and communication technologies promise substantial farm management support by improving the information basis for management decisions and facilitating the exchange of data between the farm and its institutional environment. These improvements might have fundamental effects on our views on management and the management routines that have been developed in the past. The present emphasis in the discussions on the utilization of the new technologies is on the collection and processing of information on the farm, through the use of management support computers in process control and database management. However, with farm management's dependency on outside information for production control and market engagement, the improvement of communication is of similar, if not greater, importance. This article, therefore, focusses on communication and discusses present and future developments in farm management communication. The principal directions of development derive from recent experiences with technologies introduced into the farming community of various European countries.*

## Principal farm communication patterns

A farmer is usually involved in a variety of communication patterns, linked with different management activities and utilizing various types of 'technology' (e.g., paper, speech, and similar means). Despite its variety, certain principal communication patterns cover most of the information exchange situations related to farm production and marketing. It is convenient to identify them by considering the participating institutions involved. This leads to the following categorization:

1. communication with service institutions (e.g., extension services) that provide: (a) general information to a group of farms (e.g., through magazines, radio messages, reference books, general telephone messages); or (b) situation specific information ('advice') to individual farms (e.g., through

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personal visits, telephone calls, letters);
2. communication with other farms (e.g., through meetings, personal visits) to exchange information about individual market results, production technology, and production control;
3. communication with monitoring institutions that collect information from certain farms for political, statistical, or general advisory purposes;
4. communication with trading partners in marketing to collect information from, or exchange information with (individual or collective) trading partners;
5. communication with trading partners and service institutions (e.g., bookkeeping associations) to document financial arrangements (e.g., payments) and physical transactions (e.g., product specifications, deliveries).

## The technology

The utilization of electronic communication technology requires access to communication lines, terminal equipment on farms, and off-farm computer capacity (such capacity organizes the communication procedures and provides data storage and processing capacity). The actual technical realization might differ between different systems, for example, terminal equipment can involve microcomputers, special purpose terminals, or even television sets with an appropriate link to the communication line.

In agriculture, some prominence was gained by videotex systems that use telephone lines for communication, and allow sophisticated 'user friendly' screen designs. However, the actual technological realization of an electronic communication system is of minor importance for the discussion that follows (that is, as long as it is based on the principal elements listed above). The discussion will focus on the conceptual approaches used in designing communication systems, not on the specific technology utilized for its implementation.

## Development principles

The potential advantages of the new communication technologies derive, in principle, from speed, storage and communication capacity, and processing capability. Speed and communication capacity allow distribution of information to those who need it, at the time they need it. What would improve the economy of information distribution. Storage capacity allows the accumulation of more, and often very specific information. What would improve the access to valuable information on a farm.

However, realization of these advantages is usually not just a question of simple replacing the 'old' by the 'new' technology. It requires development of approaches

that meet the communication needs of farmers and their communication partners.The new approaches also must be adapted to the specific features of the new technology. This is only partly possible through theoretical elaborations, it requires many empirical tests under real life conditions.

Most reports on the use of new technologies in farm communication refer to such (more or less developed) 'prototypes' that use a trial and error procedure to further improve a specific communication pattern. It is, however, encouraging to note that most of the designs that have emerged in various European countries are quite similar, despite differences in initial setup and development process. We assume, therefore, that the examples reported in Harkin (1990); Houseman (1989); Schiefer & Graumann (1987); and Schiefer (1988, 1989) represent development directions that can be considered as principal guidelines for the future. The next section of this article refers to these examples, and relates them to the communication patterns defined earlier.

## Some examples of recent developments

*Communication between service institutions and farmers.* Provision of general information in databases is the most widespread utilization of the new communication technologies. The main problem for the farmer remains the selection process to acquire the appropriate information, and the 'translation' of this information to his specific situation. To facilitate the selection process, information providers initially linked the various information items in a search structure that followed the principles suggested in the European green videotex tree (EGVT) (Christiansen, 1983). It parallels the administrative structure of information providers (mostly extension services), and facilitates the organization of an appropriate 'responsibility system'.

The EGVT organization is still dominant in the Balis system (Bavaria, Germany), the AgriLine system (Ireland), and the newly developed systems in Southern Europe (e.g., Spain and Italy). Unfortunately, the information linkages in the EGVT do not relate to the information needs arising from decision problems in farm management, one of the reasons for the slow acceptance of the systems by farmers. Present development efforts, therefore, are shifting towards a more 'client-oriented' grouping and presentation of information. A case in point is the Tele Agrar (Schleswig-Holstein, Germany), whose management was forced to quickly establish a broad user base among farmers.

The provision of situation specific information ('advice') can be based upon: (a) computer programs ('interfaces') that use information about a farm's specific situation to access and customize information from databases; and (b) the direct personal provision, upon request, of customized information from extension agencies. A successful approach for this 'provision upon request' is the Clinic concept, introduced by the Irish AgriLine videotex system and nowadays established in

many other European systems. It allows farmers to formulate questions that are to be answered by competent specialists. Both questions and answers are collected in a database to service other farmers.

*Communication among farmers.* A service that is widely implemented in videotex systems, and often is considered to be one of the most attractive features, allows farmers to exchange information on market conditions (e.g., prices). Often the service returns an overview of the general situation through the system to all participants. Critical parts are the design of this overview, the selection of representative farms, and the establishment of a controlled reporting procedure.

The positive response from farmers to the market reporting system has initiated trials to extend this service to the exchange of information on production and farm management actions (e.g., in plant protection). A variation of this approach relies on reports not from farmers but from experimental farms and demonstration plots supervised by the extension service.

*Communication among farmers and monitoring institutions.* In some countries, service institutions collect information from individual farms for further analysis. An example is the collection of data on the milk production of individual cows. In various systems in The Netherlands, France, and Germany the service institutions report this data back to the farms through a videotex system. In addition, it provides computer programs for the solution of farm management problems in milk production (e.g., a program to calculate individual feed mix rations).

*Communication with trading partners in marketing.* Exchange of information on sales and purchase offers is widespread, and has been implemented in many systems through bulletin boards that list these offers for specific products. Administrative support is offered at various levels, ranging from simply removing outdated sales or purchase offers to the provision of sorted listings or selective search procedures for bulletin board readers. The bulletin board approach has been extended to various experiments that distinguish between sales and purchase offers, such as experimental 'electronic markets'. Analysis of agricultural markets suggests a great potential for such developments, and coincide with substantial interest from many farmers.

Exchange of information with an individual trading partner, or contract negotiations, have not yet been implemented in electronic communication systems. Telephone, telefax, or other direct communication systems are still considered to be the prime choice for this type of individual information exchange.

*Communication with trading partners and service institutions about trading activities.* This type of communication involves the exchange of information about product specifications and financial arrangements with trading partners, and the exchange of information on trading activities with service institutions (e.g., bookkeeping services) for documentation. Both represent a 'natural' development in the utilization of communication technologies. They are the link between the

electronic data processing systems that are gradually introduced on farms, and non-farm businesses. As farmers are still slow in adopting electronic data processing systems, these communication links are not yet commonly used in the farming community. Nevertheless, this does not reduce the principal attractiveness of this communication approach.

## Development Problems

The development of appropriate electronic-based communication systems involves the solution of a number of development problems that often receive insufficient attention. These include:

1. the identification of information needs;
2. specifications on how information is formulated and presented; and
3. the development of routines for information use.

*Information needs.* Difficulties in developing appropriate videotex information systems have reflected our limited knowledge of farmers' information needs. In the past, the possibility of providing information to farmers was constrained by the characteristics of traditional information channels, such as the farm press. This, in turn, limited the pressure to identify specific information needs of farmers, and left it mostly to be discussed in direct contacts between farmers and extension personnel.

Videotex, with its almost unlimited capacity for storage and transmission of information, has changed the situation fundamentally. Utilization of the new potential requires research efforts that identify: (a) the problems farmers want to solve; (b) the information required for a solution of these problems; and (c) the present information basis and educational level of potential users. This approach allows the identification of specific information needs. For information that can be provided through electronic databases (i.e., videotex systems), the decision on its actual incorporation into the system needs further analysis of available alternatives. As a consequence, the information content of a videotex system might depend not only on the information needs of farmers and the suitability of the system to provide the information, but also on the specific media environment in a certain area.

*Formulation and presentation of information.* The provision of information through electronic means requires explicit specification of how this information is to be formulated and presented. Formulation refers to the level of aggregation and processing, presentation to display and characterization of the information value, reliability, and relevance.

Through videotex and other electronic means, farmers are often confronted with new types of information. They are not familiar with its access or use, nor with its value, reliability, or relevance for the solution of their problems. For the realization of the potential of a comprehensive database it is vital that users 'see'

the value of certain information, and are capable of understanding its relevance for the solution their problems.

*Management routines for information use.* The utilization of new (videotex-based) sources of information in farm management requires the development of appropriate linkages between the existing farm decision processes and the new information sources. The videotex information has to be incorporated into these processes. When this is established, the decision processes themselves often are subject to change. New, and more efficient decision routines tend to evolve to correspond directly with the improved characteristics of the technology.

## Management problems

The management of an electronic information and communication system raises many questions and might be one of the major challenges for the development of such systems. The main problem areas include:

1. management of the database (questions concern the frequency, organization and coordination of updates, or the further development of the database content and structure);
2. the coordination of different information suppliers, and the development and enforcement of certain data quality standards;
3. finance of the information system, with questions on the feasibility and suitability of various alternatives; and
4. the control and limitation of information access through the establishment of 'closed user groups' or through 'appropriate' pricing of information.

The value of specific agricultural information might vary among different farmers. Pricing of information is, therefore, a problem similar to the pricing of other goods. There are, however, some difficulties involved. Apart from farmers' inexperience in the evaluation of information, which might require (at least for some time) support from extension, the value of information might not always be independent of the number of information users. Especially for some types of market-related information (e.g., price forecasts), it might make a difference whether the information is accessible by a few selected farms or by everybody.

## Institutional organization

The requirements of electronic (videotex based) information and communication services have consequences for the institutional organization of the service providers. The various services require responsive institutions that adhere to these requirements. Information provision in databases, the organization and supervision of electronic markets, or the provision of advice of various kind, need the availability of institutions that are geared towards such services. As far as

extension organizations are involved, they might have to adapt their internal organizational structure, or establish appropriate service units.

## Conclusion

The further development of appropriate information and communication services requires, however, also appropriate service management and the establishment of institutional structures which correspond with the needs of the services and allow the establishment of a subsequent responsibility system.

The utilization of new information and communication technologies in agriculture is part of a development process that needs to define the appropriate formal information and communication patterns. With regard to related communication approaches, a number of principal developments have been implemented (mostly on videotex-based technology) as prototypes which show valuable development directions, but still require further improvement through research and communication with users.

Some of the applications have already reached a stage that makes them quite attractive for farmers to use, however. Furthermore, a comparison of developments in various European countries indicates a certain continuity, which makes them the first choice for a more widespread promotion of the new technology in the farming community.

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# Strategic investment in European videotex support systems for agriculture

M. Harkin

*This article[1] addresses the issue of strategic investment in support systems for European agricultural videotex. It is a wide ranging topic involving national, regional, and institutional policy, linkages between videotex systems and information sources, arrangements for keeping systems up to date, the integration of videotex systems with existing institutional information systems, and problems associated with the transition of such systems from pilot projects to sustainable services. I have approached this task by reviewing the current condition of agricultural videotex in Member States, particularly developments introduced since the midst of 1988. In addition to a literature review, a postal survey directed at selected 'national focal points' for agricultural videotex developments was conducted. The article starts out with a European overview, followed by a closer look at the different countries involved. Finally, an attempt is made to integrate the findings and produce some general statements and recommendations concerning the issues that the paper is directed to resolve.*

## European overview

A look at agricultural videotex user numbers (Table 1) gives a reasonable indication of the growth or decline of these services in various European countries between 1988 and 1989. The figures in Table 1 refer to farmer and agribusiness users; in some cases they are precise, in others they are reported estimates. Considerable growth in user number over the last 12 months has occurred in France, Germany, The Netherlands, and Ireland, although it has started from a low user base, with the exception of France. The condition of agricultural videotex in the United Kingdom, once a flagship country for the medium, remained static. Only in Germany and The Netherlands were respondents confident that previously predicted growth in numbers over the next 2-3 years (reported in the 1988 survey) would occur or be exceeded.

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Table 1: Agricultural videotex service users (1988-1989).

| | Farms > 1 Ha 1987 | Agricultural videotex service users 1988 | 1989 | change |
|---|---|---|---|---|
| France | 911,800 | 25,000 | 35,000 | + 10,000 |
| United Kingdom | 242,900 | 3,000 | 3,000 | --- |
| Germany | 670,700 | 3,000 | 5,000 | + 2,000 |
| Netherlands | 117,300 | 1,500 | 3,000 | + 1,500 |
| Ireland | 216,900 | 105 | 180 | + 75 |

Source: Harkin, 1989; Eurostat, 1990.

It is only by examining the videotex situation in each country that we can begin to understand what has brought about the present condition of the technology, its ambivalent reception, and to consider its future.

## The 'strategic investment' dimension - by country

*France.* France has demonstrated the greatest commitment to information technology (IT), particularly at the infra-structural level and even more particularly to videotex, with over 9,000 videotex services now in operation being accessed by some 4.5 million Minitels, 90 percent of which are free or subsidized (Teletel Newsletter, 1989). In France it is very much a case of the technology looking for a use, with the private sector left to find the market. A policy of liberalization and decentralization was implemented and any organization could create and operate a Teletel service on its own host with the agreement of France Telecom alone.

Most of the agricultural videotex services have been developed by independent agricultural institutions, such as the Chambers of Agriculture of which there are 117 (95 departmental, 22 regional). Because of this geographical and political independence, many separate videotex systems have been developed containing similar content and services, resulting in investment overcosts and duplication of operating costs and effort. The implementation of these services is financed by the agricultural organizations from their own budgets which are derived from commodity surcharges paid by farmers.

With few exceptions agricultural videotex services in France are not profit making, on the contrary: Netter (1989) estimates that the revenue from service provision covers only about 15 per cent of the operating and development costs involved; some 30 million francs of fresh financing must be found each year by the service operators and their sponsors.

In 1988 there were about 25,000 French farmers using the 100 Teletel based agricultural services; average monthly usage was low at 30 minutes per farmer, with an average 3-5 minute connection time. Growth in users numbers was not expected to be dramatic. The general consensus was that numbers would grow to 50,000 over the next 10 years and that the main use would be data exchange between farm-based computers with local data and central computers with collective data. In addition there would be high quality niche services providing local applications.

In 1989 this scenario changed rapidly. A niche service involving all the artificial insemination (AI) cooperatives in Brittany was used by 1,000 farmers in December 1988; by July 1989 the number had risen to 15,000 and was targeted to reach 30,000 in 1990. The total increase in French agricultural videotex user numbers in 1989 can be explained by this particular explosion, doubtlessly stimulated by the distribution of free or highly subsidized Minitels. Briefly, the AI Teletel service permits a farmer to submit his cow code and to request a specific bull and date of the inseminator's visit to the farm. The system can then interrogate the inseminator's file, schedule his visit, plan semen handling, generate an invoice and update the local files on each cow. This system is a good example of the incorporation of an information/ordering service into the existing organizational structure. It replaces the original service which was previously provided over the telephone, involved two telephone operators at each AI cooperative and considerable internal paper work. The new videotex service effects cost savings and increases efficiency. Its growing popularity is guaranteed by assigning priority to Teletel-access customers, resulting in long waiting lists of voice-telephone clients and costly consequences.

*The Netherlands.* The Dutch are the only European country with a truly coordinated national plan for the development of the new information technologies in agriculture. One of these national plans, INSP (Informatics Stimulating Plan) 1984-1988, was initiated to stimulate the use of computers at farm level; the plan continues its effect through 1991.

As a result of INSP the organizations of farmers and growers set up 5 branch organizations to stimulate, coordinate and direct the development of management systems in the following 5 sectors: dairy (Taurus), pigs (Siva), poultry (Siplu), horticulture (Situ) and arable crops (Sivak). The branch organizations are coordinated by a central agency, COAL. Global information models were developed for each branch of agriculture and these form the core structure from which the various technologies and information services emanate (Geuze, 1988). Agricultural videotex is one of these information technologies and is being promoted through projects in three agricultural sectors: arable crops (Vitak), dairying (Veenet) and horticulture (Infotuin).

The public videotex system, Viditel, also offers a small number of services for horticulturalists. Cebeco, the largest agricultural cooperative organization in The Netherlands, has recently entered the videotex arena by setting up its own system,

Agrotel, to service its members. About 1,000 farmers are users of Agrotel but since most of these are thought to also use Vitak, Veenet, and Infotuin there is danger of double counting user numbers. Finally, a videotex project (Agrocom) was being prepared for 1990 to involve some 3,000 users in the province of Noord-Brabant; it will also access Vitak and Veenet.

As in other countries the full cost of providing these services is not recoverable through user subscriptions. About 70 percent of the start-up costs are subsidized by government, information costs (excluding weather reports) are supported by agribusiness and the user pays for terminal equipment, communication and other operating costs.

Interactive videotex applications are viewed as a step in the evolutionary process of the farmer's move towards the use of microcomputers on the farm, so the farmer is encouraged to acquire a PC even for exclusive videotex access. The penetration of microcomputers at farm level is steadily increasing, almost doubling each year, from 400 in 1986 to 4,300 in 1989. Among the developments that may positively affect uptake is the introduction early in 1990 of a file transfer mechanism, via the videotex host, to provide a graphical display of rainfall information superimposed on a map of Holland at 15 minute intervals.

But in general the agribusiness sector, whose participation and contribution is required to ensure the uptake of the new technology in the farming sector, still seems to hold a limited vision of the uses and advantages of the medium. On the other hand there is some evidence of potential conflict with the arrival of commercial giants, such as Cebeco, who are competing with similar services for the same user population.

*United Kingdom.* Agricultural videotex has remained static in terms of user numbers since the collapse of the Prestel Farmlink service in August 1988. In february 1990 ADAS (Agricultural Development and Advisory Service) withdrew from Prestel leaving some 3,000 farmer users to be serviced via Prestel by the main information providers: NFU (National Farmers Union), MMB (Milk Marketing Board) and MLC (Meat and Livestock Commission). It was estimated that ADAS covered only about 20 percent of its videotex costs. When ADAS introduced page charges the number of accesses dropped off by 50 percent.

Although videotex is a two-way technology, in the UK it is still largely used as a dissemination medium and videotex systems are integrated to some degree with existing structures, forming conduits for information distribution.

There is little evidence either of real integration of videotex systems into farm business; a movement towards transaction processing ('teleprocessing') is probably required in order to have a major impact at the farm business level. A good example of this kind of activity is provided by Tabrotec, a private videotex service, which auctions 2,000 pigs per week; the buyers do not leave their offices and the pigs can go directly from the production unit to the abattoir.

The NFU and MLC are integrated with market and auction structures as market intelligence reporting mechanisms. The NFU also uses videotex as an

internal means of communication, collecting, and distributing information among its membership. MMB provides a gateway to applications on their host, giving access to the farmer's own information, and feeding back data on test results, milk prices, and quota positions.

Recent developments involving agricultural videotex in the UK have had a repressive effect. The demise of the Farmlink coordinating role, and the earlier withdrawal of ICI from videotex, can only have cast a long shadow over the future of the medium in UK agriculture and associated activities. And the shadow is getting longer; all the major agro chemical companies and other commercial organizations withdrew from Prestel in the last year.

How can these trends be reversed? Houseman (manager of the ADAS Information Service Unit, see also Houseman, 1989, this volume) advocates a vigorous marketing approach, development of special applications, low volume/high value services and, when it comes to information provision: "...don't just give them what you have - give them what they need!".

*Ireland.* Agricultural telematics is represented in Ireland by the AgriLine videotex service which is operated by Teagasc, the Agriculture and Food Development Authority. AgriLine is, following a two year trial period, promoted on a fee-paying basis nationwide. Growth in user numbers has been slow and with a current base of 180 farmer and agribusiness subscribers, it covers about one third of its operating and development costs.

In Ireland it was anticipated that large agribusiness organizations, such as dairy cooperatives, would become strategic actors in the videotex scenario through incorporating the technology in their existing systems and by providing services to their membership through the AgriLine medium. Perhaps the major problem associated with introducing videotex services to large agribusiness organizations, banks, and similar institutions, involves the proliferation of non-standard terminal equipment in an organization's computer environment. Technical solutions can be found, but its introduction is usually obstructed by DP managers and administrators on the basis on cost, space, maintenance, and support.

There can be little doubt that AgriLine, in common with other agricultural videotex developments in Europe, was initially perceived as a medium for modernizing traditional 'downstream' information dissemination mechanisms to a selected target audience, i.e., computerizing and electronically communicating the research - advisory - farmer information flow. And this is what happened: it was essentially a one-way process, although farmer users were consulted regarding the usefulness and digestibility of the information and invited to suggest improvements. Interestingly, this perception changed radically during the transition of AgriLine towards a self-sustaining service in the post-pilot period. Now the most demanded components of the service are those that are either farmer driven (the Clinics) or under direct farmer control (Closed User Group). The Clinics, which are farmer-generated, problem-databases seeking immediate solutions, in which farmers can also participate as problem solvers, illustrate the

'upstream' user influence which ensures response to specific user needs (a case study of the first 500 Clinic problems and answers has been published, see Scally & Wilkinson, this volume).

The transition from pilot project to self-sustaining service is a slow and difficult one. A number of problems associated with uptake by farmers must be overcome. Some are short-term, others are long-term. They include determining the 'correct' information and service package, the cost of user terminals, creating awareness at different levels of intensity (education, training, promotion, marketing), and institutional commitment from the host organization and information providers. Frawley (manager of AgriLine, personal communication) insists that there is a large and underrated 'missionary' dimension involved in converting the uninitiated at all levels: "...it's a bit like St. Paul on the road to Damascus - you may have seen the light but that doesn't mean that others have!"

*Germany.* There is no comprehensively defined national plan for the development or financing of agriculture IT in Germany; this role is determined by the regulating powers of the free market. Nevertheless there are authoritative bodies to coordinate development and to provide stimulus and support. These bodies include the federal and state ministries of agriculture, the Chambers of Agriculture, the German Agricultural Society, and the German Farmers' Union.

Exciting things are happening in agricultural videotex and the targets forecast (1988) for the 2-3 years to come will probably be exceeded. There are some 15 different agricultural videotex services operating on the national videotex system (BTX), seven of which are regionally based (groups consisting of extension services, Chambers of Agriculture, Ministry of Agriculture, etc, acting as information and service providers). The remainder are operated by commercial companies (such as Bayer, BASF, John Deere) which supply product information and services. Gateway facilities operate: users accessing a regional extension service, such as Tele Agrar in Schleswig-Holstein, can be gatewayed automatically to one of the private company services, on selection of a topic of information (eg., plant protection) provided by that service. This process provides great flexibility and avoids replication of information on the various services.

Videotex systems are integrated into existing structures to varying degrees, particularly in the roles of support and information provision. Among the new developments which are expected to promote the uptake of the medium are the following: the adoption of 'Clinic' systems in several federal states; a fully automated market information system, piloted by Tele Agrar, in which regional product market prices are automatically updated; in Bavaria a number of new dialogue programs have been implemented; an electronic market place for horticulture has been developed where buyers and sellers can exchange prices through an advanced notice board.

There are about 5,000 users of these services in Germany, 900-1000 of which pay service subscriptions; 800 of these are Tele Agrar service subscribers, the remainder are 100 percent subsidized. This total figure represents an increase of

some 2,000 or more users in the last year, no doubt stimulated by the distribution by PTT of some 3,000 free multitels to selected regions and farming sectors. Most of the extension videotex services remain at the moment in a 'trial-phase'.

The exception is Tele Agrar of Schleswig-Holstein were the Chamber of Agriculture issued an ultimatum: recruit 1,000 fee-paying subscribers within a specified time or the service will be shut down! It was felt at the time, since Tele Agrar was being supported at considerable cost out of general farmer contributions to the Chamber, that it had become a rather expensive 'free' service to an exclusive few. Interestingly, the ultimatum produced results: through a vigorous selling campaign the Tele Agrar management is achieving the target on time. Users numbers now stand at 800. No doubt this activity was paralleled by the development of marketable information services on Tele Agrar. The subscription fees of 15 DM per month are expected to cover all costs, including staff. The lesson is clear: it can be done if pressure is applied, attitudes are positive, and the mix is right.

## Some general conclusions

What conclusions can we draw from our agricultural telematic trawling around some European countries. Let's take a look at investment, support systems, linkages and integration with existing systems, and the transition from pilot projects to post-trial services.

*Investment, support, and integration.* There is considerable investment of varying degrees, in videotex support systems in each of the countries under review. A major question is, however, whether the task at which the investment is directed has been properly defined, or even defined at all ? This brings us back the strategic dimension of the investment - well defined objectives and an overall coordinated, planned approach.

The Dutch come closest to meeting these criteria. Other countries appear to operate on a more 'ad hoc' basis, the probability of success being a feature of the power and influence of the host institutions and their level of commitment.
Agricultural videotex, in global terms, does not pay its own way in any European country. In France there is a national shortfall of some 30 million francs; in Germany, Holland, Ireland, and UK we have seen a similar, though not quite as dramatic, picture. Where does the quite substantial financial support come from, how is it justified, is it sufficient, and can it be more effectively used?

Very broadly, in most transitional and post-pilot situations, support comes from either farmers' organizations or agricultural institutions, such as extension services, research organizations and ministry departments - or a combination of these - together with assistance from PTTs, meteorological services, cooperatives, banks, and commercial agencies in the form of service and information provision and other contributions. So, to a considerable extent, although it is generally

accepted that the golden days of 'government supports for everything agricultural' are gone, government and its agencies does provide support.

Is the investment sufficient? This is a highly debatable issue and unlikely to be resolved to mutual satisfaction. The budget provider will quote a track record of unachieved user targets and seek justification for new allocations. The service provider will seek an increased allocation to provide an enhanced service and improve promotion to achieve new targets. Often it is a matter of retrenchment, revising targets and objectives, improving coordination and the integration of the system within institutional structures, to ensure its survival whilst awaiting changes in the 'market place', e.g., improved communication infrastructures, cheaper terminal equipment, emergence of niche areas, etc. Too often however, transitional services are not given the 'push' that is needed to vitalize them. Institutional initiatives are needed to critically review their future and to either promote them properly or to kill them off decisively. Tele Agrar did achieve remarkable results when put under external pressure.

*Linkages.* The linkage dimension between videotex systems and information sources in terms of providing, maintaining, and updating information is incredibly variable, particularly in the non-commercial sector. It varies from strictly formal to very casual arrangements, which might effect the quality of the service provided. In an ideal world the linkages would be formalized and schedules implemented and maintained and, if the users were paying commercial rates for information, this would be realized. But this is seldom the case; subsidized information is one of the principal and most commonly provided supports of agricultural videotex services across Europe.

There are considerable demands imposed on organizations which accept the role of information provider in any serious sense. Depending upon their level of contribution, staff time and changes in existing operational procedures are often involved, the degree of disruption being determined by the extent to which the organization is already collecting and distributing information. In the absence of financial incentives, considerable institutional commitment and goodwill is required. Linkages requiring highly structured formality arise where information, such as weather or market prices, is provided frequently at predetermined intervals. In the other extreme, there is the demand for once-off or relatively stable information, requiring infrequent communication, though not necessarily less formality, in terms of institutional linkage.

The important thing is that linkages should be strengthened, be effective, and should yield results. Too many linkages are proclaimed institutionally and are never implemented; others are quite informal and operate smoothly. Institutional grey areas of territory and influence are often involved. Sometimes the most effective investment is one of goodwill and reciprocation; a matter of identifying suitable contributors, creating enthusiasm, encouraging participation, and providing recognition.

*Transition.* Finally, we must deal with the difficult matter of the transition

process of videotex systems from pilot projects to sustainable services. Apart from some highly specialist niche services, such as the AI service in Brittany, we have very few commercially successful models. These successful niche services tend to exploit the unique characteristics of the medium in relation to its competitors (press, periodicals, leaflets, newsletters, radio, television, etc.), namely its speed, 24 hour availability, timeliness of information, single source reference, digestibility, two-way communication, interactivity, and transaction capabilities. Identifying suitable niches is undoubtedly a successful formula, particularly where an extensive and essentially free terminal population, such as Minitels is already in place. The problem with the exclusively niche approach is that it is not a transferable success formula to many other services which have adopted a more generalistic approach and are looking for mass appeal. However, the particular lesson is clear: each system should search, identify and service niche applications within their general framework, including institutional niches.

The matter of the implementation of videotex systems in a post-trial environment was one of the issues the postal survey addressed. It was generally accepted that the technology itself is not a problem. Identification of the 'correct' information/service package was stressed, as well as a targeted approach; to provide the users with what they need, not with what is available; to provide a low volume, high value service. The other emphatically underlined component was marketing - to adopt a marketing approach.

Lets take a look at the 'correct' package dimension, both in content and design. Without doubt the most dangerous people to be let loose in this process are the designers themselves. Too often systems are constructed and designed by information specialists without regard to the skills, aptitudes, or educational background of the end-user. Their familiarity with the system and its operation, without interplay with the target audience, can induce a myopic condition in the design process that results in plain 'user hostility'. We have all seen examples of this 'Vasco da Gama' school of design, where the user is abandoned to navigate through vast uncharted oceans of information and treacherous search structures. The message is clear: involve the end-user in the content and design process early in system development.

Efforts in the marketing of agricultural videotex in general have been fairly pathetic (Harkin, 1988). The service providers tend to be information and technical specialists, and the marketing function is seldom reflected in the overall budget in terms of salespeople or media advertising. Marketing, promotion, and education have been neglected at the expense of technical issues and a shift in emphasis is now required. However, vigorous marketing alone is unlikely to be effective without appropriate environmental supports; it is no coincidence that the recent rapid growth in user numbers in France and Germany has been associated with a substantial distribution of free or highly subsidized user terminals.

## And finally .....

It was Victor Hugo who said that nothing is quite so powerful as an idea whose time has come! There is little doubt that the new technologies can contribute significantly to the value-added transformation of data -> information -> knowledge, a process involving both machine and human intervention. The particular features of videotex make it a major contender for the affections of the non-professional user. Considerable investments have been made in most European countries to introduce and promote the technology in the farming sector. And yet the target audience hesitates. This article tried to make a first assessment: what is not ready, the package or the farmer. Given the 'user-hostile' nature of many videotex developments and operations, the 'package' seems the more likely contender.

## Notes

[1] This article is a condensed version of the seminar paper. Because of space limitations it concentrates on five countries only (France, UK, Germany, The Netherlands, and Ireland), whereas the seminar paper dealt with videotex developments in ten EEC countries.

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# Agricultural videotex developments in France

L.N. Netter

*Teletel, the French videotex, was originally developed to replace the telephone-book by an electronic directory. As such, it was meant to be available for free to all telephone subscribers. Furthermore, it was obvious from the start that Teletel might also allow the development of other services. And that is exactly what happened: at the moment around 7,000 videotex services are available, of which 117 focus exclusively on agriculture. This article explores the nature and importance of the existing agricultural videotex applications. It presents a classification that allows comparison of the services. Using this classification, some observations and comments on recent and future developments will be made.*

Teletel combines six components:

1. the telephone lines network;
2. the French packet-switching network (Transpac);
3. terminals (the 'minitels' are widely used, but any micro-computer with a videotex card will do);
4. the French videotex standard;
5. price-fixing and standards;
6. host computers.

The French telecom public service, France Telecom, is responsible for the first five components, while private companies operate the host computers (this component includes hardware, software, authors, editors, and broadcasters).

The price-fixing implies two systems:

a. for using both the telecom facilities and a videotex service the client is charged solely by France Telecom. This according to a predetermined tariff depending only on connection time. France Telecom refunds the service providers with a constant percentage (e.g., 50 percent of a tariff of one franc per minute);
b. France Telecom charges the client the normal tariff for the use of telecom facilities. The client can be charged separately for using a videotex service by the service provider (who might decide not to charge).

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## Agricultural applications

Agricultural applications can be divided into nine groups:

*1. farm management with permanent file creation.* For such applications videotex very often competes with micro-computers. This is strange, because micro-computers are much more efficient when farmers have to deal with a great number of data, whereas videotex is indispensable when data need to be transmitted to central storage and computing units, when individual applications only require few data, or when the videotex system is totally integrated into an organization. So, when farmers need applications that require little data handling, but yet give rapid and precise results, videotex offers advantages.

A typical example of the possibilities these applications might offer stems from rabbit breeding. Farmers need weekly results, which involve keeping record of 20 types of data. Videotex is the ideal tool, but unfortunately there are only a few applications of this kind in effective use, advisers being very reluctant to promote them. The main reasons for this are: (1) with such applications, farmers take care of the input and give first comments on the results. This used to be done by the advisers, who might feel and fear they are no longer useful; (2) these applications force the advisers to provide more detailed and more relevant advice, tailoring their advice to more specific questions raised by the farmers. The reluctance of the advisers to do so is probably due to their too low average level of education.

Consequently, the mainstream of these applications still consist of accounting programs, presently used by a few thousand farmers. Where the accounting offices have chosen Teletel as part of their organization, a small central unit in each local telephone tariff area is linked with the Minitels on the participating farms. Some of the farmers that work this way feel too dependent on their accounting offices and wish alternative structures to be set up, especially referring to micro-computers.

An application of this type now widely used is the one available to advisers in animal breeding. They use micro-computers as daily tools in assisting farm management and visit about 100,000 farmers on a regular basis. All historical files (e.g., containing farm identification data, and data on individual animals, herd changes, monthly economic results) are kept in a central storage and computing unit. At regular intervals (daily or weekly) and at night, to cut down expenses, data are exchanged both ways between the micro-computer and the central unit through Teletel. From the central unit historical files are down-loaded to the micro-computer for each farm the adviser plans to visit before the next exchange session. From the micro-computer, data are uploaded to the central unit, concerning farms visited since the previous session;

*2. individual data delivery.* Nowadays, milk analysis results are often directly accessible through Teletel. Due to new analysis techniques, farmers have their cows' individual results very quickly and can react in time. Soil analysis results are also made accessible trough Teletel but a rapid answer is not of equal importance

here. Information on auction sales results are available in some areas, an application that is expected to expand in the future;

*3. on-line computing without permanent file creation.* 'Slide rule type' programs are available in several videotex services, and many people believe Teletel is the perfect tool for such programs. It seems that advisers use them quite regularly. Farmers, however, do not use them as often as some would have hoped for. Hence, a few disillusions. Those applications combining 'slide-rule' programs with short-life information files, such as irrigation programs linked to meteorological files, appears to be more successful;

*4. access to short-life information.* Many videotex services display short-life information that is constantly up-dated (e.g., market prices, weather forecasts, pest control information). For instance pest control applications are based on field observations done by a permanent panel of three thousand farmers who nowadays send their observations daily through their Minitel to the Pest Control Service computers, instead of sending prepaid postcards as they used to do: the process is cut down by several days. Although videotex gives very up-to-date information, other media (such as newspapers and telephone) are still great competitors. The traffic generated on videotex by such applications is not as high as one would have expected;

*5. access to long-life information.* This type of videotex use has drawn most attention, yet it is the one in greatest competition with all other information media (such as paper, radio, and television). It has provoked great expectations and the creation of a vast number of services and applications. At the same time, it is the most deceiving one, as connecting times and number of calls are very low on all services. In my personal opinion, the main error has been, and probably still is, that far too much emphasis is laid upon this type of application without giving enough attention to other types;

*6. electronic mail.* The past three years have shown a considerable growth in the use of electronic mail. Several thousand farmers have an individual and a group mail box in one of the 26 services that are on the market. But, since France Telecom will set up an electronic mail service open to all telephone users without any subscription fee or procedure, all other electronic mail services will, undoubtedly, show an important decline in their activities, if not a total stop;

*7. links between farmers and their buyers and suppliers.* When farmers deal with their bankers and suppliers, or wish to sell their products, videotex is a perfect tool. Let us give two examples. At the moment the artificial insemination cooperatives of Brittany have 15,000 farmers who order all their inseminations trough Minitel. The farmer puts in his name, the cow numbers, the chosen sire name, and the chosen date for the insemination. On-line, the cooperative computer checks these data and determines the date and time of the visit. Then the inseminator's time schedule is updated with the new appointment.

Another example is found in the marketing of fruits and vegetables (chicory and potatoes) in the North of France. Two days before the farmers deliver their

products to their cooperative, they send information on quantity and quality through Minitel to the computer of the cooperative. The cooperative gets a fair impression of the total quantity and quality it will have to sell. It can warn its farmers in time when over-production threatens (so picking operations are delayed), can plan crate delivery to farmers, etc.

Up till now, this application domain has hardly been explored. My personal feeling is that there is a tremendous increase of productivity to be found when such applications are further developed (see also the remarks of Blokker on chain informatization, this volume);

*8. electronic auctions.* None of the several experiments with electronic auctions have been a complete success, some were a total failure. The ones that nowadays still function are mere electronic catalogues. This might be a improvement compared to previous stages, but it is definitely not what was planned for in the beginning of many experiments. Some of the major reasons for these disillusions include security problems with the electronic identification of authorized operators on a market, too rapid instrumental change in operators habits, and lack of political support when switching from the old to the new organization;

*9. miscellaneous.* Some applications classified as 'agricultural' cannot be categorized in one of these eight groups, although they are produced and displayed by agricultural bodies. As an example, there are several applications dealing with holidays and home rentals in the country, lost in more technical services for farmers.

**Figures, observations, and comments.**

At the moment, around 4.7 million Minitels are in operation, most of them (90 percent) were provided free by France Telecom. It is estimated that (out of a total of over one million) 150,000 farms are equipped with a Minitel, of which only 35,000 are being used for agricultural purposes. Of the nearly 7,000 videotex services now available, 117 deal exclusively with agriculture. Most agricultural services offer their users more than one application. On an average, an agricultural user connects himself for a little less than half an hour a month, which is far less than the average connecting time on the whole Teletel network (approx. 80 minutes). Yet, one must note that these 80 minutes include the time spent on the electronic directory, train or plane schedules, games, etc.

A scanning of the catalogue on all 1988 agricultural videotex applications, published by ACTA (1989), gives the following results (Table 1). These figures, and further observations and analysis of videotex developments in France, do allow some comments.

Most videotex services are in the hands of local and regional farmers' organizations, like Chambers of Agriculture and farmers' unions. In other words, almost none of the services has a national coverage. Moreover, none of the services is run

Table 1: Number of videotex applications, per group and per domain.

| | crops | animals | other | total |
|---|---|---|---|---|
| 1. farm management | 6 | 14 | 8 | 28 |
| 2. individual results | 2 | 17 | -- | 19 |
| 3. on-line computing | 33 | 31 | 29 | 93 |
| 4. short-life information | 59 | 19 | 18 | 96 |
| 5. long-life information | 33 | 27 | 65 | 125 |
| 6. electronic mail | 2 | -- | 26 | 28 |
| 7. link farmers-suppliers | 2 | 3 | 1 | 6 |
| 8. electronic auctions | 3 | -- | -- | 3 |
| 9. miscellaneous | 1 | 3 | 28 | 32 |
| | | | | 430 |

on a really commercial basis, as farmers' organizations support nearly all the development and operation costs of the videotex services.

Three groups (on-line computing, short-life, and long-life information) count up for nearly 73 percent of the total number of applications. It is here that many very similar applications exist. For instance, the 59 applications providing short-life information for crop production only give three types of information: weather forecast, pest control, and market prices. The information is obviously not the same for two different regions of France, but each application has been developed in isolation, as if something like it never existed before, representing a great loss in energy and money. For a great deal this is due to the political and geographical fragmentation of French agriculture, with its 95 financially independent departemental Chambers de Agriculture.

In spite of the large numbers of applications these three groups are the ones the farmers seem less interested in. Connection times and the total number of queries show that those applications displaying long-life information are considered irrelevant by most videotex users. Even though there is a lot of disagreement on the potential uses of Teletel in agriculture, there is a minimum consensus on the fact that videotex is not meant for long-life information. Yet they represent more than one fourth of all available applications, and many editors seem to feel the urge to establish an application containing long-life information, and use it like a signboard. This might be induced by the fact that they are relatively easy to set up and expenditures are underestimated as updating costs are rarely included.

Applications can be split up into two large categories:

1. the ones that have a direct link with the information normally gathered by a service provider. Often they help existing information exchange to function more smoothly. In this category we find all applications from group 2 (individual results), 6 (electronic mail), 7 (links between farmers and their buyers and suppliers) and 8 (electronic auction), and part of the applications

from group 1 (farm management applications);

2. applications that are especially created to establish new information exchange patterns, or open up new information. Their content might bear hardly any relation with the daily activities of the service provider. For instance, pest control information can be displayed by banks as a way to attract attention from farmers.

Commercial relationships between videotex service providers and farmers should differ according to the family their applications belong to. The services based upon applications of the first family call for relationships that may be described as partnership or membership. Applications of the second family, on the other hand, call for relationships that are much closer to simple commercial relationships, which might be reflected in the price-fixing system and tariffs used.

Although we all have nearly ten years of experience behind us, many agricultural videotex service managers and a good number of high level farmers' representatives still think the creation and the running of a videotex service is a political matter. In my opinion, if all decisions were strictly logical, there should have been no general agricultural videotex service creation in 1989, yet there has been.

## Financial considerations.

Every month, the 117 agricultural services are used by a total of around 35,000 clients. A connection time of little less then half an hour a month per user leads to a total of around 14,000 hours. We can roughly assume that, depending on the arrangements on tariff charges with France Telecom, an average service editor collects 30 francs per hour. The total monthly revenues for all agricultural services would then be 420,000 francs, or around 5,000,000 francs a year.

The total expenses for 1988 were about 35 million francs. This estimate includes running costs, costs for updating databases, commercial costs, as well as costs for the development of new applications. With a total revenue of 5 million francs, the total annual deficit of agricultural videotex amounts up to roughly 30 million francs, which local and regional farmers' organizations must pay one way or another. Presently, the deficit is decreasing. An explanation might be that, the more time passes, the better the applications get, and the less unused applications are kept on-line. As an example, Guillaume Tel, the service run by the Normandy Chamber of Agriculture has dropped many long-life information applications that were hardly used, thus reducing production and updating costs.

## Conclusions

Two main points deserve to be raised as conclusions. Videotex is referred to as synonymous to communication, forcing it to compete with other communication

media in the same market and on the same fields of application. It is very interesting to note that the major part of the experiments with videotex were concerned with application that provide long-life and short-life information. With the benefit of hindsight, one could conclude that these types of application should receive considerably less attention, or even be stopped totally.

I am convinced that the future of videotex, and more generally of the coming new telecom services (Numeris in France), lies with applications and services fully integrated in broad information systems in which farmers have their place. As I have shown, several of such applications are already at work in France, and with good results.

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ACTA. (1989). *Applications télématiques agricoles: catalogues 1989.* Paris: ACTA.

# Rurtel: a rural communications network, some lessons from a 3-year pilot project

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*The highlands and islands of Scotland are the most sparsely populated region in Europe, with a harsh natural environment, limited natural resources, and considerable problems of remoteness from main markets, high unemployment, low incomes, and geographical isolation. In 1986 the Arkleton Trust, established to study new approaches to rural development and education in this area and to stimulate greater interaction between policy makers, researchers, and field workers, set up Rurtel as a pilot project to explore the use of new information and communications technologies. Rurtel is an electronic mail (E-mail) and computer conferencing system based on CoSy software, which was developed at the University of Guelph in Canada. It had an initial target of 60 users by the end of three years. This article will provide a broad overview on the project.*

## Objectives and design of the Rurtel project

The objectives of the pilot project were to:

1. establish a computer conferencing system in the Highlands and Islands;
2. demonstrate thereby that such services could be competitively set up and run from rural locations;
3. explore the usefulness, including cost-savings, of computer conferencing for groups working together and organizations with diffused personnel in remote or scattered locations;
4. explore the usefulness of links to national and world-wide databases and other communications-based services;
5. explore and assess the role of computer based networks as a means of strengthening 'horizontal' links between rural organizations and people, thus providing new opportunities for new forms of mutual learning and advisory or support systems;
6. assess the role of computer conferencing as a tool for distance learning and distance working.

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The project was initially aimed in particular at voluntary, educational, and other organizations known to face distance-related problems, but it was open to all organizations and individuals who expressed an interest. It was not specifically agricultural, but rather aimed at all sectors, functions, and interests in rural areas, including agriculture. Nor was it providing information or advice. Rather it was providing a facility, at low cost, which could be used by people and organizations to exchange information, manage their business or networks, and create their own services. It avoided the sophistication and complexity of videotex systems like Prestel, opting for teletext with simple ASCI text and data transfer. In these and other respects it differed from most other rural or agricultural pilot projects at the time, for example those like Bruetel, Grassroots, AgriLine, and Farmlink. From the users point of view, almost any micro-computer with standard communications software and a modem could be used to access Rurtel. For those who already had a computer, entry costs were therefore very low. There was no requirement that a single operating system would be needed. By using CoSy, which was at the time regarded as extremely user-friendly and amenable to self-learning, it was hoped that the entry to computer communications for rural users would be relatively painless!

Rurtel was also a low-cost project - initial investment was around £22,000 in total, and running costs are of the order of £14,000 per annum. It is now used by some 150 individuals and organizations, mainly in the Highlands and Islands. The heterogeneity of users demonstrates the range of activities and organizations in rural areas which have an interest in information technology (IT) and computer communications.

## Evaluation of the project

The recent evaluation of the pilot phase of Rurtel set out to examine the relationship between the original ideas about the potential of the technology and day-to-day practice. 52 Rurtel users or persons identified as related to the network were interviewed in August and September 1989. The main objectives of the evaluation were to:

1. establish the expectations of the users concerning the benefits of the network prior to joining it, and the degree to which these expectations have been realized;
2. describe how Rurtel has in fact been used by the membership (e.g., to identify new/unexpected uses that have emerged during the pilot project);
3. identify problems and/or roadblocks that have prevented the original objectives from being realized;
4. suggest ways in which the network could be improved.

The rest of this article will concentrate on the last three objectives.

## Uses

The network has been used in five key areas during the pilot project:

*1. for distance-management.* Rurtel is proving to be a very effective management tool for organizations or research groups involved in the development and implementation of international and local research and development projects. Many institutes are using the network to develop project proposals, coordinate project development and research, schedule and prepare for meetings, and assemble research material. It enabled teams of project personnel located in various centers in Europe as well as the Highlands and Islands to coordinate their efforts independent of time and distance;

*2. to provide improved services to rural people and increased participation in decision-making.* A typical example is way the Association of Community Enterprises in the Highlands and Islands (ACE-HI) uses Rurtel. It is encouraging the community enterprises it works with to install computer equipment and join Rurtel as a means to access improved services. In the Orkney Islands, for example, ACE-HI provides management and general business support to three community enterprises based on the islands of Hoy, Eday, and Papa Westray. The ACE-HI development officer based in Kirkwall and the three enterprises all have passwords on the Rurtel network. This means that the development officer is now able to maintain daily contact with each enterprise without constant travel. The system also enables the development officer to access the personnel and other resources of the main office at times that are most convenient to his work schedule. In future, enterprises plan to down-load their financial records to the main office for review and financial management guidance. This service will enable them to take advantage of financial expertise not available in their home locations at a fraction of the cost;

*3. to enhance employment opportunities.* The existence of the Rurtel network has enabled a number of individuals both rural and urban based to combine income generating opportunities in a way not previously possible. Carola Bell, a crofter (and also a qualified sociologist) on Lewis in the Western Islands exemplifies the employment opportunities that Rurtel can offer rural people. The network makes it possible for her to continue to manage her croft and function as a part-time researcher for the Arkleton Trust and as a training organizer for the Agricultural Training Board. There is also a project planned to use Rurtel to employ remotely-located indexers and abstractors, providing information for electronic databases;

*4. to improve educational programs and access to them.* An example is provided by the Information Technology Education Center (ITEC) based in Inverness which used the Rurtel network to coordinate the delivery of a computer training program out of centers in Kirkwall (Orkneys), Wick (North-eastern Scotland), Portree (in the island of Skye) and Inverness. Rurtel enabled the three tutors and the project manager to deal with administration concerns and to evaluate and

redesign the learning modules. The three individuals interviewed pointed out that the administrative aspects of the project could have been handled by mail or phone but only the interactive conference enabled them to evaluate each module as it was being offered and redesign the modules in time for the next group of learners;

*5. to improve communication within and between rural groups and individuals.* One of the key objectives of Rurtel was to facilitate the development of 'horizontal' patterns of communication within and among rural organizations and individuals. 'Horizontal' may be contrasted with 'vertical' or 'hierarchical' patterns of communication, where an separate and usually centralized agency provides information beamed to users - the typical case of many videotex and database services. Increasingly it is recognized that centralized provision of mass information has failed to meet the actual needs of many users, who require much more targeted and specific information (see also Engel, this volume; Fearne, this volume). Very often, the development of information within small user groups, with highly defined needs, is proving to be a more effective approach (see Scally & Wilkinson, this volume).

Several examples exist of the development of horizontal communications on Rurtel. Perhaps the earliest were to be found in the various 'Install' conferences, where users helped each other solve hardware and software problems, as well as problems of communication, uploading, and downloading. Rurtel is now being used by a growing number of individuals to establish and improve their personal information exchange networks. For example, a development officer from the Highlands and Islands Development Board (HIDB) stated that the Rurtel conferences he participates in have enabled him to communicate with a range of individuals he had not had the opportunity to meet. These contacts have helped him to better understand what people are attempting to do in rural areas and the human resources that are available. In turn the conferences have permitted him to encourage and assist people to move their projects forward to the stage where they are eligible for funding support from the Board.

Although horizontal communication, and the ideas about knowledge systems to which it relates, is still in its infancy, it is clear that this will be an important area of future development on Rurtel which allows both closed and open user groups to share conferences. Privacy can be maintained for those who need it.

## Organizational, attitudinal, and technical problems

The majority of the individuals interviewed understood and appreciated the potential benefits that the Rurtel network offers their organization or group. However, many of the organizations on the network are struggling to realize these benefits in practice. Some organizations interviewed seldom use their passwords and conferencing and E-mail have as of yet provided few benefits; too few of the

organizations have initiated or participated in open or closed conferences.

We have identified 5 key organizational and attitudinal factors most often mentioned in the interviews that seem to be limiting the use of Rurtel:

1. the membership of many organizations are unfamiliar with any computer application. They need considerable training and support to develop the technical skills and more importantly the confidence to use the technology. So far Rurtel did not provide a comprehensive approach to this training and support. Furthermore, many organizations have limited staff resources and these resources are often overworked. Under these conditions staff find it difficult to take the time to learn and work with a technology that may be intimidating;
2. for many individuals the groups or persons that they need or want to communicate with are simply not on the network. For example, the people who could provide the fish farmers with essential price information were simply not on the system. For a group the network is only of real benefit when all its relevant membership is on-line; few organizations have been able to achieve this (e.g., because of the cost of the equipment or because some are not inclined to use the network). Too often the decision to join Rurtel has been made by one individual, and not as a result of an organizational discussion and commitment;
3. despite the claims that the computer conferencing system is an electronic version of a face-to-face meeting it requires the user to overcome certain fears. First of all, one needs to overcome the view that all messages need to be structurally and grammatically correct. This view is held strongly when comments may be read by an unfamiliar electronic audience. Secondly, it is not always easy for users to get beyond the attitude that every message must be important or profound. In face-to-face conversations our ideas or comments often only take on meaning when they are part of a larger dialogue but many users have not realized that this is also true of conferencing;
4. competition between organizations, even extending to the setting up of duplicate systems, can prevent a 'holistic' approach from being taken to the needs of client groups, or, more generally, rural development. In some cases this is due to a lack of proper liaison between organizations, which leads to lack of knowledge of plans and activities. In others it is due to the need to compete for limited 'market' shares, for example in the field of training and consulting services. In yet others it seems to be a simple case of institutional rivalry;
5. some of those in possession of information and knowledge are not too interested in its wider diffusion, reflecting the fact that information has value to the possessor, both as a saleable commodity and as a source of power. This often leads to situations where individuals or groups will join conferences for what they can obtain, rather than what they can give. There are some

notable examples of this in computer conferencing, including one at the forefront of biotechnology research. Some groups cope with this by being ruthless with non-participant members of conferences. Where action is not taken, conferences may simply not work as media for communication.

Some characteristics of the adoption and diffusion process might put these observations into perspective. Adoption-diffusion processes are facilitated when innovations provide clear immediate benefits that are perceived as important to the user group (Lamble, 1984). A clear, immediate benefit (e.g., a well functioning computer conferencing system) helps confirm the decision of those who have adopted the innovation and sends out a positive message to those who are interested but undecided. Therefore, it is crucial that the agent encouraging the introduction of the technology and the potential users participate in a strategic planning process to introduce the technology. This process should identify the communication/information problems and needs of the users, how this technology will meet these needs, whom the users need and want to see participate in the conference and anticipate problems that might arise. Strategic planning determines the capacity of the extension agent to assist the potential innovator to apply and realize the benefits and to address the limitations that could serve as barriers.

## Lessons for the future

Further analysis made it possible to identify six main lessons from the pilot phase of Rurtel which will need to be tackled. These are:

*1. it is very important that organizations, groups or individuals be encouraged to analyze their communication problems and needs. If computer communications can serve these needs, a strategy relating to its adoption and use should be developed.* There needs to be a recognition of common interest and a willingness to share information and knowledge. This cannot be presumed at that start. Strategic planning for the introduction and use of Rurtel could eliminate many of the problems described in the previous section of this paper. Strategic planning should address:

a. why an organization or individual is joining the network, the practical benefits expected and an assessment of how Rurtel can help to realize a more effective pattern of communication;
b. how the network will be used, which support is needed;
c. the members of the own organization that need to be on the network to enable effective communication and whether the resources to bring these members onto Rurtel are available;
d. the 'outside' organizations or individuals looked for, are they already on the network, or can they be persuaded to join;
e. the type and amount of training necessary to enable Rurtel use, the resources available to provide this training;

*2. a systematic approach to training and support is required to enable more effective use of Rurtel.* In an interim evaluation in 1988 the Arkleton Trust identified that the training needs of the users had been underestimated. Training and trouble shooting has, since 1986, been provided by Trust staff, consultants, and other Rurtel users working almost entirely on a voluntary, unpaid basis. A variety of more formal mechanisms were developed by the Trust to help users to get started, including a Rurtel manual, a series of specially designed start up guides, on-line training conferences, and where possible, brief face-to-face training sessions and telephone and on-line assistance. Still quite a few users remain uncertain concerning their ability to follow the instructions provided and any problems that they encounter when they attempt to log on or use the network only confirms their fears. Much of the training required relates to the basic operation of computers, communications equipment and software, rather than to the use of Rurtel as such.

The users emphasized that the training and support should include the following:

a. a series of learning modules that familiarize the user with the technology in stages rather than one immersion session. These modules should allow for hands-on practice with the technology under the guidance of a trainer;
b. on-line tutorials and face-to-face workshops that increase the users knowledge of the system;
c. on-line guidance on how to rationalize ones use of the system, enhancing ones ability to get the most out of the system at the least cost in terms of time and money;
d. training in the preparation of messages off-line and uploading them into the network during off peak hours, and in parallel techniques of downloading messages and transferring these to and from word-processing packages;
e. training in moderation (chairmanship) of computer conferences;

*3. the provision of a development officer.* As the pilot phase of Rurtel draws to a close, there is a clear need for a full-time development officer who would be responsible for the following:

a. encouraging and assisting users to develop a strategy relating to how they will use the network through strategic planning;
b. developing an inventory of potential users that could benefit from and to the network, and promoting the system with these potential users;
c. organizing and presenting a comprehensive training program, including on-line troubleshooting, tutorials, and site visits;
d. assisting users to identify conference topics that could prove beneficial and persons who should moderate and participate in these conferences. Moderating conferences that can be initiated as open conferences. The moderation of computer conferences requires considerably more skill and energy than many people expect. Some users noted that many of the conferences that they had participated in or monitored lacked focus, failed to generate their

interest, and all to often became a dialogue among a small group of participants. Intervention (e.g., effective moderation) by a development officer could help demonstrate that Rurtel conferences can serve as a useful medium for information exchange, debate, and decision-making.

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# The AgriLine Clinics and the IFA Closed User Group

Q. Scally and M. Wilkinson

*AgriLine, the videotex service for Irish agriculture, is operated by Teagasc, a government organization for agricultural development. This article concentrates on two of its applications; the Clinics and the Closed User Group. The Clinics are problem answering services for farmers, with every Clinic covering a specific knowledge domain (e.g., dairy). Simply put, the farmer enters his problem into the system and a specialist will respond generally within 24 hours with an answer. The Closed User Group is a 'farmer driven' service that allows members to share valuable market information (e.g., on farm input and produce sale prices). This 'inside' information is provided by the farmers themselves, and is listed in easy access videotex files. This article starts out with a description of AgriLine. It continues with a closer look at the Clinics and concludes with a evaluation of the Closed User Group.*

## AgriLine

AgriLine was launched in March 1985 with considerable financial support from the European Community. After a two and a half years trial period it is now promoted on a fee-paying basis. It reaches a steadily growing group of farmers and agribusinesses, at the moment it includes around 180 subscribers. Its earnings cover about one third of the operation and development costs.

Teagasc initially focused a large proportion of its development effort on the compilation of encyclopedic databases on all aspects of farm management. This involved producing skeleton frameworks for each of the commodity areas under consideration, which subsequently formed the basis of the videotex menus. Work was then assigned to relevant commodity specialists contributing to AgriLine. Comprehensive databases were built up in each of the following areas: dairy; cattle; sheep; cereals/combinables; and farm business. However, there remained a number of problems with the above approach:

1. in order to attract farmers other than drystock, dairy, or tillage farmers, it

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was apparent that similar large size databases would have to be developed in areas such as pigs, horticulture, etc. This would have required a similar development effort for a much reduced return in terms of paying subscribers;
2. it became clear that these databases would never be 'completed' given its scope and the range of expertise involved. New sections continue to be added to the database in response to the demand from farmers and specialists;
3. in general, for more comprehensive videotex databases the procedure of obtaining the required information becomes slower and sometimes more difficult for the farmer;
4. it was evident that a large proportion of AgriLine usage involved farmers accessing the service in order to find a solution to a particular problem. Still, AgriLine could never guarantee that a farmer would acquire the right answer by searching the databases. Sometimes there simply was no right answer, and sometimes it just could not be found. This was causing some frustration and disillusionment among both farmers and service providers;
5. it was also evident from analyzing usage patterns that the most popular services on AgriLine were those which were 'farmer driven', i.e., whose content was determined by farmers themselves. Examples of these were the Small Ads and Notice Board and the IFA Closed User Group. These required significantly less effort to operate for a much greater return, in terms of usage.

These difficulties were apparent during late 1987, as the pilot project was coming to its end and AgriLine entered into a marketing and commercialization phase. While the encyclopedic databases were, and still remain, an essential component of AgriLine and are highly valued by its users, Clinic services were developed in order tackle the above problems.

## The Clinics

The essential features of the Clinic system are as follows:

a. the farmer can 'post' a problem up on the AgriLine system. He can choose whether to attach his name to the problem or not, in the which case it is termed a 'confidential' problem;
b. a relevant specialist attached to AgriLine will normally respond within 24 hours with an appropriate answer to the problem. Once the reply has been entered by the specialist, the farmer can read it when he next enters the system;
c. the Clinic allows only the registered specialists to provide the initial answer to the problem. After this, the reply facilities can be used by all farmers to add their comments. The problem thus becomes an open forum to which all can contribute;
d. all farmers can read all problems and responses, the most recent ones

appearing first in the filing system, thus being the most accessible;

e. all problems, answers and comments are stored, for practical purposes, forever. Each of the 17 Clinics can store 1000 problems. This allows the build-up of a 'farmer-orientated' database of problems, answers, and comments which can be reviewed by farmers.

The two primary components involved in the development of the service were software development and specialist support. About six man months were devoted to the software development of the Clinic service. This included initial design and development, testing, and full scale implementation. The development language was Fortran, which was used to link all videotex applications software to the videotex host software known as "IVS" developed by Aregon International Ltd. The operation of the Clinic requires a sophisticated applications programming interface to the host software not normally found on videotex host systems. The interface on the IVS system, which is known as ADS (application development system), allows the text of videotex pages to be modified, page choices to be set up, pages to be copied and deleted (etc.) via software, and it is these facilities that the Clinic software uses. The first operational Clinic was the tillage Clinic and this was used to test the software.

The cooperation of specialists over a wide range of disciplines was essential. It was achieved over a period of six months, starting with the tillage Clinic in January 1988. The development of this Clinic allowed AgriLine to establish practical procedures required to operate all the other Clinics. There are currently 17 Clinics functioning (dairy, cattle, sheep, pig, animal health, animal nutrition, silage, grassland, tillage, horticulture, soils, fertilizers and trace elements, forestry, drainage, reclamation and irrigation, farm business, taxation, machinery and building), with a total of 32 regular Clinic specialists, and a further group of 20 occasional contributors. The majority of these specialists are based at 7 Teagasc research centers located around Ireland. At each of these centers a contact person linking that center and AgriLine. This contact person checks the relevant Clinics each morning for new problems. When problem arrived they are printed and passed on to the appropriate specialist. The specialist returns a written reply to the contact person, who inserts the answer into the Clinic. The majority of the specialists are primarily engaged in research work and none of them are fully devoted to handling queries from the AgriLine Clinics. This gives rise to difficulties during times when specialists are unavailable (attending conferences, etc.). In order to maintain a 24 hour response time for the farmer, AgriLine needs to closely monitor the progress of queries coming into the Clinics and if specialists are unavailable, to pass them on to alternative specialists. Difficulties can also arise when problems are entered into inappropriate Clinics, it inevitably reduces the response time.

The Clinics accounted for 20-25 percent of total annual AgriLine usage in 1989. As expected, usage of individual Clinics is largely influenced by seasonal factors. During 1989 the most used Clinics, in terms of problems entered, were dairy,

tillage, horticulture, and building. Growth of usage is expected, but a system redesign, which might involve either subdividing a particular Clinic into differing areas of expertise or else duplicating the busier Clinics, is not likely for quite a while. Short-term developments might center on reducing the response time for problems entered. But given the fact that almost every problem requires some time for consideration and/or research, only a limited improvement can be achieved. However, in order to reduce the delay between the moment the problem is entered and the moment it arrives on the specialists desk, the system could be integrated into a corporate electronic mail (E-mail) system, which has yet to emerge within Teagasc and which is likely to be PC based. This would allow the specialist to receive and reply to the problem while avoiding the communications delays described earlier. For the specialists who are perhaps occasional contributors and not connected to an E-mail system, the service could be integrated into the fax network, transmitting problems to the specialist as they arrive.

A significant proportion of the problems submitted could have been answered by consulting AgriLine's encyclopedic databases. We can speculate on a number of possible reasons for preferring the Clinic service: (a) farmers are experiencing difficulty in finding the required information in the databases, given the level of computer expertise that they have; (b) the 'laziness' factor; if the information can be obtained by simply describing the problem, rather than searching a database, then users will choose this method; (c) although users can find solutions to many of their problems on the databases they need to be reassured by having it confirmed by a specialist. The real answer is likely to be a combination of these reasons.

The numbers of farmers using the reply facility to comment on their own experiences of other farmers problems has been disappointing, however it is used occasionally by the more experienced users and may in time be more widely used. The facility has been used more often by commercial companies promoting their products as an aid in solving the particular problem. Yet, commercial interest in the AgriLine Clinics has to date been slow. We expect that, as farmer numbers increase, some companies may consider operating independent Clinics as a forum for problem solving and disseminating information about their products. A trial service of this kind will soon be operated by a company dealing in farm computing. The real benefits, however, can only be established when the numbers of users are much greater than at present. On the positive side, our experience has been that well over 90 percent of problems entered can be dealt with over the videotex medium, with only a small number of problems not being answered by specialists due to the need for a site visit and inspection.

At the end of 1989 it was decided to publish a wide selection of the problems dealt with in book form ("500 Farming Problems"). It was produced for a number of reasons: (a) earlier problems were becoming difficult to access; (b) the book can be used for promoting AgriLine to potential clients; (c) combined with a

comprehensive index, the book might reduce the number of repeat problems of a similar nature; (d) we were aware that a number of AgriLine users were printing off relevant problems and answers and building up their own libraries; (e) book sales are expected to become a useful source of revenue for the service; (f) if proven useful, an annual publication giving the latest problems and related research results might be issued.

As a parallel development to this publication, we envisage equipping the farm advisor with the database of problems and answers and making it available on his local PC. This database would be accessed via an 'intelligent interface' or expert system allowing the advisor to formulate real life queries from farmer clients with the expert system being able to select similar or related problems from the database. The value of this service to the advisor would be increased as the number of problems in the database multiplies over the coming years.

## The IFA Closed User Group

Prior to the introduction of AgriLine, a number of farmers were looking for a means of disseminating information in a way that would give them an advantage over other producers. They did not know it then, but videotex was just the medium to serve this purpose. Shortly after AgriLine started, a Closed User Group (CUG) of grain growers was founded. A CUG is a group of people who share a computer conferencing facility to which others do not have access. The CUG of grain growers allows exchange of information on the prices of farm inputs and on produce sold, so as to prevent exploitation. This information is gathered by means of response pages, which route the farmers' quotations to a private page range where the editor checks the data before copying it to pages accessible to all.

By November 1987, the CUG was proving to be very popular, so it was decided to expand it by trying to appeal to all farming enterprises. With this in mind, the CUG was taken over by the main farming organization, the Irish Farmers Association (IFA), and became known as the IFA CUG. Ever since then it has topped the ratings as the most popular service on AgriLine. One of the reasons it became popular was that as farmers often return late at night (e.g., from harvesting) they cannot 'phone around' when they need market information. But they can contact their viewdata service anytime during the 24 hour day.

By far the most popular items on the menu are fuel and fertilizer prices, probably because they affect all farmers. In addition, we have sections for livestock and arable enterprises, each with their own input and market index. On the basic menu we have two other topics of interest: our own Forum and a Notice Board. In the Forum, any member may initiate or add to the threads of a discussion on any subject. This functions in exactly the same way as the AgriLine Clinics. The Notice Board is self explanatory and is also open to everyone in the

CUG to use.

From every page of the CUG, keying 8 will call up the Response Page, which the member then uses to send the editor his 'quote'. This quote is appended with the date, the users name, the county he lives in, and his AgriLine number. The date is important as all quotes remain in the system for a period of one month (when they leave the system, the quotes are saved on disk by the editor). Adding the user's name to a quote makes it possible for the editor to verify its authenticity, or in the case of an error (typing, etc.) contact the sender by Mailbox to put it right. All this information is followed by a two letter code simply stating the county of origin, or whether it is an average price (e.g., TS - Tipperary South, AV - average). The AgriLine number allows the editor to make a statistical breakdown of each member's performance on a monthly, quarterly, and yearly basis.

When the editor makes a quote available for all CUG members these additions are deleted to assure anonymity. The main reason for not revealing the source of the quotes is, of course, that merchants and suppliers would attempt to penalize the individual and prevent him from quoting by exerting market pressure. So we preserve anonymity. What we are trying to do is to show farmers the 'ball park figure' and to make it easier for them to establish some countervailing power. Newspapers cannot pass on all of the information that CUG members share. If they, for instance, would reveal the actual prices of farm inputs (e.g., fertilizers and feeds) they would jeopardize their advertising revenues. In fact, the prices of such inputs quoted in newspapers we call 'dirty info'. For the host organization of a Closed User Group to be regarded as trustworthy it is essential that it remains independent.

The hardware must be simple to use, with automatic log-on, a good keyboard and its own clear screen. The original French Minitel, now also available in Ireland, seems to fit this specification, although it is a pity it is not in color. There is no doubt that bad equipment can quickly 'turn-off' an early user.

It is difficult to find the right people to adopt this technology. A bad user is one who looks in, perhaps frequently, but never quotes. They are called 'snoops'. The editor spends a considerable time coercing, bullying, and generally cajoling these members into participating in the information gathering process. Threats, such as "Those not quoting during the current quarter will be suspended from access" often do produce results! Still, in the future we may devise a system of excluding them altogether or making them pay for the information.

New ways of presenting data in a more easily read and attractive manner are continually being thought up. There is some interest in having more historical analysis of the market place. Lately CUG members have been asked for new ideas, and were offered a prize for the best one. As the competition has generated a lot of interest and some useful ideas, this 'carrot' approach will probably be used more in the future.

Finally - do farmers make use of the CUG information? Some of its members claim they save the cost of their AgriLine subscription every (!) time they 'log on'.

# Strategic investment in IT systems for extension

C.I. Houseman

*This article documents the establishment of a corporate strategy and a permanent institutional capacity within the UK advisory service ADAS to design and support information technology (IT) applications and projects. The process of establishing them was based on careful systems analysis of research, extension, and practice covering a four year period. The article singles out extension for an in-depth analysis of strategic investment in IT.*

Agriculture in the UK has an annual gross product of around £10 billion, represents two percent of the gross national product, and employs around two percent of the work force. The food industry is worth many times more with food consumption running at 1½ times UK production. Agriculture has steadily diminished in importance since the end of World War II. Only about ¼ million farms remain, of which about 40 percent of are part-time.

The UK government has supported agriculture in different ways for many years. A constant feature since 1947 has been a state-funded advisory service along with animal and plant disease control and R&D. These three functions are now embodied in the Agricultural Development and Advisory Service (ADAS) of the Ministry of Agriculture, Fisheries and Food (MAFF). Since 1979 the government has progressively reduced the amount of public funding available for R&D and advisory work. In 1987, commercial fee-paid advisory work was introduced. The original target of 20 percent of costs has been raised to 50 percent for the 1993/94 financial year. In his report (ADAS, 1984), the Director-General also made a commitment to the wide-spread introduction of the use of IT into the work of ADAS. Current policy implementation in the UK is leading to a widening of the gap between the R&D and extension domains. For example, in the sphere of horticulture, the R&D component in ADAS is to be combined with institutes of the Agriculture and Food Research Council (AFRC) in a new organization called the British Society for Horticultural Research (Hansard, 1989).

Research, extension, and farmer practice are all capable of benefiting from investments made in IT. The research domain is essentially a knowledge

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production process and the key needs are in experimental design, data capture and validation, data analysis evaluation and interpretation, reporting and dissemination, and finally storage and retrieval. The extension domain's main requirements are to be able to survey information sources, to collect, store and retrieve information, to adapt, transform and communicate, and to interpret, evaluate and synthesize. The practice domain also has a requirement to store and retrieve, to collect, evaluate and interpret, and to communicate. There is also a considerable need to be able to capture data but much work remains to be done (Finney & Houseman 1987). All three domains have many common needs, and need to communicate across the common interfaces between them.

The rest of this article singles out extension for describing the systems approach and the introduction of IT.

## Focus on the extension domain: preliminary studies

*Background.* Extension services are large-scale processors of information. ADAS has over 4000 staff in nearly 200 different locations, covering 35 professional, scientific, and technical disciplines. In the past, it depended very heavily on the use of manual methods and developed a technical filing system for extension based on the Dewey decimal system. Written material was posted out to advisers for them to store in manual filing systems. This was supplemented in the 1970s with a capacity for on-line bibliographic database searching.

*The data flow study.* In 1985, a major study was undertaken to investigate the flows of data to, from and within ADAS. This data flow study (MAFF, 1985) revealed some startling statistics and has been the basis of further studies and planning projects. The study identified a very wide range of categories of data produced by ADAS. These were in two groups:

1. primary data. Advisory, background, statutory, survey, trial and test data, largely generated by staff from within their own technical resources with only limited reference to other sources of data received;
2. secondary data. Amalgamation of an adviser's own primary data together with data from other sources both internal and external to ADAS. The process of producing these data includes the functions of interpretation, evaluation, amalgamation and transformation. Over 120 types (formats) of secondary data were identified.

It was clear that to produce this wide range of secondary data required access to proven reference data. However, most of the secondary data were produced on an individual basis. Problems identified were: (a) widespread duplication of effort; (b) the inefficiency of managing unstructured data with an inadequate knowledge of user needs; (c) restricted flows of data between organizational units inhibiting the delivery of integrated service to clients; (d) unresponsive data handling methods with poor timeliness; (e) client-based information and previous

interactions with ADAS to all staff who need it; (f) data not made available in the most appropriate format and therefore not ready for use; (g) much of the same primary data had to be processed for a very wide range of needs; (h) a requirement to service increase demands for responses to policy and technical questions; (i) poor quality communication relying only on paper, telephone and limited availability of telex; (j) inadequate dissemination of results from laboratory services; (k) difficulties in securing access to relevant technical data held by administrative staff.

The study also analyzed the data received from 2,200 internal and 2,400 external sources across commodities. This analysis confirmed the importance of the ADAS experimental farms and subject matter specialists and the AFRC Institutes, scientific literature and the agricultural supply trade. The volumes and frequencies of data flows from these important sources were estimated. The manpower effort which ADAS expended in handling data was estimated to involve some 1,500 man years annually.

*Establishing the requirements for IT*. A planning study to analyze and specify the user requirements for IT support was undertaken in 1986/87. It identified six major job elements for the advisory staff: (1) to market ADAS services to generate revenue; (2) to provide and interpret information for farmers to improve their profitability, including providing accurate and up-to-date advice and defining options and making recommendations; (3) to provide advice to associated industries; (4) to perform statutory duties; (5) to gather information for policy purposes; and (6) to undertake research and development work.

The text and numeric data distribution systems were analyzed and categorized:

1. manuals of best practice. A limited selection of manuals, each intended to be the complete ADAS view across a commodity. They are prepared by subject matter specialists. It was felt that they would occupy the equivalent of 12,000 sides of A4 including text, tables, graphics and photographs and be needed by 2,500 staff. The material would either be distributed on paper or on floppy disk as it did not change frequently. Original texts would be constructed using word processors.
2. technical notes and other leaflets. Many publications are produced by ADAS including research papers, pest and disease reports, advisory leaflets, product evaluations, etc. They include text, graphics, tables and frequently photographs. Distribution is variable and sometimes adheres to the technical filing system classifications. This current technical information needed to be produced (on word processor) and stored on a central database for access. Each professional would be making between five and 20 enquiries per day and the volume of material would be 20,000 items per annum, average size five pages of A4.
3. external papers and journals. Collected from a wide range of sources often by individuals or made available through MAFF Libraries. Further use/circulation of the document is usually at the discretion of an individual.

4. electronic information. Videotex (Prestel) and existing in-house databases. Very limited coverage is provided.
5. advisory applications. Various computer packages are used by advisers. Many programs for micros and mini computers are available. Incomplete coverage of all commodity areas. They should be organized at a central point (the ADAS Information Services Unit) for development and support.
6. office systems. They needed to be able to handle information in a variety of forms. The requirements were for basic office automation facilities to improve staff productivity, electronic mail and presentation graphics. The portable (laptop) PC was seen as the ideal tool for this area.

The study identified a number of problems in information handling: (a) poor information retrieval; (b) poor quality of information available; (c) slow distribution; (d) inadequacy of the existing computer services; (e) poor quality of service provided. The main requirements were for the following:

1. text. Structured text information covering current technical information and manuals of best practice;
2. advisory applications. Programs that are integrated with numeric data and easy to use;
3. office automation. To improve the appearance and speed of production and distribution of reports, letters etc;
4. telecommunications. Facilities for professionals to access the information and facilities they need.

The various requirements were then used as a basis for deriving the basic entity definitions, volumes and rates, the data stores and the descriptions of the processes using the structured systems analysis and design method (SSADM) described by Houseman (1988a). The technology choice was based on MAFF's existing network and hardware. The costs of the whole project were anticipated to be £45 million over a 12 year period with benefits of around £70 million (largely staff savings). The report also identified the need to set up a central IT unit.

## The ADAS IT strategy

*Objectives and business.* Another team formulated the ADAS IT strategy. Its report (MAFF, 1989) was accepted as the agreed basis for the widespread adoption of IT. The strategy is designed to meet fully the business needs and priorities of ADAS. The strategy project was managed by a project board and used a proprietary methodology (Tetrarch).

The strategy drew out a set of agreed ADAS priority objectives: (1) contribute to the development of government policy; (2) implement statutory and other regulations; (3) develop ADAS revenue earning; (4) improve efficiency and effectiveness of ADAS; (5) implement appropriate non-statutory government policy; (6) promote the uptake of effective and efficient use of agricultural

resources; (7) promote consumer protection, animal welfare and the uptake of the best environmental and husbandry practices.

The strategy developed a structured functional description of the business of ADAS covering 8 main areas: (1) prepare strategies and plans; (2) provide infrastructure; (3) contribute to policy making; (4) provide R&D services; (5) advise on best practice; (6) apply statutes and regulations; (7) provide laboratory services; (8) monitor the achievement of strategies and plans.

*System grouping and data structures.* Some 150 candidate systems were identified and consolidated into 30 major system groups in seven blocks. A central tranche of four major business streams concerned with R&D, advisory work, statutory work, and laboratory services, are brought together at in a block of core systems which tie them together for management and administrative purposes. Laboratory services underpin three business streams, but is a business area in its own right. Also underpinning these areas is a block of knowledge systems. The structure as a whole is based on support systems (see Figure 1).

ADAS is a knowledge-intensive organization handling a great volume and diversity of data and information. The strategy classified ADAS data into four major information sets: the administrative data needed in order effectively to administer the ADAS business was further classified into:

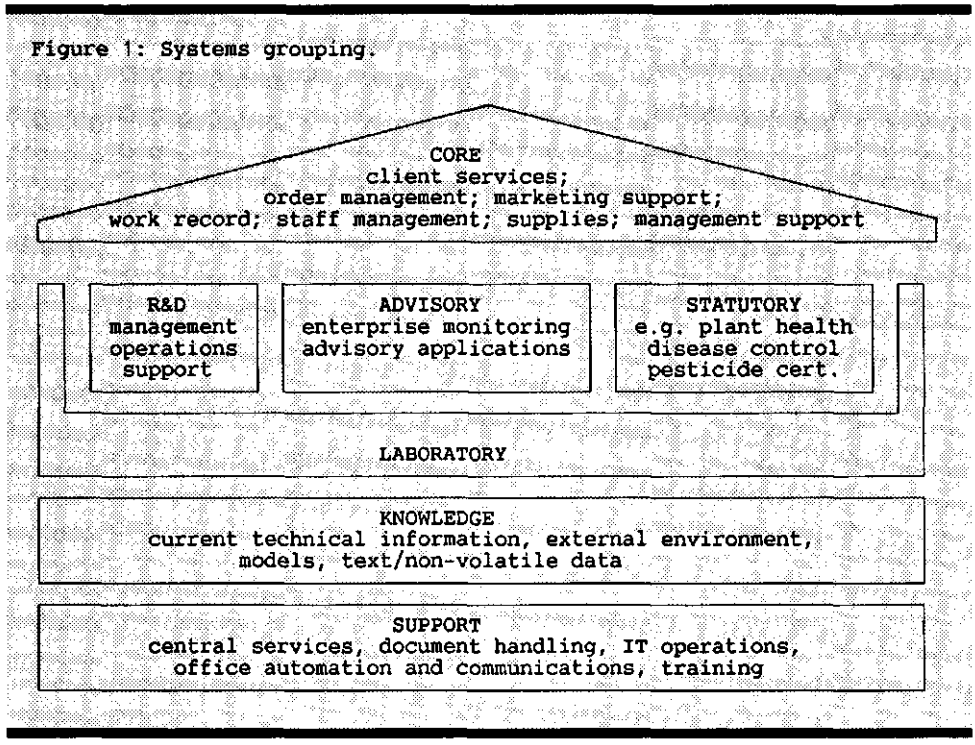
1. operational, describing ADAS activity, e.g., giving advice;
2. infrastructural, enabling the structure and functions of ADAS to be maintained;
3. environmental, describing things and processes outside ADAS but which impact on it. The fourth set comprised of technical data describing the agricultural industry and the processes within it. These data are needed by ADAS to perform its primary business functions.

*The usage matrix.* The candidate systems and data structures required by ADAS were used as a basis for developing a 'usage matrix'. It showed how systems and data were used throughout ADAS, how and in what order systems should be developed. It allowed development of a data management policy for owners and users of data and definition of an overall management policy. The analyses showed several key aspects which determined the approach chosen:

1. there is a relatively low level of coupling between systems in terms of data usage (shared data).
2. much of the technical data that ADAS uses is 'soft' or unstructured. Support is required for exchange rather than integration.
3. data used widely throughout ADAS are concentrated in the core systems and some of this is also common to MAFF.

This lack of tight coupling of ADAS systems and data, reflects the very diverse nature of ADAS operational activity, which falls into relatively discrete local pockets. It also reflects the high incidence in stand-alone text databases and specialized scientific applications.

Core systems form a relatively tightly coupled set on which operational systems




depend. Operational systems are only loosely related to each other but may be dependent on the data architecture defined by the core systems. Knowledge systems have data which are structured around discipline/problem areas and are soft or unstructured. There are few dependencies amongst these systems, but many of the operational systems depend on current technical data. Support systems are largely independent and hold their data locally, often for economic or operational, rather than technical reasons.

The low level of technical coupling means that much of the administration and management of data can be pushed to lower levels in the organization. Managing IT places the emphasis on a high degree of involvement of local users, especially for technically discrete systems. In addition, this also means that IT functionality and processing power should be pushed outwards towards the users as far as possible. However, some systems will have to be retained and managed at the center.

It became clear that micro-computers would be a key part of the ADAS hardware strategy, with communication between PCs and the central machines of great significance. Portability of PCs was also a major issue to provide advisers and field staff access to remote services.

*Data management.* The objective for data management is to maximize the value

of ADAS data in terms of accuracy, integrity, currency, consistency, accessibility, and timely availability. ADAS information generally has a high interpretive content and is clustered around a technical problem area. The major exceptions are the highly structured numeric data on prices, yields, fertilizers, feedstuffs, etc., and structured weather data.

Data management depends on the commitment of adequate resources and requires that primary ownership of the information is assigned at the outset. The information needs to be serviced by the owners for use by the customers. The performance of the owners needs to be monitored and the economics of information handling need to be periodically reviewed. The above factors critically affect the value of the information used by an extension service. In order to identify information management responsibilities, the following classification was made:

1. data definition. The logical structure and properties of the data, including keys, attributes, domains, validation rules and access rights and privileges. Owners are responsible for developing and maintaining definitions and authorizing changes;
2. logical data. The actual logical instances of data structured according to the data definition. Owners are responsible for e.g., the provision of data for users that is of adequate quality (accurate and up-to-date);
3. physical data. The physical representation of the logical data in a particular system. Custodians must be responsible or maintaining physical data in a secure state on behalf of owners and users.

*Systems business classification.* From a management viewpoint, it is important to classify the systems in their contribution to the overall business aims of ADAS, according to the scale of benefits they deliver and the degree of business innovation they incorporate. The classification chosen was as follows:

1. support systems. Valuable but not critical to current success. The major benefit is economy;
2. operational systems. On which the organization currently depends and the main benefit is efficiency;
3. business-impact systems. Critical to support present and future success of the business, eg advisory applications. The major benefit is effectiveness;
4. opportunity systems. may be important in the future. Allowance made for innovation and technology in a forward looking manner.

Each requires a different style of management. For example, support systems require low risk solutions with proven technologies with justification based solely on tangible return on investment with optimal use of resources. Operational Systems are automating the primary business activities and the systems should deliver solutions with a good fit to the essential business requirements. Integrity and cost effectiveness are the key components. Business-impact systems require users to play a central role and the emphasis should be on problem solving using new technologies where appropriate and accepting an element of risk. Opportuni-

ty systems however are often user initiated and often contain high levels of risk. Again, they are driven from a problem solving viewpoint and represent essential investment in exploring forward. There needs to be an encouragement of innovation and risk taking, but controlled by stringent reviews.

*Investments and benefits*. The main investment costs are in software development, central and local (PC) machine costs and running costs. The main savings accrue as staff time released for other activities or to be saved directly. There are also benefits in terms of performance, quality of service and revenue earning.

In making the investment appraisal, it became clear that the key determinant of viability was the terminal/PC population. Benefits increased rapidly from a low terminal population (800) to the optimum (1,500), mainly due to the need to establish a critical mass of users. This spreads development and support costs, makes electronic mail viable, allows the cessation of manual systems, gives ready access to users and creates group pressure for people to move to the new technology.

Other intangible benefits including improved staff morale, more consistent advice, better ADAS image and more flexible working, were also identified.

## The ADAS Information Services Unit

*Structure*. The implementation plan in the strategy mapped out a proposed sequence and timetable for developing the candidate IT systems. The manpower profile identified a required staff resource of approximately 20 staff in year one, rising to about 40 by the end of year two. The main need was to develop in-house expertise as quickly as possible but assistance from outside contractors would also be required.

The Information Services Unit (ISU) was established in October 1988 with some 40 staff (1 percent of ADAS manpower). The Head of the Unit reports to the Commercial Director. Its program of work is overseen by the ADAS IT Committee on which sit representatives of the main user groups and MAFF. A number of smaller isolated IT Units were brought together to form the ISU. It has close links with user groups and specialist IT Units in laboratories and R&D establishments. ISU presently has the following branches:

a. business and systems analysis, programming and development;
b. data administration and management, videotex;
c. user support and training;
d. statistics, R&D support;
e. project management, planning, and control.

*Linkages*. In terms of knowledge management, a key feature is the work of Statistics and R&D Support Branch. Its aim is to aid the electronic capture of data in R&D work, and to analyze and evaluate them. However, this only extends to the ADAS R&D effort which, as we have seen, is diminishing and being moved

away from the extension domain. It is unknown at this stage to what extent fee-paid extension work could support near-to market R&D.

The Agriculture and Food Research Council (AFRC) institutes have, for many years, had ADAS scientific liaison staff attached to them. These staff have, on a manual basis, provided an invaluable interface mechanism between ADAS and AFRC. The AFRC also runs an X.25 network and some attempts have been made to transfer data between the two networks (MAFFnet and Agrenet). Indeed, there have been several instances of joint development of models and some of these have found their way into commercial advisory work.

In the past, the AFRC also processed ADAS R&D data, but this is now carried out at the ISU. In future it will be important for the extension domain in ADAS to establish efficient IT links with AFRC to ensure the continued smooth flow of data and information from the R&D domain into the extension domain.

At the extension/practice interface, the main aim is to provide the extension worker with a portable micro. In this way the adviser can provide an improved service through the advisory applications available to him. It is also hoped to use this means to introduce farmers to IT and to overcome what seems to be a barrier to the further adoption of IT after the initial flush of enthusiasm in the early eighties. ADAS continues to operate an expanding range of post in/post out bureau services for farmers. Currently these cover dairying, pigs and poultry, with sheep and arable crops to be added shortly. Electronic information dissemination to farmers through videotex has been extremely disappointing. ADAS have curtailed its activities in this area.

## Conclusion

For the moment priority remains with the introduction of IT into ADAS and the implementation of the IT strategy, now being revised after one full year of work. In many ways IT developments in ADAS are closely associated with revenue earning and IT products currently support some £2 million worth of advisory business. In this environment, it is important to ensure that advisers are highly motivated to use the technology (Houseman, 1988b). A further key aspect is to ensure that the full benefits of the strategic investment in IT are achieved. This requires the provision of good quality training and support services.

Finally, be warned, the time scales are long, the road is hard and it seems that there is only a small light at the end of the tunnel! But persevere, because attitudes and organizations can be made to change.

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# Developing extension support systems in agriculture

C. Leeuwis, N.A. Hamilton, and G. Moorman

*In recent years there has been increasing interest in the use of modern information and communication technologies to support agricultural extension. In this article we will focus on information technology (IT) applications that (endeavor to) support communication processes between extension workers and farmers. Two major questions are addressed: (1) identification of problem areas (or knowledge domains) that require, or are suitable for the development of extension support systems (ESS); and (2) methodologies that are appropriate for ESS development. We will reflect on several case studies (see Moorman, 1989; Hamilton, 1989 & 1990; Leeuwis, this volume; Leeuwis & Arkesteijn, 1991), as a basis to elaborate on these questions and suggest directions in which answers might be found.*

## Identification of problem areas and opportunities

*Past and present approaches.* The identification of suitable problem areas and opportunities in early examples of ESS development often depended on individual initiatives of extension workers, researchers or farmers (e.g., Wheatman[1] (Hamilton, 1990); Delar[2] (Leeuwis, 1991); and Bea[3] (Moorman, 1989)). In many cases, the first prototypes of these ESS were the result of largely individual 'projects' and/or hobbies, in which lots of spare time was invested. Only at a later stage the employers of these individuals became interested in their achievements, and felt an urge to capitalise on the investments already made. Often, at this point it was considered necessary to take up the development activities in a more systematic way and involve more people (such as farmers, researchers, extensionists, information analysts, and professional programmers).

Although some ESS have come to play a prominent role in day-to-day extension activities, the use of many has been rather disappointing. This can partly be explained by the fact that these programs originated from prototypes that had a particularistic nature, that is, they were developed from an individual's point of view. Even if their development was taken up in a more systematic fashion at a later stage, this did not always result in major changes in the nature

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of, or the philosophy behind the ESS, as, for example, Hamilton shows in relation to Wheatman (Hamilton, 1990). Indeed, over-formalization of development procedures, even if 'user participation' is included, may in some cases be counter-productive, as is shown in Leeuwis and Arkesteijn's (1991) case study on Infotuin and Teletuin[4].

For Dutch agriculture, efforts were made to develop a more systematic and planned approach to the identification of suitable problem areas. Central to this approach is the information engineering methodology (IEM) developed by James Martin Associates (Ministry of Agriculture and Fisheries, 1987). It was first used by state subsidized branch organizations established to coordinate IT developments in their respective branches. They stimulated the building of information models for each agricultural sector. These models analyze a farm in terms of the activities carried out, and the corresponding information input and output. The relation between information input and output can be quantified, so, in theory, computer models can be built that simulate 'proper' decision-making on a farm. Also clusters of logically related activities and data can be identified; each cluster represents a knowledge domain for which IT applications (e.g., an ESS) can be built. Commercial software developers are supposed to adhere to these information models in order to ensure compatibility between programs at all levels.

Recently, the Dutch extension service has adopted basically the same methodology for the identification of ESS. Their approach differs in the sense that the questions extension workers encounter and the activities that they carry out in order to respond to these questions, are the point of departure for the information analysis, instead of farmers activities (DLV-centraal/IKC-varkenshouderij, 1990).

This methodology basically leaves the identification of priorities for IT development with policy makers. In that sense 'Information Engineering' is not directly selective. It is argued, however, that this methodology is indirectly selective through (a) the inherent subjectivity of clustering 'logically related' activities and data; and (b) the perspective from which the identification of relevant activities and related information is made.

The clustering of 'logically related' activities and data is inherently subjective, even though the methodology may suggest a certain objectivity. Farmers and extensionists, or even different categories of farmers, do not follow the same logic in structuring logically related problem areas. The case study on Delar shows that different categories of dairy farmers, on the basis of different strategic considerations, perceive the interrelations, the priority, and causality between variables differently. That is, different dairy farmers have different conceptualizations of both the problem area and the variables relevant to it. Such different 'patterns of logic' can easily result in ESS that farmers judge to have serious omissions and gaps, inappropriate decision rules, and/or many redundant elements.

The identification of relevant activities and related information is also selective. Bots and Van Heck (1989) have shown for Dutch horticulture that it is possible to

develop a completely different information model of a potted-plant breeding enterprise from the one developed and coordinated by the horticultural branch organization. Bots and Van Heck's model was developed from a management perspective, defining the activities and the related information in terms of this perspective. It is unlikely that extension workers, management scientists, and farmers would consider the same activities and the same related information, relevant.

Using such an informatics approach, therefore, clearly implies a major risk of abstracting from the activities and 'patterns of logic' as seen by the farmers (the eventual beneficiaries of an ESS). Approaches such as the IEM, therefore, seem to reflect a rather simplistic and mechanistic interpretation of farming (and extension). In reality, farming and extension are complex activities with a highly social character.

We can conclude that neither the approach based on individual initiative, nor 'information engineering' approaches (if applied in isolation), guarantee an appropriate identification of specific problem areas (knowledge domains) or opportunities that are suitable for ESS development. Even if a suitable domain was identified, this would not automatically result in identification of appropriate criteria for such an ESS. It is argued elsewhere (Leeuwis, this volume) that the conceptualization of a 'user-interface', and hence the conceptualization of an 'IT application', needs to be considerably broadened in order to arrive at relevant, viable criteria for a specific ESS. An ESS is not just a soft- and hardware package. Other aspects must be considered. These include:

- the organizational and political arrangements to further develop, update, and adapt the program;
- the financial, physical, educational, and organizational arrangements made to support farmers, extension workers, and other people involved in the use of the program;
- the financial, social, legal, institutional, and other arrangements implied (for all people involved) by the use or operation of the program.

Thus, an ESS cannot be viewed simply as a soft- and hardware package. An ESS is also a social package, operating in a social environment. Consequently, ESS development implies the development and restructuring of social relationships. Social aspects will also have to be taken in consideration when identifying problem areas or opportunities for ESS development.

*Including the social dimension in the identification process.* Several methodologies are available for use as substitutes for existing approaches. It seems possible, for example, to combine some of the tools developed from a knowledge systems perspective (see Röling & Engel, this volume), and the methodologies suggested by an actor-oriented perspective (see Leeuwis, Long, & Villarreal, this volume). The methods associated with these two perspectives reflect two different directions in which a broadening of analysis is required.

In the first place, it is necessary to recognize that a specific communication

process, including computer-aided communication, cannot be understood in isolation from other communication processes. Tools originating from a knowledge and information systems (KIS) perspective (for example Van Beek's 'interface matrix' (Van Beek, this volume) can be used to describe how a specific knowledge domain is organized in terms of institutions, individuals, networks and communication patterns. Such an exercise allows an inventory of the variety of sources that are relevant for solving problems in that particular knowledge domain. This inventory can provide indications for the feasibility of a future ESS. In addition, such tools can 'sensitize' researchers to the social interfaces that are relevant for the successful operation and development of a specific ESS.

Secondly, the prospective ESS designer needs to recognize that communication processes are social processes, of which meaning, domination, legitimation, and agency are important aspects. It was shown elsewhere (Leeuwis, this volume) that these aspects are crucial for understanding extension processes. Thus, the social interfaces that were identified with the help of KIS theory tools could be used as the starting point for an actor-oriented analysis. The purpose of such an analysis is to gain an in-depth understanding of the social context in which the ESS is to operate.

The starting point for either of these analyses will, in practice, usually be a specific social activity that a policy maker considers to possibly require, and be suitable for IT support. Such a labelling might derive from an information engineering exercise, or from pressures exerted by farmers, extension workers, and/or others.

Usually, the initial formulation of a problem area will have to be further refined. A method developed by Engel (1988) could be used for these purposes. On the basis of empirical analyses, he constructed what he called 'the main menu' that extension workers were using in the problem solving process. Such a 'main menu' reflects a 'mental matrix' or 'cognitive map' of the extension worker. On one dimension of the matrix, Engel identified fields of analysis (related to stages in a problem solving process), and on the other dimension, different areas of specific knowledge (such as the present situation, strategic considerations, markets, government policy). Different extension workers appeared to have similarly structured 'main menus', but there were major differences with regard to the 'cells' of the matrix that were relevant in specific extension interactions (on the same subjects) and the order in which they were dealt with. By carrying out additional quantitative analysis of such individual extension encounters, Engel suggests that it might be possible to define those sub-areas that are most relevant for ESS development.

The advantage of such an inductive method is that it takes the empirical reality as point of departure, which contrasts to methods such as information engineering that tend to be very theoretical and deductive. One of the short-comings of Engel's approach is that it gives us little understanding of what is actually taking place and why. The approach emphasizes the interpretation of reality of the

extension workers but fails to give a balanced picture of the interactions since the farmers' interpretation is lacking. Therefore, it fails to clarify whether the development of an ESS is appropriate of not. In order to reach such a balanced understanding, a more actor-oriented approach is required.

An actor-oriented analysis will also have to focus on the empirical reality of the specific advisory process under consideration. The questions that have to be answered relate to five dimensions: meaning; domination; legitimation; agency; and social activity. Below, a brief impression of the types of questions applicable for each dimension are outlined.

1. Meaning. Who are the actors that the farmer and extension worker involved consider to be relevant to the problematic situation? What do those actors see as the most important variables[5] relevant to this advisory process, what meanings do they attach to them, and what incompatibilities exist? What is the meaning that different actors attach to this specific advisory process?
2. Domination. What interests do different actors have in relation to the advisory process and the variables under consideration, and to what extent are they mutually exclusive? What are considered to be relevant resources (in regard to the problem and the interaction itself), and who can (or cannot) exert decision-making power on these?
3. Legitimation. What (differences in) norms and ideologies are related to both the advisory process and its relevant variables, and why? To what extent is external intervention considered to be legitimate by the different actors?
4. Agency. Why do (or do not) actors get involved in the advisory process and the variables under consideration? What strategies do they have in relation to these? What are priority 'projects' that people have, how do they try to create space for them, and how do the relevant variables, and the advisory process itself fit in with this?
5. Social activity. What are the characteristics of the advisory process. How do different people handle these situations, and why? Which elements are considered to be crucial by different actors for a 'successful' advisory process, and why?

Investigating a social situation in such an inductive manner allows the investigator to 'get a good qualitative taste of it'. It allows the identification of criteria that an IT application and its user-interface should meet if the IT application is to support activities of actors involved, given the fact that these actors are (by definition) diverse (Leeuwis & Arkestijn, 1991). Once the criteria are identified, decisions can be made related to what (if any) types of soft- and hardware are suitable, what functional specifications are relevant, what sort of organizational and political arrangements are needed. Finally, given the criteria, the practical requirements and the specific context of the possible ESS application, the crucial question whether the whole operation is viable or not, must be addressed. At this stage also political desirability and priority will have to be discussed.

In all, such an approach has a double advantage. It provides us with criteria that

the proposed ESS should meet, and with a 'thorough' assessment of its viability and political implications. The success of this approach requires that researchers involved can operate in an independent manner; the social setting of research should allow for negative conclusions (if necessary), suggestion of alternatives, or even complete negation of the idea to construct an ESS. Only a relatively independent position can assure access to, and relatively unbiased participation of, all relevant actors.

**The development process**

After the identification of a problem area has been completed, the actual development process of an ESS can start. This includes the development of soft- and hardware, and the development of a network of social relations. Engel (1990) speaks about "carrier networks" and identified 4 key processes that are decisive for their success:

1. development of a network of actors;
2. development of transparency and agreement among actors;
3. the development and consolidation of a 'resource base'; and,
4. the development of key teams within the network.

The Wheatman, Bea, Infotuin and Teletuin case studies suggest that involvement of the intended users in such a network is of crucial importance. In the following we will discuss some issues related to such user participation. Although it is argued elsewhere that all parties involved in an IT application are 'users' (Leeuwis, this volume), we will (for the moment) focus on those who are supposed to be directly involved in an ESS; extension workers and farmers.

*Who are the users of an ESS?* In some ESS cases (e.g., Bea and Delar) extension workers were considered to be end-users; consequently, farmers were not involved in the development process. In others cases, such as Wheatman, farmers were also (at least at a later stage) considered to be end-users, and therefore became involved in the development process.

Deciding who is an end-user is a very basic issue. The question is whether an ESS has to anticipate on a category of users, or on a social process in which different users are involved? It is recognized that different types of ESS exist, for example:

- ESS that extension workers use as a preparation for a specific interaction, and of which farmers see at the most a print-out (e.g., Bea);
- ESS that are operated in the actual interaction between farmer and extension worker (e.g., Wheatman);
- ESS that a farmer can use himself (e.g., Wheatman); or
- ESS that provide farmers with a print-out, on which they can seek additional advice (e.g., Delar).

Whatever the case, all these ESS do, in some way or another, interfere in the

social process between farmers and extension workers. Therefore, we argue, that ESS developers have to anticipate on the social process, rather than just on one of the parties involved in it. This is implied by the actor-oriented methodology that was suggested for the identification of initial criteria for such an ESS. To enable the developers to anticipate the social process, farmers have to be involved in the development process.

The problem then becomes: which farmers are to be involved. It was argued by Leeuwis (this volume) that the identification of homogeneous target groups; is an illusion. Comparison of the cases of Infotuin and Teletuin (Leeuwis & Arkesteijn, 1991) shows that the intensive participation of the growers used in the development of Infotuin resulted in a less optimal IT application, than in the case of Teletuin. This was partly due to the diversity of growers and diversity of crops involved in the development of Infotuin. This resulted in a program that required excessive compromise between these groups. Diversity can never be avoided, but it must be limited to manageable levels.

Relevant delimitations for diversity can be based on the criteria that are formulated in an actor-oriented identification procedure. Similarly, the political question (of which category to support) cannot, and should not be avoided.

*How and where are farmers and extension workers to participate?* By widening the conception of what an ESS is, the number of areas in which users can be involved is increased considerably. In many case-studies, the social arrangements included in the ESS (be they political, educational, financial or organizational) have proven to be of decisive importance for its success or failure. The initial criteria that were formulated in the identification procedure may serve as a basis to establish teams in which the different parties involved, develop and negotiate the necessary arrangements. It is important that farmers and extension workers have sufficient decision-making power, in order to ensure proper motivation (Moorman, 1989) and real anticipation on the advisory process. The same is true for the software-development part of ESS development. It is often insufficient to use farmers and extension workers solely for testing purposes. Hamilton (1990) for example shows that when an ESS has reached the stage of a testable prototype, many important decisions and assumptions have already been made, and, as a result of institutional interests, it is simply not realistic to expect major changes of plan.

In the case of Wheatman and Teletuin, is has also been shown that good results can be reached with what Hamilton calls "evolutionary prototyping", in which a series of different prototypes are developed as a result of continuous feedback from the parties involved. The case of Teletuin suggests that such prototyping could very well take the form of action research.

A disadvantage of a prototyping approach, is, from a software-technical point of view, that a chaotic program may be created as a result of continuous changes. This problem may be considerably reduced if actor-oriented identification criteria are already known at the start of the prototyping process. A predefined software technical concept might severely limit the flexibility of a future ESS, whereas a

'chaotic prototype' can, at a later stage, always be 'streamlined' at the software technical level. This brings us to our next important issue.

*When is an ESS finished?* If ESS are to anticipate on social situations, they must have a built-in flexibility. Social contexts are dynamic and subject to rapid change. In some cases only regular updating of specific data (e.g., market prices) is needed, but in others, the models included in the program itself may have to be changed. New legal regulations, scientific or non-scientific insights, technological devices, political priorities, organizational structures, etc. may significantly affect the rationalities of the actors involved, which consequently reduces the validity of the ESS.

In addition, people who have become familiar to an ESS will usually formulate new problems and interests in relating to, or resulting from the program. Thus, even after a 'final' version of an ESS has been issued, arrangements will have to be made to assure that an ESS will not become outdated, or that it will be 'sacked' in time.

In some cases, such as Delar, farmers' study groups have proven to be relevant organizational structures for the provision of continuous feedback. Frequent in-depth empirical analyses on how farmers and extension workers are actually using an ESS, may also provide useful new insights. It is often surprising and enlightening to see that people use an ESS, or other IT applications, in ways that nobody imagined beforehand. In the Wheatman case for example, some users would run the program with data from previous years (of which wheat performance was already known), in order to validate the program and identify a multiplying factor that could be used to 'correct' (at least in their perception) the program's estimates for future years. In the case of Delar farmers appeared to be selectively ignoring the normative values in the program, while formulating their own objectives in relation to them.

It is obvious that such empirical observations are of great importance for the further development of IT applications.

## Costs and benefits

Practical viability and political desirability are important aspects for decisions related to ESS development, and so are financial costs and benefits. We can be rather brief about costs; they are high. Moorman (1989) showed that the development (including implementation and evaluation) of two highly interrelated ESS required 840 full working days (3,5 man years). Both were relatively simple spreadsheet applications, with much of the work already completed in previous projects. Furthermore, these costs did not include costs as overhead costs (they were borne by branch organizations and the Ministry of Agriculture); maintenance costs; or costs related to the development of the necessary social infrastructures.

ESS benefits are much harder to assess. In the Dutch situation, to date, farmers did not have to pay directly for the use and development of ESS (such as Bea), or have only paid for some of the operational costs (as was the case with Delar). It is assumed that the benefits of an ESS are of a more qualitative nature, and are to be found in increasing effectiveness and efficiency of the extension service. So far, it is unclear if greater effectiveness and efficiency have resulted. Our observations in this respect show some paradoxical tendencies.

On the one hand, it seems possible that ESS allow for more context-specific calculations (on the basis of specific farm data) than would otherwise be the case; therefore, they could result in more appropriate individual advice. On the other hand, however, the calculation models themselves often appear to be too general, and their output often needs additional translation to the specific context.

ESS development often seems to make those involved in the development process aware of what they do *not* know, and therefore of what assumptions they make. However, the Delar case, indicates that computer models, in their day-to-day use, tend to obscure such underlying assumptions and gaps.

Similarly, it appears that ESS can be an important aid in providing an agenda for discussion among farmers, or among extension workers and farmers. Again, we see that ESS cannot only facilitate, but also severely obstruct such discussions.

The main advantage of many ESS seems to be that they reduce the amount of time needed for making complex calculations. This allows extension workers to redirect their time allocation, and/or carry out such calculations for a greater number of clients. Although this improves the flexibility of an extension service at a certain point in time, it is (especially if clear qualitative advantages are lacking) questionable whether or not this is sufficient justification for the considerable costs involved.

The alternative approach presented in this contribution, is recommended if developers want to improve the state-of-the-art of present-day ESS development.

## Notes

[1] Wheatman is a program for extension workers and wheat farmers in Queensland (Australia). The program estimates wheat performance under several decision options growers may consider.

[2] Delar is a program that analyses feed and fodder costs and benefits for Dutch dairy farmers. On the basis of intensive registration by farmers, it provides them with aggregated actual and normative figures for several key variables.

[3] Bea is a spreadsheet program aimed at supporting extension workers in giving business management advice to Dutch farmers. The program does so by calculating the consequences of alternative management decisions.

[4] Both Infotuin and Teletuin are IT applications aimed at supporting enterprise comparisons within a network of study groups in Dutch horticulture. By means of these programs growers can exchange up to date information on the operation of their enterprises.

[5] In the case of an advisory process on grassland management for dairy farmers, these variables may be 'different grazing systems', 'required equipment', 'required labor', 'environmental regulations', etc.

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# Computer supported generation and diffusion of agricultural technologies in developing countries

R. Ausher

*Agricultural production is a complex process dependent upon many factors that are often difficult to predict or control. To allow rational decision-making in such intricate situations farmers need ample and reliable outside information. Computer support and audio-visual techniques are both unique opportunities offered by 20th century technology. Carefully applied to uphold agricultural know-how and information, computer support can lead to a breakthrough in the processes of generating and diffusing agricultural information. In the western world these technologies have definitely gained foothold, but using a microcomputer in most developing countries is, for numerous reasons, considerably more difficult. This article examines what computer support can actually mean for these countries. It provides strategies for the promotion of computer support, with a special focus on computer aided activities in extension services. It elaborates on the expected changes in advisory work that might result and their organizational implications. It makes clear that the experience gained in developed agricultural systems indicates several erroneous concepts and strategies that should not be replicated by these extension services, and gives some recommendations in order to prevent such replication.*

## Introduction

Computer supported activities in an agricultural advisory system fall under two main headings: (a) problem-solving or decision-making tools assisting the definition and fine-tuning of a technical message; (b) information dissemination techniques. In both areas, computer support changes the existing extension system into one that adequately handles quantitative field data and observations, on the basis of which more precise and field-specific technical messages, based on an integration of relevant elements of some of the major production factors: weather; crop; soil; pests; produce quality; marketing conditions; and costs, can be formulated. Also human factors, such as the grower's professional needs and

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abilities, his social and financial situation, can be included. The development of microcomputers has provided the individual decision-maker and his agricultural adviser with cheap, personal, high-capacity decision aid tools. Computer-generated optimizations like feed rationing, resolving of irrigation networks, linear programming of farm operations, and crop-budget analysis, give solutions that are usually superior to any manual calculations.

With all the recognized limitations of computer support, there is no other technology that offers greater potential to facilitate the transition towards a more business management oriented agricultural sector, and to create the right technical environment to support this process. Computer support (requiring facts and data) encourages collection of field observations, monitoring, and record keeping of findings. The potential embedded in computer support can be fully unraveled, if computer technologies are adopted by extension organizations in the framework of a system wide priority. Providing leadership and physical conditions for computer activities, the extension management can request the integration of the computer supported approach in the annual plan of work of every individual subject-matter specialist. The advantage of computer support in both the developed and the developing environments will be distinctly felt in cases where conventional technical decision-making is already relying on fact finding and handling of quantitative field variables, or mature enough to embark on such an approach. In the latter case, introduction of computer-aided extension will trigger professionalism.

The ability of computers not only to calculate but also to store data is an asset creating an basis for management and retrieval of field trial data, surveys, and observations of the individual extension officers, extension working teams, or other extension units. Data processing can be standardized within the extension system and coordinated with both research and farmers. Information can be disseminated in large batches, in a short time, and to a large number of users.

Although research and extension have their own agenda, it is essential for the technology generation and transfer process to function in a collaborative manner. In doing so, extension's role is to be aware of problems at local level, while research develops solutions that apply to these problems. Joint development and application of computer programs promotes the formation of more 'intimate' and more institutionalized research-extension linkages. Building computer programs is a continuous process starting with definition of needs, coding of the program, pilot evaluation and application; never ending up in final completion. Extension should be involved in problem identification, and subsequently, in program definition and evaluation, otherwise research might come up with useless programs.

Computer-supported technologies that are part of agricultural knowledge systems, and information technology (IT) in general, deserve at least the same attention from international development agencies as is currently lavished on biotechnology. While the end results of biotechnological efforts are still distant

from both practical agriculture and agricultural extension, computer technologies have been successfully tried out for more than a decade by farmers, extension, and research in several industrialized countries. Sporadic attempts of utilization can be found in developing countries, and this very fact calls for a much more systematic approach to implementation.

## A strategy for the promotion of computer support in developing countries

Using a microcomputer in most developing countries is, for numerous reasons, considerably more complex than in the western world:

a. established dealerships are rare outside national capitals;
b. potential customers lack much of the information available on the racks of many newsstands in developed countries;
c. local computer publications, support groups or fellow users, and training manuals can be hard to find;
d. repairs and service remain inevitable where offices are more likely to be hot, damp, and dusty;
e. public power supplies are often unreliable;
f. telephone systems are sometimes so poor that a modem is useless.

This situation is changing as many countries are in the process of installing modern communication networks. The striking differences between developed and developing countries in computerizing their agricultural knowledge system can be demonstrated by the fact that recently in developed countries active farmers have started to purchase microcomputers and software utilizing both on- and off-farm data and information. In the U.S., six - eight percent of all farmers (2.2 million farms) already own microcomputers. The farms that have microcomputers often are those with a high annual gross sale (McGrann, 1985). The kibbutz type of collective farming in Israel is by now fully computer-equipped.

It can be anticipated that in the developing countries, large farms will be the first to adopt computers in their operation. In many Asian countries, non-agricultural enterprises are computer-conscious, what will have an impact on the agricultural sector as well. A similar trend can be identified in Israel where the computerization of Jewish farming and extension has precipitated computer-awareness of Arab extension specialists, teachers, and farmers.

As far as small holders in developing countries are concerned, this trend towards the use of computers is not foreseeable in the near future. Therefore, the introduction of computers in third world agriculture will start first with extension and research, while farmers will enjoy the ensuing end results. For the private software industry the agricultural market in the developed world is not as attractive (yet) as the industrial and the financial ones. Much of the dedicated computer programs are developed by the public professional sector. In the developing countries the market is even less attractive for private software

companies; this means that also here the public sector will have to play a leading role. For national systems that are disabled by economic or political problems or that are at an early stage of development, computer support can be provided by the regional research and development agencies. Later on, the national environment should also be moving in the same direction.

Computerization of extension activities in the developing world should be geared to the sophistication of technical messages that are to be delivered by extension at the right time, and to a large part of the farming population. Extension's role in adopting computer-supported advisory work is to employ this powerful tool of information and data management for the improvement of technical field performance. Real problems in agricultural production in which lack of data or computed information are a stumbling block, should be identified in a bottom-up manner, and then be matched with the computing abilities of IT applications. In collaboration with research, a parallel effort should be made in order to select computer applications with promising potential for both the improvement of agricultural production processes and extension management capacity.

The experience gained in developed agricultural systems indicates several erroneous concepts and strategies which should not be replicated by extension systems in developing countries. The following recommendations can be made in order to prevent such replication:

1. begin with developing modest down-to-earth programs, offering an answer to a specific technical demand not easily resolved without computer support;
2. identify technical problems at the field level that originate from the extension-farmer interface rather than define complex issues at the research-extension interface;
3. promote the use of stand-alone microcomputers and modular software rather than comprehensive and heavy mainframe or minicomputer supported programs;
4. avoid over-integration of production factors in one system, or linking-up computer programs with many other systems, such as videodiscs, data loggers, sensors;
5. identify highly motivated and capable staff ready to embark on computer applications;
6. involve managerial echelons in the introduction of a computer-supported approach in the organization;
7. create a software oriented environment with emphasis on agricultural production decision-making, closely linked to economic considerations, rather than on mere data processing;
8. limit the role of subject-matter specialists in software development whenever local programming ability is available. Subject-matter specialists should cooperate with programmers and system analysts, but be mainly responsible

for the subject-matter technical base;
9. draw-up the development of computer applications as a first step towards their conversion into new extension or research methodologies;
10. plan out the promotion effort of computer assisted extension methodologies, but be flexible and pragmatic trying to attain the possible within the given limitations;
11. do not expect computerization to occur overnight; it implies a long process of re-education.

**Promotion of computer aided activities in the extension service**

In most extension services the first three technical areas to show leadership in the area of computer applications are farm management (agricultural economics), crop protection (mainly entomology) and dairy cattle management (ration formulation and lactation prediction). Extension specialists in these three fields have always utilized quantitative data in their conventional decision-making and consultation processes. Therefore these disciplines are suitable areas to be first exposed to a computerized environment and training, and can further be expected to exert organizational leadership in relation to IT matters.

Positive results have been achieved in the involvement of technical divisions in computer supported activities in cases where extension staff from above mentioned disciplines, with additional background in computer work, have been appointed first on a part-time basis as responsible for the promotion of computer based activities in their respective units. The same pattern can be followed with regard to other divisions in which computer activities are to be promoted.

The motivation for the adoption of a computer supported approach, or at least for the acquisition of microcomputers, can already be found in developing countries. The trend is conspicuous, especially in Asia where several technical divisions in the extension services already operate machines contributed by international development agencies. It is important, however, to stress the fact that the very existence of a computer in an extension office or unit is far from being an achievement per se, but just the beginning of an adaptation process. At the same time, computer 'addiction' can frequently be diagnosed among beginners. Therefore it is the responsibility of the executive level to find the right balance between the time devoted by subject-matter specialists to augment their expertise in computer work, and the time allocated for field work.

At the organizational level, promotion consists of two dimensions. It is important that someone at the management level is made responsible for the identification of computer prone technical areas in the service, and for ensuing software development and adaptation. Several extension organizations have failed in their attempts to computerize their activities where a hardware or hardware-acquisition orientation was the predominant one. Thrust should be definitely

software oriented, involving the entire organization, and computerizing it step by step moving down the road from routine office uses to the very sophistication of the technical message and its diffusion. A second level of promotion involves technical coordination at IT application and subject-matter level. People knowledgeable in their subject-matter and with sound background in computing should lead this evolutionary process within their respective regional extension offices and/or technical divisions. Setting up a computing services unit can expedite standard working procedures, release of software, and take care of training needs. As far as hardware and operating systems are concerned, adhering to mainstream industry standards seems to be a sound choice, ensuring services in the respective individual countries, and compatibility with most of the relevant software written for agricultural purposes.

**Expected changes in advisory work**

We envisage that the subject-matter specialist who can rely on better computing facilities, can devote more time to R&D, field-validation of new production programs, and the provision of field data on the established ones. He will provide less direct guidance and recommendations to farmers but interpret results and printouts, search for options, weigh alternatives, and make sure that the results are incorporated in decision-making processes. He will identify needs and production bottlenecks, and pass on the more complex ones to competent researchers. Furthermore it can be expected that:

a. the use of microelectronics enables the inclusion of economic evaluation in otherwise purely technical and cropping oriented extension programs;
b. basically in a computer supported environment the quality of the encounter between advisor and client will improve significantly. A better technical message relying on monitored field data can be delivered more efficiently by the advisory systems;
c. a computerized system can take over repetitive tasks of extension workers, thereby enabling professional personnel to devote more time to technical duties;
d. IT will have an impact on the graphic quality of messages and on the diffusion speed of both written and orally recorded messages. At the same time the timely updating of these messages can be facilitated.

**Expected organizational implications**

It is hard to foresee all organizational implications of a computer supported extension service, but it is evident that the technology will affect the structure and extension methodology of the service in a wide array of areas such as: in-service

training; standards in planning, execution, analysis, publication; storage and retrieval of field trials; recruitment-criteria for specialists and advisors. The two main channels for information delivery and feedback, the one with research and the one with farmers, can be brought closer with the introduction of electronic technology. In the following we will briefly touch some cost, time, and human constraints that will have to be solved within the organization.

Although costs of both computers and software are declining in the long run, the computerization of an entire extension organization and its system maintenance and renewal, imply considerable expenditure. This outlay should be budgetted up-front on a long-term basis. Computer supported extension is not cost-effective yet in the most advanced countries in the western world. However, it already produces numerous intangible spin-off benefits that are hard to be quantified. The introduction of computers into extension work in developing countries should not be halted until this medium will become profitable in the developed world.

Apart from the financial requirements, it takes a long time before people are sufficiently acquainted with computer hard- and software, even within a supportive environment and with a sufficient amount of equipment. Microcomputers do not save time because users do more analysis and raise their expectations and needs for additional information. In both, research and extension, computer use should contribute to reaching higher levels of productivity. It is important for both extension administrators and clientele, in terms of both image and management, that time investment of extension personnel in computer expertise is increased in order to stimulate professional leadership. However, extension specialists should remember that the focus of their activity is out in the fields. One of the major achievements of strengthened extension schemes like training and visit (T&V) is to keep extension staff on a regular field visiting schedule.

Furthermore, like any change in concepts and working methods, the introduction of computer applications in an organization is met with different attitudes. Early adapters may be both technical people and administrators who are exposed in their day to day technical work to complex problems. It is usually easier to persuade people to get personally involved in computer applications when programs, suiting their specific needs, are available and can be demonstrated. Younger computer literates with educational background have fewer adaptation problems. The introduction of a computer-supported approach in a research or extension organization is a lengthy and complex process. It can be speeded up, however, by an early integration of programs yielding quick results and impact. Statistical analysis, word processing, electronic spreadsheets, graphic applications fall in this category.

## Software development

Software can be produced in a myriad of ways. Planning good software is a tedious task that requires insight and foresight. Several projects have been developed or designed that have one major goal or recommendation as output. However, with careful planning, software can be developed as smaller useful packages that can be bundled or combined into larger systems. The beauty of such an effort is that a modular system can be developed that meets all the needs, with useful products that operate independently and can be generated as interim products. Any software development project that is undertaken must have the relevant expectation that it can be used in the operation of a farm, or to advise agricultural producers. Each project should have a realistic expectation that it can be completed to a useful point before it is undertaken. A new program should function on the standard microcomputers available to extension staff. This negates some projects such as large Monte Carlo simulations of pest models, large scale ecosystem simulations, and expert systems, if they do not run in a time scale that can make them useful.

Each program must be user oriented in the sense that it fills a need for the user, requests only relevant information, and presents the output in a form that is easy to understand. With changes expected in the market with regard to both hard- and software, we can plan only to survive these changes as smoothly as possible. Software development is an educational process in itself. In the design stage, producers, extension specialists, system analysts, and computer technical personnel have to collaborate and come out with an implementation plan. In the next stage, under the guidance of extension, program staff is involved in considering soft- and hardware specifications, and in defining the social environment in which the system is to operate. This process reveals some of the technical bottlenecks of production technology which are masked under day-to-day routine activities, bringing up problems which need further experimentation. Usually, software catering for the dynamic decision-making process during the growing period of crops and livestock, has better prospects for adoption and utilization than strategic planning programs.

## The role of international development agencies

International development funds should regard promotion of computer supported generation and diffusion of agricultural technologies as an investment in the augmentation of agricultural production and marketing capabilities of developing countries. Most Asian countries, after the completion of several generations of strengthened extension systems, are ready to accommodate computer support in the framework of system-wide programs, while African countries may follow this experience. Several of them can embark right away on the application of

computer programs in fields where immediate benefits and returns on investment are likely to be drawn. Computer support should focus therefore on an immediate application of existing software suitable for the actual needs of developing countries, and on the preparation and build-up of the professional cadres capable of coping with future opportunities offered by electronic technologies. International development agencies should lead this process, creating the right supporting environment stimulating the utilization of computer applications by the professional establishment in the developing world. In doing so, international development agencies should involve officials and professionals from the developing target countries in order to make sure that local input is taken into account, that the professional establishment supports the program right from its beginning, and that the resulting concepts and activities are of relevance.

## Conclusions

In promoting computer-support for the generation and diffusion of agricultural technologies in developing countries, we advocate a problem oriented, empirical, and pragmatic approach; an approach that allows us to make the best decisions even when we do not have all the answers. Programs should better be 'cheap and nasty' than conceptually elegant, and act with precision within a narrow range of operating conditions, rather than be of high generality. The only criterium is: "does it work and does it show impact?".

In the long run the development of both decision-making as well as information delivery systems brings data banks, production models, diagnostic expert systems, etc., close to the access of research and extension personnel. Subject-matter specialists can collect data and information in the fields, and compare and verify them right on their desks. Thus, technological, marketing, regulatory, and social factors can be incorporated in the recommendations flowing to the producers. Collection of field data and utilization of computers by regional extension specialists (as against only at state or headquarters level) will pave the way to the major advantage of computers, namely that of supporting the fine tuning of recommendations to local conditions, needs, and abilities. Thus, the monopoly of centrally issued recommendations from a remote capital city can be replaced by a more powerful and well documented local message. It is a great opportunity for extension organizations to embark on this new medium and make best use of its advantages for the development of agricultural production and the welfare of farmers who are struggling with decision-making in a changing and unstable environment.

Basically we advocate a flexible, software- and user-oriented approach, driven by a real demand for information at production or farm level. This 'bottom-up' type of approach has been successfully taken up by end-users in the western world. The first set of programs to be mastered by subject-matter specialists

should include: a word processor, an electronic spreadsheet, and a package for statistical analysis of field trials. This can be followed by specific and dedicated programs related to the characteristics of different extension specialists. Programs should function on the standard microcomputers available to extension staff.

The promotion of computer-supported technical and management tools within the national agricultural research and extension systems of countries that are beyond certain thresholds of development, is a highly responsible venture and requires a conceptual debate that is to be followed by planning and operations. The right framework for this kind of debate may be a workshop that brings together specialists from the computer technology area with policy makers and professionals from the agricultural research and extension system. Computer-supported agricultural extension has proved itself as a powerful tool in many countries. However, plenty of problems can be expected in dealing with the development and introduction of a computer-supported approach in an organization. The confrontation of different views and the formulation of an adequate concept requires the involvement of professionals at different levels in the organization, in the process of IT application development. A workshop may provide the right framework to stimulate and accommodate this essential primary discussion that should pave the way to embarking on the educational process of supporting agricultural extension with computer technologies.

By providing better know-how and information in time, a collaborative effort of extension and research can facilitate the transition of agricultural producers to agricultural entrepreneurs. Extension and research are to become central elements in establishing information oriented agricultural sectors in the developing world.

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# Knowledge systems and health promotion

M.A. Koelen and A. Brouwers

*The knowledge and information systems (KIS) perspective arose from reflections on agricultural development. In the health sector, it is not quite as common to think in terms of KIS. Yet in this complex field, in which health education and promotion play increasingly important roles, the KIS perspective might be very useful. In this article, an attempt is made to apply ideas about KIS functioning and knowledge management to the health sector, by paying attention to historical development, especially of public health, and by exploring the contribution these ideas could make to the field. Some of the observations made in this attempt are: upstream information flows often are developed poorly; interaction and exchange among the different KIS parties require ongoing stimulation; in special projects and complex communication situations, a system-integrator is needed.*

## From health education to health promotion

In health education, health and the prevention of disease take a central position. However, health in itself is difficult to define in terms of objective, measurable criteria. We would define health as the capability of a living system within a given context to maintain a state that enables it to subsist in accordance with its constitution.

If we consider how health education developed as a professional and scientific field we can observe an interesting shift. In its early days, health education asked: "how can we make people aware of the health consequences of their behavior?" Research in health education was directed at methods to transfer its messages. The approach was based on medical practice at the time, in that it was prescriptive and unidirectional. Individuals were expected to process information in a logical manner and subsequently act accordingly. Changes in individual opinions, attitudes, and behavior were seen to result of information and knowledge.

Practical experience and several studies showed, however, that information and knowledge are important but not sufficient factors in behavior change. Individual motivation, skill, and the influence from the social environment appeared to be very important conditions as well (Ajzen & Fishbein, 1980; Green et al., 1980;

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Kok, 1986). It became recognized that individuals cannot be isolated from their material and social environment and that a single behavior cannot be isolated from its context. The (social) function of behavior in the wider context of life-styles had to be considered (Koelen, 1988). In research, the attention gradually shifted to determinants of behavior (including factors such as knowledge, attitudes, social influence, and opportunity/possibilities), the modifiability of such behavior, and characteristics of the target population. In order to implement effective health education, the focus shifted to gathering information from and about the intended target population, and the approach changed from a prescriptive and unidirectional to a more participative one.

Health is affected by a multitude of factors, be they biological (e.g., age, sex, heredity), environmental (e.g., air and water pollution), socio-cultural (e.g., housing, income), or behavioral (e.g., alcohol consumption, physical activity) in nature. Also the organization of health care services and the availability of means and facilities to affect health (Lalonde, 1974; Blum, 1982) are known to be factors. Over the years, it became evident that, due to the complexity and variety of factors influencing health, health education can develop its full potential only if it is supported by structural measures, such as legal, environmental, and regulatory ones (Kickbush, 1986). Health education nowadays is covered by the umbrella of 'health promotion', which can be defined as the process of enabling individuals and communities to increase control over the determinants of their health, and thereby improve it (WHO, 1986). Health is no longer seen as an end in itself, but rather as a resource for everyday life.

If we are to achieve the potential for positive health, a broad-based approach will be necessary, one that stands in contrast with the strictly medical approach. This point is very well expressed in five principles of health promotion (Ashton & Seymour, 1988):

1. health promotion actively involves the population in the setting of everyday life rather then focussing on people who are at risk for specific conditions and in contact with medical services;
2. health promotion is directed towards action on the causes of ill-health;
3. health promotion uses many different approaches that combine to improve health, including education and information, community development and organization, health advocacy, and legislation;
4. health promotion particularly depends on public participation;
5. health professionals, especially those in primary health care, have an important part to play in nurturing health promotion and enabling it to take place.

The key issue of health promotion is that health cannot be ensured by the health sector alone. It demands an inter-sectoral approach and a reorientation of medical care, primary and community care, and prevention, with public participation as one of the important issues. Furthermore, it demands coordinated action of governments, health and other sectors, non-governmental and voluntary

organizations, local authorities, as well as of industry and the media (Kickbush, 1986; WHO/HWC/CPHA, 1986; Thornton & Draper, 1987). In order to realize real health promotion, an open flow of information is required to produce an informed public, as well as responsive and supportive professional activity (Ashton, this volume).

**The health knowledge and information system**

The health sector is a knowledge intensive one. The amount of scientific and practical knowledge and information in all fields relevant for health promotion grows rapidly. Also the major issues change continuously, due to, for example, new insights, knowledge, or health hazards, and societal changes. At this moment, topics such as AIDS and the consequences of aging draw attention, while they were not important ten years ago. Furthermore, the public actively interferes with the professionals. Active client groups (e.g., patient groups, organizations for parents of handicapped children) seek for information, and in turn provide professionals with practical experiences. And, probably partially due to health education in general, the public at large became more and more health-minded and shows an increased 'need to know' about health-related topics.

In the continuum from fundamental research to client involvement, many individuals and institutions from different professions and in different countries are active, either at the scientific, intermediar, or public level. Each of these subsystems creates and transforms knowledge and information in its own specific manner. In the process a distinction between 'knowledge by experience' and 'scientifically validated knowledge' can be made. Knowledge by experience is integrated in all facets of public health and is used in all subsystems, but most extensively by the public. Scientifically validated knowledge, which can be divided in 'application oriented' and 'fundamental' knowledge, is fragmentary in nature, as it is directed at specific aspects of public health. Scientifically validated knowledge is not an exclusive domain of the scientific subsystem, it is accessible to and used by intermediaries and the public as well, be it to a lesser extent.

In a KIS, a differentiation between 'downstream' and 'upstream' flows of knowledge and information can be made (Röling & Engel, this volume). Downstream flows refer to information flows from the scientific subsystem towards the public, whereas upstream flows refer to information flows from public towards science. For a KIS to operate effectively, knowledge and information must circulate between the different subsystems. However, in the health sector, as in other domains, downstream transfer is dominant over upstream influence. So far, the upstream process did not receive much attention. This may seem contradictory to what we said earlier about the shift from a unidirectional to a more participative approach, but it is not. The shift mainly reflects the intention to take the characteristics of the target population 'into account'. This population itself is

often not actively involved. However, effective health promotion asks for such active involvement. What is needed is an interactional approach, with active sharing of information, dialogue with the target population, and participation in decision-making.

The activities to enhance public health undertaken by the subsystems can be placed on a time scale, ranging from direct action to long-term activities. The short-term activities refer to operational processes that deal with ad hoc problems regarding the primary necessities of life (e.g., immediate life threats). The medium term activities concern tactical processes, for example, activities aiming at changes of specific health-related behavior and adoption of healthier life-styles. Long-term activities refer to strategic processes, basically aiming at long-term health effects. Each of the processes has specific characteristics, requires typical actors, and provides specific needs for exchange and extension.

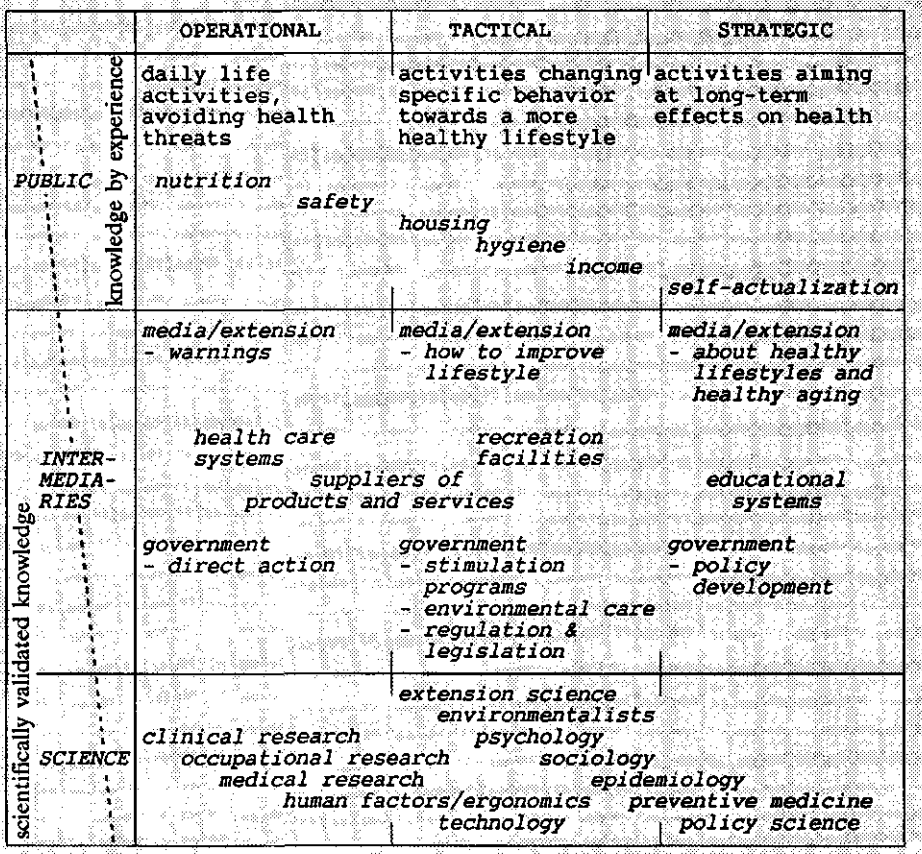
To illustrate this, a health knowledge and information system can be placed in a diagram with the subsystems (the public, intermediaries, and research) along the vertical axis (including the two distinguished types of knowledge), and the different time horizons (defining the operational, tactical, and strategic processes) along the horizontal axis (Figure 1).

## The need for coordinated action

Due to the rapid growth in the amount of information and the complexity of the field, the need for quick and adequate exchange of knowledge and information increases. Health promotion, therefore, demands coordinated action from all professionals and institutions involved (e.g., governments agencies, research centra, and volunteer organizations). However, it is an extremely difficult task to manage the downstream and upstream communication processes. Often, actors have their own specific knowledge domain, their own philosophy, their own objectives, and a need for protection of their domain (Warmenhoven & Hagendoorn, this volume), and their own finite horizons (Brouwers & Graafmans, 1989). Experiences from the Department of Biomedical and Health Care Technology (Technical University Eindhoven) show that the diagram presented in Figure 1 can be of practical use to initiate and reinforce communication and coordination between the different parties involved in a health knowledge and information system.

In KIS theory, much attention is paid to interfaces and linkage mechanisms among subsystems. These are extremely important, for example to bridge the gap between research groups and target population. Interface management provides a practical approach to the design of knowledge and information systems. Health promotion often requires multi-disciplinary projects. The Healthy Cities project of the World Health Organization (WHO) is a fine example (De Leeuw, this volume; Ashton, this volume). Such interdisciplinary projects require a great

Figure 1: Healthcare: subsystems and time horizons.




variety of expertise. Each domain brings its own specific knowledge and information contents, its own general aims, and its own finite horizons, making heavy demands on health education. A multi-disciplinary project usually cannot function without effective intermediaries, and especially needs a powerful 'system integrator'. Its coordination requires mutual information and education. A 'shared KIS' has to be developed around the explicit goals of the project, and the incentives for the parties involved should be reflected in the general objective of the project. Cooperation only works when participants gain enough to make it worthwhile to invest the required extra effort. Furthermore, the function of the system integrator has to be self-sustaining (economically, or otherwise).

## The variety of standards

We mentioned that the KIS includes several subsystems. In many ways, these subsystems are inclined to function as closed systems (e.g., research often acts as a closed system). Generally speaking, a university researcher concentrates on a limited area of reality. He applies specific tools developed by his own discipline on mostly self-chosen problems. He is inclined to explain only certain parts of reality. Very often fundamental researchers are not really interested in the practical value of their results. Their standards are based on the question whether statements or hypotheses are true or false.

Applied sciences, on the other hand, are more sensitive to the applicability of their theories and products. Their standards are related to the question whether their results are efficient and effective. Health educators have again other standards. They work on a problem, and in doing so, they make use of knowledge and information from and about the target population (e.g., for a better definition of the problem), but also of insights from the research system (e.g., for a better understanding of the problem). Their standards are related to situations-specific effectiveness and efficiency. In multi-disciplinary projects, this variety of standards can obstruct communication and cooperation processes. It is for this reason that such projects need a strong system integrator, and that special attention is required for the sharing of knowledge and information, as well as for mutual insight into each others standards.

## Concluding comments

Health care is a complex problem area. Science is making astonishing progress. One experiences rapid increase in the number of specialties and dynamics of all research fields. However, our ability to cope with integration of the knowledge of the many experts (including the public) needed for complex problem areas, seriously lags behind. In dealing with such challenges much can be gained by looking at extension research and training.

As may be clear from the above, KIS theory can provide a useful framework for the exchange of ideas and experiences with regard to public health. We pointed out that the upstream transfer of knowledge and information, even if we take into account the recent tendency to consider the target population, has been neglected in the past. In the new approach to public health, involvement of the public is a crucial element. The upstream transfer, therefore, is in need of strong support. In health education and health promotion, several organizations, departments, and institutions are engaged in the gathering and exchange of knowledge and information, either on the theoretical, practical, or political level. These organizations often are more or less autonomous, and share the tendency toward closeness and defense, not only with regard to their ideology, but also with regard to their

professional territory.

It is of great importance, therefore, to stimulate interaction and exchange among parties involved. The communication diagram, presented in Figure 1, can be a practical instrument at the onset of such a process. In complex communication situations an effective system-integrator is indispensable. Communication is not only important to establish exchange of knowledge and information, but also to gain insight into the various standards and the needs for coordination.

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# GGD and LCGVO: two organizations in the health KIS

N.E. Warmenhoven and J. Hagendoorn

*In the Dutch health sector many organizations can be distinguished, operating at local, regional, or national level. Organizations that often function both as a system in itself, and as part of the larger system. Applying knowledge and information systems (KIS) theory to this field, therefore, might prove useful. This article presents two such efforts. First, as an example of organizations functioning at local level, Warmenhoven describes the Municipal Public Health Services (GGD). She relates tasks and activities to the progress made in approaching the public, and discusses how the GGD fits into the concept of a health KIS. In the second part, Hagendoorn continues the discussion by focussing on the Health Education Center (the LCGVO), an organization at national level, with a documentation, information, and research function. Attention is paid to the backgrounds of the foundation of the LCGVO, its present functioning, the experienced problems and opportunities, the national and international system in which it functions, and its role in knowledge management.*

## Health education by the GGD

*Health education and counseling activities.* In The Netherlands, a variety of organizations is concerned with health education and counseling activities. These organizations supplement to direct efforts of health professionals, teachers, and social workers. On the local and regional level we find the following organizations:

- around 90 'Kruisverenigingen', dealing with home-care, child health clinics, (for children up to four years of age), and related preventive tasks (e.g., patient education);
- 62 Regional Institutions for Ambulatory Mental Health Care ('RIAGG'), offering psychological help and counseling (e.g., prevention of child abuse and memory training for the elderly);
- over 20 Alcohol and Drug Clinics, offering help for addicts as well as

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D. Kuiper & N.G. Röling (Eds.). (1991). *The edited proceedings of the European Seminar on Knowledge Management and Information Technology.* Agricultural University, Department of Extension Science, Wageningen, The Netherlands.

programs to prevent alcoholism and drug addiction or abuse;
- 63 Municipal Public Health Services (GGD), with a different set of tasks, like the prevention of the spread of infectious diseases, school health services, ambulance services and, in general, collective prevention programs.

These four types of organizations all have national coordination centers (e.g., for the GGD this is the Society of Municipal Public Health Services (VDB)). Furthermore, there are national centers to deal with specific topics in health education (such as the Dutch Heart Foundation, the Foundation for Consumer Safety, the Foundation of Public Health and Smoking, the Cancer Society, and numerous patient organizations). All these organizations are target groups for the Health Education Center (the LCGVO), to which we will return in the second part of this article.

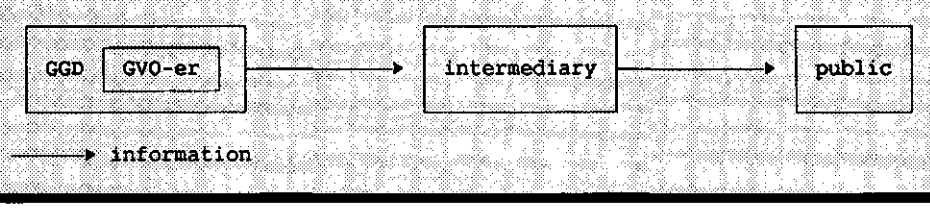
*The GGD.* These municipal organizations often combine very different tasks. Some, like prevention of infectious deseases, are already more then a century the responsibility of municipalities. For others, GGD accepted responsibility because no one else did (e.g., the ambulance service), and sometimes tasks are relatively new. Recently, a new law gave GGD responsibility for coordination of collective prevention activities in the municipalities. As a local organization, one of the important tasks of a GGD is to make existing knowledge about health, health care, disease, and its prevention available to the public.

In executing this task, its health education workers have travelled roughly the same road as extension science as a whole. In its early days extension science used to focus on the question: "how do I get them where I want them?". The question "why don't they do what I want them to do?" came only slowly in focus (Röling, 1985, Röling & Engel, this volume). The development path of GGD health education is marked by the same questions.

"*How do I get them where I want them*". When the GGD started systematic health education, and employed health education workers (so called 'GVO-ers') to coordinate this process, there were just a few of these functionairies working, spread over the country. Starting with one in 1968, the GGD employed no more then ten GVO-ers in 1980. Since, health education gained recognition: in 1989 around 160 GVO-ers were working with the GGD (Warmenhoven, 1989). In the 'early days', to reach as many people as possible with so few workers, an approach via intermediaries seemed most suited. Of course, there were and are other good reasons for an intermediary approach, such as making use of already existing relationships (e.g., between a doctor and patients). Furthermore, the GGD and its GVO-ers were quite convinced of the importance of their messages for the different target groups. Their approach was based on medical practice at that time, in that it was uni-directional and prescriptive (Koelen & Brouwers, this volume). Figure 1 illustrates the process.

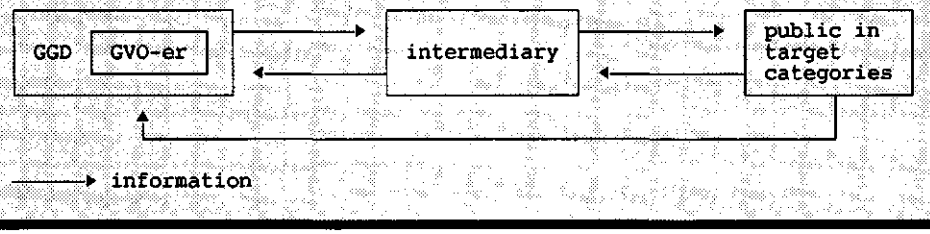
*Why don't they do what I want them to do?.* As in other fields, health education workers were surprised that people did not follow their sound advise. To find some answers they looked at other sciences, such as sociology and marketing, and

Figure 1: The process of health education in its early days.




the practical experiences of extensionists in other areas, like agriculture. Gradually, it became clear that people are not 'empty vessels': it is important to consider what the public already knows, and what they want to know. Health education workers, therefore, started research among their target groups to discover the best possible approach. In this way, the target group gained some influence on the health education process, although this influence was still initiated by the source (e.g., the GGD). Furthermore, health education workers discovered that it was important to distinguish different types of target groups. In all, the approach gradually shifted to a two-way process (see Figure 2).

Figure 2: Health education and target groups.



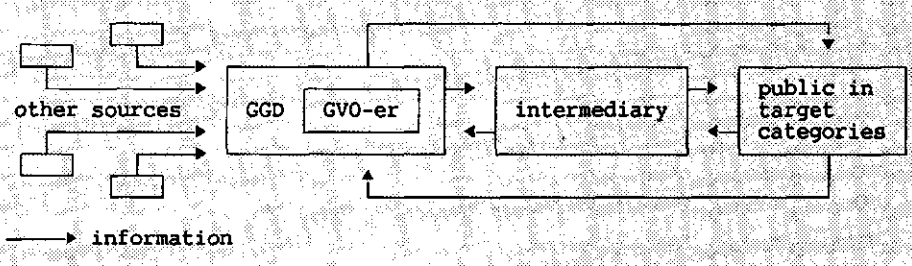

*The direct approach.* More recently the GGD have, in addition to the intermediary strategy, started to approach the public directly. There are several reasons for this step. First, working with intermediaries has advantages, but also limitations. Not all members of the target population come into contact with intermediaries, and not all intermediaries are able to communicate effectively. Second, there is a growing consciousness of the fact that people have a right to access important information (a right clearly stated by the Geneva Convention's Universal Declaration on Human Rights, and which includes, beside information of a general nature, also patient specific information). Third, the WHO-concept of Health Promotion underscores the need for direct public contact. One of the main issues in this concept is the responsibility people have for their own health, and the necessity to involve them actively. Fourth, successive reorganizations of

the Dutch health care system and its financial structure made the system quite complicated. People often need information about different types of care, responsibilities, types of insurances, and related issues. Intermediaries, such as doctors and teachers, cannot be expected to have this kind of information up-to-date and available all the time. Fifth, last but not least, there is growing concern about high-risk groups; often these groups are at the same time 'hard to reach' with current strategies of health education. It seems important to experiment with other communication methods to reach a better coverage among target groups.

There are many ways to make information directly available to the public. The GGD most experienced in the field now combine different methods, of which two stand out: (a) information centers that people can visit, phone, or write to ask questions. An information center can vary from a simple set of organized written material, with or without someone to guide the client, to a well-documented center (or network of centers) with automated information; (b) information by the mass media. Especially local newspapers, radio, and television are interesting in this respect, but also displays, expositions, and other dissemination techniques can be used to reach the public at large.

GGD health education has thus changed from a simple, one-way process via intermediaries to a process with many different routes to provide the public with information. In her efforts, the GGDs do not only make information available that is generated by the organization itself, but also generated information from other sources (see Figure 3).

Figure 3: The GGD in today's health education.




*Remaining questions.* Of course, there are still questions to be answered and problems to be solved. For example, the fact that health education aimed directly at the public is attractive from a public relations (PR) point of view because it increases the visibility and prestige of the agency, is an important issue. In itself this is no problem, but there is a risk that methods are selected not because they fit best to the objectives and target groups, but because they have PR-value.

Another matter that needs a lot of research, experimenting, and thought is how

the 'hard to reach' can indeed be reached by information centers and/or various mass media. Some experiments are hopeful. Some of the local television programs for migrants (mostly Turkish, Moroccan, or Surinam) that are broadcasted in the larger Dutch cities reach many of their intended audiences. Futhermore, most elderly people appear to read local (house-to-house) newspapers thoroughly; messages placed here can be very effective.

It still needs some effort to assure that the local GGD information centers collaborate as much as possible. It would be a waste of time, money, and energy if all information centers did their own documentation, and prepared all their own educational material. The VDB, the national GGD coordinating center, is currently investigating how these information centers can benefit from networking.

*A final word.* In the previous I tried to fit some of the recent developments around GGD health education into the concept of knowledge systems, which is relatively new to me. It is up to the reader to decide whether this perspective offers wonderful new and clarifying viewpoints, or is just another way of talking about something we knew all along.

## LCGVO: an organization for knowledge management

The LCGVO (Landelijk Centrum Gezondheidsvoorlichting en -opvoeding), the national health education center, is located in Utrecht with a staff of around 60 people. It is officially designated by the World Health Organization (WHO) as a "WHO Collaborating Center for Health Education and Health Promotion". The main tasks of the center are to stimulate, promote, and improve health education. The LCGVO is a 'second-line' organization: it never engages in direct health education work, but only supports others to improve their efforts in this field. It therefore operates on a different level from the GGD (which concentrates on 'first-line' health education). To perform its tasks, the LCGVO makes strategical use of knowledge management, e.g., by collecting, processing, and disseminating important information, and by establishing linkages between different actors.

*Backgrounds of the foundation of the Center.* World War II, and the cold war that followed, created greater awareness of the power of propaganda, mass persuasion, and extension. Great importance was attached to the transfer of knowledge (e.g., polical views) to the public. It was a flourishing time for research on issues related to information transfer, often with an uni-directoral bias and focussing on the question: "how do I get them where I want them?" (as was illustrated earlier in this article). Also health education earned some credibility in these years, although providing information on health related topics was not immediately experienced as essential. It was a time of unlimited optimism and belief in the progress of medical science. The invention of a vaccine against cancer seemed merely a question of money. Health education, therefore, was primarily seen as complementary and supplementary to health care, and often not

perceived as a 'must' (see also Koelen & Brouwers, this volume).

Slowly this optimism and perspective changed; health care expenses are at the moment 30 times as high as they were in 1960, and the limits of scientific progress in the medical field are abundantly visible. It has been recognized that maintaining and enhancing health calls for health education that encourages prevention, self-care, and early detection of disease. Since the end of the sixties, health education activities received more systematic attention by policy makers. Decision-makers were particularly influenced by congresses of the International Union for Health Education. The concept of health education introduced here was translated in Gezondheidsvoorlichting en -opvoeding (GVO), and was included in policy measures.

In the seventies, the need for a central institute in this very diverse and divided field became apparant. Here, knowledge important for health education could be brought together and made available for 'health educators', as well as policy makers (e.g., the government) and scientists. The institute should collect scientific and practical medical knowledge and experiences, and insights gained on the different health education approaches. It should, futhermore, 'translate' and combine information, and make it avalaible for others. In addition to this transformation and dissemination function, the center should stimulate actively health education work. In 1979 the Landelijk Centrum Gezondheidsvoorlichting en -opvoeding (LCGVO), the national health education center, was established by law, it started work at the beginning of 1981.

*The present functioning of the Center.* By now, the LCGVO had functioned for about one decade. Especially in the first few years it was difficult to find the right approach to the complicated tasks that it was assigned to fulfil. Central institutes are not easily established in the split-up and often divided Dutch society. There is a traditional tendency to regulate things as decentralized as possible, a tradition that can be traced back to the middle ages and probably originates from often local struggles 'against the water' and the autonomous administrative units that emerged thereby. As a consequence, there is a centrifugal tendency that can sometimes be disadvantageous for scientific progress and its application.

In time, the LCGVO developed to an institute capable to function as an organization for knowledge management. As such, its performance includes a number of permanent and temporary tasks:

- information provision (through books, journals, health education materials, audio-visuals, guidance of activities):
- advancement of expertise (organizing congresses, conferences, workshops, courses);
- research-registration and consultation (translating results from research to practice, and vice versa);
- methods development (making new methods and/or new concepts applicable, screening of health education materials, etc.).

Each task can be divided into activities. The first activity is to supply an overview of developments in the specific task field, followed by analysis of these developments, consultation, and finally, stimulation and initiation of promising developments.

Information provision by the center is now computerized, and will soon be ready for on-line consultancy. Furhermore, the LCGVO publishes a monthly magazine that reports on developments in health education: "het Tijdschrift voor Gezondheidsvoorlichting" (the Journal of Health Education). Stimulation and initiation of activities take place by means of projects, mostly for a period of three or four years. To give some recent example: health education in primary schools; introduction of AIDS-education in secondary schools; development of patient-education, and development of health education in the workplace.

It is furthermore interesting to note that also in other sectors central organizations for knowledge management have been established, see e.g., Bos et al. (this volume) for the first experiencess with the recently established information and knowledge centres (IKC) in the agricultural field.

*Experienced problems and opportunities.* Although knowledge and information systems (KIS) perspective in theory already looks rather complex, putting theory into practice proved even more difficult. The LCGVO resembles a complicated switchboard, with many possible connections, where plugs regularly fail, electricity is interrupted, in- and outputs are only partly obtained, whether or not caused by human failure. One of the most difficult task is to find the upper limits of completeness, and the lower limits of work that should be aborted. Related questions are: "how complete should the documentation system be?", "what should be added to the collection, and what not?", "on which extension methods should the center focus?", etc.

The government largely funds the LCGVO. Therefore, the center has to pay attention to political considerations as well. Fundamental science is not devoided of value judgements, and neither is an applied science such as health education. This is certainly true when political expectations are high. Politics follow trends, and trends often change faster then one would prefer. This sometimes entails important consequences for present and future health education efforts and directions. In short: development and performance of an institute as the LCGVO largely depends on political and official support, views, and pressure.

*LCGVO and its national and international environment.* The environment in which the center operates consists of a number of arenas, each with its positive and negative characteristics:

- the health care system. In total, health care costs mount up to around $20 billion each year, which provokes, on the one hand, discussions about commercialiations, and on the other hand, the need for more prevention. The Dutch health care system is a conglomerate of closed systems, which tend to guard their own interests first, and often try to protect their territories. They accept the need for health education, but rarely approach it with

an open and broad vision;
- the official, bureaucratic system. The Ministry of Welfare, Public Health, and Culture (WVC) has a special division of health education, but many other divisions have tasks that also include health education activities. Furthermore, the closeness and defence of each party's policy areas are strong. In contrast, openness is needed for the creation of the flexible monetary system that effective health education requires. Often, each segment holds different opinions about health education; whether it should be more or less medical, more or less socially embedded, etc.;
- the political system. As stated before, political parties agree on the necessity of health education, or, the general need for a preventive approach, but in their commitment little is explicitly, and much fashionable. For example, suddenly a lot of money was made available for health education to prevent AIDS infection;
- the educational system. Health education, as the term implies, lies on the edge between public health and formal schooling. If anywhere in The Netherlands, denominational segregation prevails in these departmental work fields: the climates are completely different.

Health education furthermore relates to scientific findings and insights, societal opinions, economic principles and opportunities, etc. At this point, health education should be placed in the larger context of health promotion, that also consideres the physical and social environment in which people live. When people suffer from e.g., excessive noise, bad housing, unemployment, or work stress, the conditions to sustain or improve health are poor. This has serious consequences for the effectiveness of health education.

The focus on helping people to make the right choices in an environment that promotes that choice, shifts the accent from a behavior-descriptive to a behavior-facilitating approach. The LCGVO actively supports this approach, in accordance with international developments, carried by the World Health Organization (WHO). The WHO more or less defines the international conceptual frameworks in which the center works. As a WHO collaborating center, the LCGVO has a formal contract for the conduction of health education and health promotion activities within the Health For All strategy (see Ashton, this volume). Furthermore, in the international field also the EEG, the International Union of Health Education (IUHE, of which the center is a national constituent member), and the many contacts with individual scientists, are important. On the international health education level, therefore, the LCGVO also plays a role.

*Conclusion.* As shown, the LCGVO plays a central role in Dutch health education. The center collects, processes, and distributes a lot of useful and important information, and in doing so, functions as an valuable partner for others. To perform her tasks, it looks for cooperation with other actors in the field, such as the GGD. Much attention, therefore, should be paid to the organization of these interfaces. KIS theory seems to offer some helpful insights

on these topics.

An important benefit of thinking in terms of knowledge and information systems is that the manifold connections of health education to society are explicated. For many actors, certainly for policy makers, it is insufficiently clear that health education is needed for further development in the health sector. This is certainly true for captains of finance who prefer to see large actions in the utilizer atmosphere rather then mundane extension activities. These beliefs apply for politics and officials, but sometimes also for the work field, where health education workers often operate alone and uncertain. They, therefore, clearly benifit from support of an organization that plays 'center-field'.

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# Policy and information: an inseparable couple in health promotion

E. de Leeuw

*John Ashton (this volume) reflects on the role of information (education, extension) as an agenda-setting and knowledge enhancement device. This approach is indeed the crux of health promotion and the Healthy Cities movement. In this article, however, a complementary perspective, that in essence may not differ too much from Ashton's ideas, will be presented. The reader has to bear in mind that, although urban (metropolitan) health problems in western industrialized countries are probably of the same magnitude, the cultural and political contexts for development of specific health promotion programs and Healthy City activities are different. The political environment for efforts in the realm of virtual health policy may be less stimulating in Britain or Germany than it is in nations like Finland, Australia, or The Netherlands. This article focusses on the Dutch policy considerations in the area of health promotion, and their relation with information, networking, etc. First, a brief overview of the development of the so called 'new public health' or 'health promotion WHO-style', and its premises, will be given. The efforts of the government to increase the feasibility of an effective health policy in our country will be described. This outline results from an extensive research project (De Leeuw, 1989b). Finally, the use of information as an instrument to carry out or develop policy will be explored, at first in more abstract terms, then followed by some examples related to networking and knowledge management.*

## Development of health promotion

Over the past years we have come to realize that health is not just the end of a tour through the medical circuit, or that health may be enhanced through lifestyle advice and guidance alone. Social and physical environments, living conditions, levels of education, hereditary preconditions; all of these and many more influence in numerous ways a multitude of health expressions, including illnesses (but also vitality).

Starting with publications by Blum (1974) and the Lalonde report (1974), this

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D. Kuiper & N.G. Röling (Eds.). (1991). *The edited proceedings of the European Seminar on Knowledge Management and Information Technology.* Agricultural University, Department of Extension Science, Wageningen, The Netherlands.

realization slowly trickled down to policy levels in public as well as private sectors. The US Healthy People documents (USDHHS, 1979), the Health for All ideas of the World Health Organization (WHO), and efforts in corporate environments to promote employee health, reflect a shift in thinking from attention for the health care system infrastructure and financing, toward the development of a virtual health promotion vision (De Leeuw, 1989a).

Health promotion in its new conceptualization has been defined by the WHO as follows: "health promotion is the process of enabling individuals and communities to increase control over the determinants of their health, and thereby to improve their health" (WHO, 1986). On various occasions (at the health promotion conferences) this definition has been endorsed by professionals, and it has been made clear that health education and something called 'healthy public policy' play crucial roles in furthering the objectives of health promotion.

'Healthy public policy' is a rhetorical term. It is ideologically used to refer to all public policies that include explicit reference to health affairs and should take positive or adverse effects of the policy into account (WHO & ADWH, 1988). This means that healthy public policies might only be slightly concerned with health care organization policies. On the contrary, healthy public policy may be found in the realms of environmental protection, civil rights, education, occupational legislation, traffic, and many other sectors of daily governmental and corporate life.

There are some countries that have developed national policy plans to address such an integral and inter-sectoral scope. To some extent they are based on WHO's thoughts on Primary Health Care, Health for All, and its Health Promotion Program. The proposed policies are (among other things) supposed to be inter-sectoral, integral, participatory, and structural. In short: taking a more holistic and ecological perspective (De Leeuw, 1989c).

The Dutch government presented its policy plan in the spring of 1986. It was called "Nota 2000: facts, considerations, and policy intentions" (Ministry of Health, 1986). It was a completely new approach to addressing health issues, for parliament the time was clearly right to suggest such a fundamental policy paradigm shift. Therefore, the ministerial unit responsible for the production of Nota 2000 decided that extensive rounds of consultation, discussion and reflection should be initiated among the wide array of interest groups.

## Increasing health promotion standing

Since publication of Nota 2000, the Ministry of Health increased its efforts to inform all kinds of interest groups about health policy issues. The channels and instruments included an information campaign using the professional media, publication of a series of books, organization of seminars and conferences, and marginal stimulation in financial terms of the Dutch Healthy Cities network. The

basic idea was that through increased awareness of health policy issues, interest groups would urge parliament and government to formalize the integral and inter-sectoral public health policy suggested in Nota 2000.

"Did they succeed?", "has 'healthy public policy', 'health policy', 'health promotion', or whatever you may want to call it, acquired a position on the parliamentary agenda?". These are fascinating questions. Our research project (De Leeuw, 1989b) provides a basic answer, which at first may seem to be a flat-out "no". Although most interest groups acknowledged that the notion of health promotion is a sensible one, few organizations felt that public policy could adequately address the issue. In this respect, the initial information campaign by the government was apparently not effective.

Of course we have investigated what were the specific barriers, in the perception of interest groups, to establishment of a formal health policy statement. The results primarily applied to the unique Dutch situation; once again, as has happened in all discussions over health care policy reform in the past, the actors referred to situational and managerial problems outside their own sphere of influence. An action-oriented reflection on the contents of the proposed health policy was only rarely found.

The perceived problems related i.e., to lack of funds, failing legitimacies, insufficient political support, and a said 'uncontrollable society'. Most interest groups assured that in principle they would be willing to contribute to the establishment and implementation of health policy. However, they also make it very clear that present conditions did not stimulate such activities. An essential problem seems to have been the simultaneous publication, next to Nota 2000, of a major report by a committee on restructuring the health care system (Rapport Dekker, 1987).

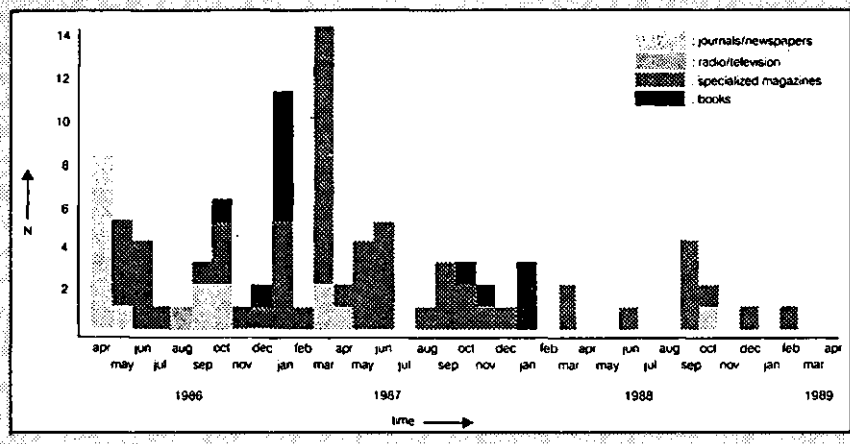
The theory employed to investigate and explain the phenomena described above was the 'agenda-building theory' (Cobb & Elder, 1983). This theory suggests prerequisites for successful establishment of policies. These may be delineated into three sets: first, involvement of relevant interest groups (or "publics", as Cobb and Elder refer to them); second, the impact of their perception of the policy issue on societal and political agendas (which is supposed to be equivocal, with political and social relevance over longer periods of time, without any precedents, and little technocratic); and third, the frequent use by the media of images, symbolism, and metaphors to reflect that issue.

Interest groups were found to be widely involved in the discussion process initiated by the governmental bureaucracy, but did not perceive the issue as the theory would have predicted. In our research, we therefore investigated media coverage of the health policy issue.

In Figure 1, the various sources of 'independent' media coverage are presented over time. It appears that 'fast' popular media (radio, television, daily newspapers, and magazines) have covered the issue at a rapidly decreasing pace. Interest groups therefore depended, in their formation of beliefs about health policy,

mostly on journals issued less frequently, and with a generally limited (or rather specialized) audience.

Figure 1: Media coverage Nota 2000 over time.

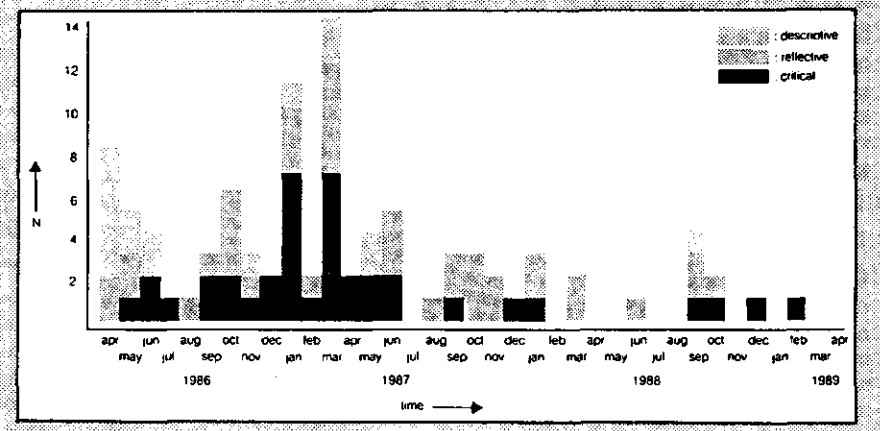



Another indicator of knowledge of, and value attributed to Nota 2000 among organizations is the attitude expressed in the media coverage. These attitudes are classified and presented in Figures 2 and 3. It is clear that descriptive attitudes expressed by the media have decreased in number rapidly, while reflective attitudes decreased less rapidly. It is remarkable, however, that even when time passed and many other developments (like the report 'Rapport Dekker' from 1987 on establishing market mechanisms in the Dutch health system) emerged, the critical attitude is persistent. Clearly, we may expect that knowledge about Nota 2000 among most organizations does exist, but also that the document is critically evaluated over time.

Finally, the agenda-building theory asserts that media, symbolism, and the use of metaphors are important instruments in the expansion of issues to a wider public. We have reviewed in what way the media covered Nota 2000, making a distinction between single issue coverage (meaning that only a limited part is taken out of Nota 2000; such as prevention, or budget cuts, or future trends) and comprehensive coverage (Nota 2000 as a total set of health policies). The results are presented in Figure 4. It appears that 61 of 95 coverages are of a comprehensive nature. There seems to be no time trend in the proportion between single issue and comprehensive coverage.

Comprehensive coverage does not lend itself to the use of metaphors or

Figure 2: Media coverage and attitude expressed towards Nota 2000.



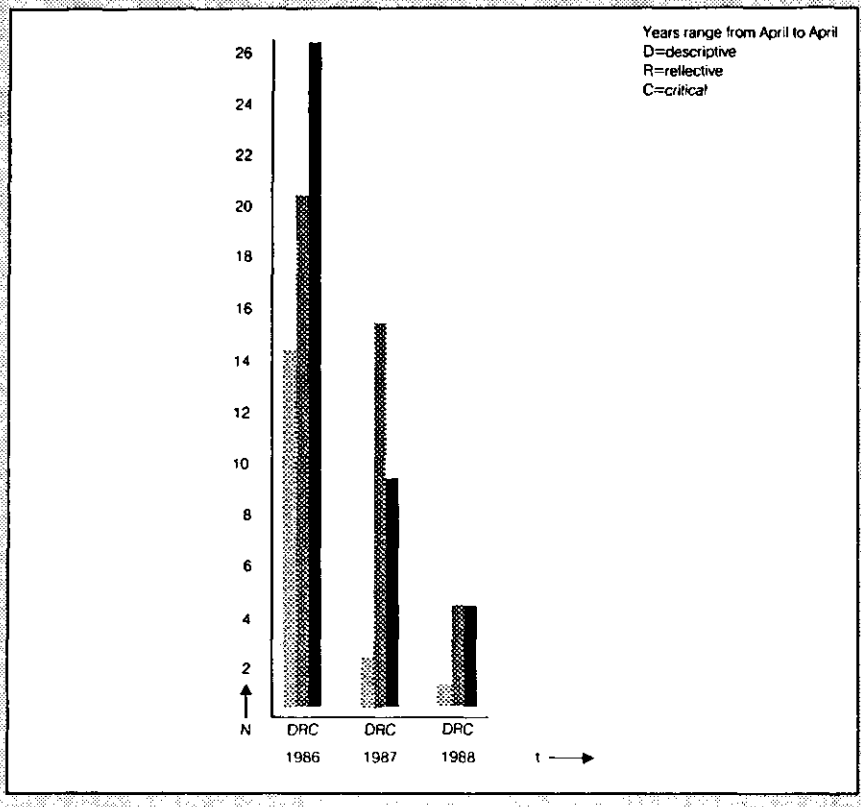

symbolism. Most comprehensive coverages relate to the nature of Nota 2000 (such as future orientation, focus on health), while most single issue coverages relate to a specific health sector (e.g., mental health, prevention). About one sixth of all coverages (e.g., newspapers and magazines) uses some form of metaphor, mostly referring to future trends (captions like: "more disease by 2000!" or "budget cuts: people will have to take care of themselves."). Only two coverages use a virtual metaphor: "Nota 2000 fairy tale" and "the evil nightmare from WHO".

Clearly, the initial information offensive by government seems to have failed. Information per se is not enough. Therefore, we have structured our recommendations along two main lines: first, further development of an information strategy (or, in terms of the seminar, adequate knowledge management in the existing knowledge and information system). Second, strategic action in policy development. As the second set of recommendations does not really fit in the scope of this article, it suffices to say here that governmental bureaucrats should further establish their capacities to present the various more or less powerful interest groups with appropriate advantages or disadvantages of the proposed policy to secure their action.

**Governmental public communication**

Regarding the information strategy, we found (De Leeuw, 1989b; Winsemius, 1985; Stoof, 1989; Van Riel, 1986) that a communication process to enhance

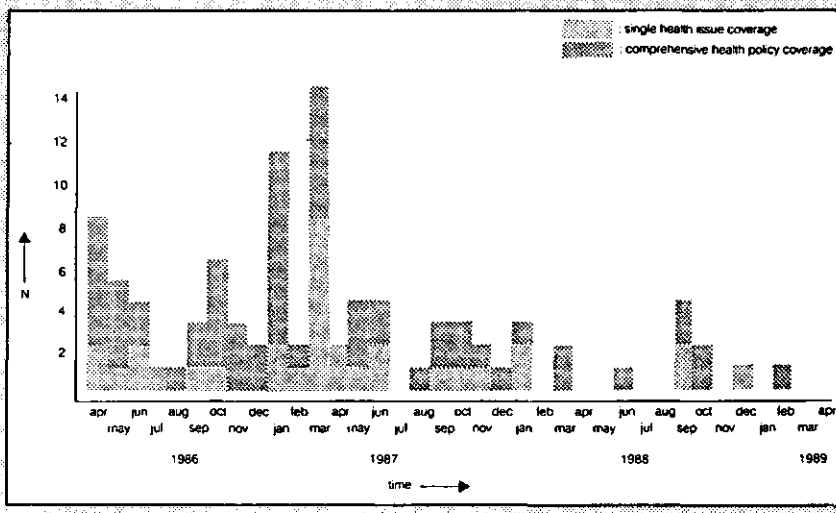
**Figure 3: Media attitude cluster analysis.**




feasibility of policy proposals should: (a) be active and intentional, i.e., the objectives of the process will have to be clear; (b) be an integral part of the policy process, i.e., the instrumental as well as publicizing functions of governmental public communication should be integrated in the work of policy makers); (c) use intermediary levels and organizations outside the traditionally limited policy field to disperse information. Preferably, the groups should express their commitment to the envisioned process, i.e., not necessarily to its objectives or preferred outcomes.

Such a process is not easy to establish. On the contrary, maybe we should not even try to establish the process and its structural prerequisites, and leave it to the open systems environment already suggested by Ashton et al. (1988). Such an environment could eventually lead to evolution of networks.

Figure 4: Media coverage modes.




## Networks and information

The Healthy Cities project of the WHO is a fine example of a health promotion/ health policy program (here in the urban context). As we have seen, specific projects may have tangible political spin-off (Ashton et al., 1988). In that respect, the support by the Dutch government of the WHO international Healthy Cities network, as well as its concern with the Dutch national network is clearly an activity that enhances the feasibility of a comprehensive health policy as suggested in Nota 2000.

Now, here we come across a term that has a lot to give to knowledge management and information strategies, as well as the development of virtual health policy. A network is a web of free-standing participants cohering through shared values and interests. Networks are composed of self-reliant people and independent groups.

Where needs and resources are connected among peers, networks start to be created. As you will clearly recognize, the concept of knowledge and information systems very well applies to networking. Networks are considered to be crucial organization forms in the field of health promotion where such multitudes of professions, fields of interests, organizations, and levels of involvement are

concerned.

Networks are built on by what Gerlach and Hine (1970) call SPIN, which stands for segmented, polycephalous, ideological network. The S, P, and N represent organizational factors; what really binds effective networks is an agreement on ideology. In the field of Healthy Cities, there certainly is a definite degree of ideology involved.

In the network environment, participants agree on each of their specific expertise areas, on the non-hierarchical structure of the network, on the liberty to access the network, and on the ideology that binds the network effectively in order to produce tangible outputs. Networks without agreement on these issues, consequently do not work. It may therefore also be concluded that the structure of networks cannot be pre-determined through a top-down initiative. Networks have to shape themselves.

However, the formation of a network may be facilitated and stimulated, either by an initial group of participants, or by certain bureaucracies. This might include the establishment of prerequisites for participation, such as housing facilities, monetary resources, and information exchange facilities (e.g., newsletters, fact sheets, telematics such as electronic mail services and computer network clipping board, interactive media, such as expert systems, etc.). Furthermore, some degree of consensus on scope and purpose of the network is essential. This consensus can either be created out of necessity (e.g., when potential participants of the network are facing threats to their organizational survival in terms of decreasing legitimacy of their work, budget cuts, or diminishing support from traditional sources), or out of ideological factors such as paradigm changes, emergence of new legitimacies, etc.

When these sets of prerequisites are compared with the objectives and purposes of the information strategy outlined above, it will be clear that a sophisticated plan of action in this field may facilitate the establishment of effective networks for health promotion. In fact, the WHO Healthy Cities program is structured along these lines, in which an international network of so called 'core cities' has been set up, in which the core cities in each country will have the responsibility of facilitating and stimulating the establishment of national city networks. This structure has been growing at an extremely rapid pace over the last few years, and clearly addresses the needs of local officials in the realm of health promotion.

Theoretically, the prospects for an effective contribution of health promotion networks to the establishment of virtual health policies may therefore be considered viable, not only because of the increasing knowledge base among network participants, but also because these networks can exert the 'public pressure' needed for establishment of healthy public policies.

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# Informatics and the new public health: two case studies

J. Ashton

*Policies to enhance public health have made an important shift in the last decade, and now consider physical characteristics, lifestyles, and the environment. Furthermore, active participation of other parties (e.g., the public at large) in formulation and execution of health-related policies is often looked for. This article presents two case studies, both situated in Liverpool, that reflect on the results of such endeavors. First, some experiences with a health fair, which was attended by around 250,000 people, and five travelling health double-decker busses that continued serving the public after the fair, are reviewed. This will be followed by a discussion of the origins and formulation of the World Health Organization (WHO) Healthy Cities project.*

What has come to be known as the 'New Public Health' differs in a number of important aspects from the public health that our Victorian forebears developed. The old version, which arose out of the threat to life posed to populations in industrial cities by epidemics of infectious disease, relied heavily on the activities of city medical and sanitary officers in enforcing public health regulations with the back up of law.

In retrospect such an approach seems understandable, given the nature of the epidemics, the lack of real understanding of their causes at that time, and the nature of societies in which the mass of the population was still illiterate and was only just beginning to emerge from a state of feudal serfdom. The idea of mass public participation in health would presumably have been considered a ludicrous proposition and if considered to be possible at all might have been thought to carry with it a threat to the existing economic and political order.

Our understanding of the interactions between lifestyles, the environment, and human beings and their state of health have come a long way since the origins of urban public health in Europe of the 1840s. We now have a sound knowledge basis to work from with an understanding of the primary social, economic, and biological causes of much of the burden of premature death and disability. We

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now understand with McKeown that most of the improvement in health in the past came about not as a result of the application of scientific treatment based medicine as such, but that "past improvement has been due mainly to modification of behavior and changes in the environment and it is to these same influences that we must look for further advance" (McKeown, 1976).

Building on these insights and on the increasing acceptance that today's health problems are similarly rooted in our lifestyles and the environment, the work of the World Health Organization (WHO) has helped to create the framework in which the New Public Health has begun to emerge (WHO 1978, 1981, 1984, 1985, 1986). The core element of this framework is a commitment to reducing inequalities in health. The methods advocated are the achievement of much greater public participation in health, an intersectoral approach, and the reorientation of medical care towards primary and community care, prevention and health promotion. Common to all these methods is the notion of involving the public in public health. In order to do that not only does there need to be a change in the power relationship between professionals and public and in the style in which professionals work but, most importantly, there needs to be an open flow of information to produce an informed public and responsive, supportive, professional activity. It is proposed to illustrate the application of an open approach to information in public health by reference to two case studies:

1. the health fair and travelling health buses in Liverpool;
2. the WHO Healthy Cities project and the growing world movement towards tackling urban health issues.

## Background in Liverpool

While the old public health may have been paternalistic and not sought to involve the mass of the population as agents on its behalf, some of its practitioners recognized the importance of an information flow that went beyond the immediate professional clique of doctors. In Liverpool, William Henry Duncan who was the first "Medical Officer of Health" to be appointed in a British city in 1847, recognized a number of timeless truths about public health information. (Ashton, 1989a).

In developing a strategy of health promotion for a region of 2.4 million people based in Liverpool we have tried to learn from these truths and to develop their relevance for contemporary times (Ashton & Seymour, 1988):

1. populism. Duncan did not only talk to his medical peers. His analyses and lectures on the state of health in Liverpool were delivered not primarily to the medical society but to the Literary and Philosophical Society, to the opinion formers and decision-makers of the day, and he made the facts he gleaned widely available. They were extensively reported around the town and created considerable interest;

2. appropriate research. Duncan had to cope with what would certainly today be called inadequate information, but that did not deter him from using it to argue the public health case. In the 1830s he carried out a survey of the housing conditions of the working class in Liverpool and found that one eighth lived in underground earth floored cellars with no ventilation and as many as 30 people to a room. In analyzing national data he showed that the average age of death in Wiltshire was 36.5 while in Liverpool it was only 19 years; that the annual death rate in Liverpool was one in 28 while the rate in Birmingham was only one in 37. In short he used simple basic data but he put it to good use;
3. report writing. The production of regular reports on the state of public health has been an important and powerful part of the public health tradition. Duncan produced a pamphlet on "the physical causes of the high rate of mortality in Liverpool" which enjoyed wide circulation and which influenced public policy. He demonstrated that producing a report is not in itself sufficient, it is what is done with it subsequently that determines whether or not a public health worker makes a contribution to public health.

These three truths must be considered in the light of the much wider scope of democracy in the 1980s compared with the 1840s and that of WHO "Health for All by the Year 2000" with its emphasis on public participation. These both point towards a widening of the information perspective to include not just the decision-makers and opinion-formers but the public at large (in short to develop both agenda setting and widespread consciousness-raising as part of a public health information strategy).

**Developing the New Public Health in Mersey**

The first step was to establish a multi-disciplinary Regional Health Promotion Team within the Health Authority along the lines outlined by the Unit for the Study of Health Policy and by Ashton (Dennis et al., 1979; Ashton, 1982). In particular, six underlying principles have been suggested for catalysts of a new public health movement (Ashton, 1982):

1. activity on health promotion and disease prevention should be carried out at the most decentralized level that is compatible with effective action;
2. there should be a team approach;
3. participation by the community should be an overriding principle;
4. health promotion teams should have security of employment and independence of action;
5. a strategic plan for the promotion of health should be produced at the regional level which is informed by the priorities and objectives decided at the periphery;
6. health promotion teams should produce annual reports based on the

development of appropriate indicators that can be used to assess progress and revise objectives.

The most important initial function of this team was to obtain access to the range of resources that exist within health authorities, and to open up channels of communication for influencing policy making. This group has undergone several changes, the most recent being to incorporate District Health Authority representation, and exclude non-National Health Services (NHS) members of officers. The first of these measures should improve the links between the region and the districts, the second resulted from an Authority decision about the nature of the team, which reflects a difficulty in making intersectoral working a reality from a health authority base.

The work program of the Regional Health Promotion Team (now described as the Health Promotion Management Steering Group) is implemented by a Health Promotion Section under the direction of the Regional Health Promotion Officer in conjunction with the Regional Specialist in Community Medicine (Health Promotion), an academic with an honorary service contract. The Regional Health Promotion Officer post is the first of its kind in the UK and is jointly funded by the Health Education Authority and the Mersey Regional Health Authority.

As a sub-committee of the Regional Health Authority, the Health Promotion Management Steering Group has access to both the planning process and program budgeting. Through the work of the regional Health Promotion Officer and Specialist in Community Medicine, it has also developed a wide range of links with other statutory and non-statutory organizations. In setting about its task the group has drawn freely on lessons to be learned from the public health pioneers of the nineteenth century.

## The Health Fair and Travelling Health Buses

Mersey Regional Health Authority's strategy has had two main elements: (1) to place health promotion on the agenda of the key decision-making bodies within the region; (2) to increase the general public's awareness of the individual and collective action necessary to improve health.

Setting the agenda for key decision-making bodies was the aim of "Health in Mersey - a Review", a report on health and disease in the region from which 12 priority topics for health promotion were identified (Ashton, 1984). The International Garden Festival from april to october 1984 offered a unique 2opportunity to bring health-related information to a mass audience as part of the region's health promotion strategy (Hussey et al., 1987; Hopley, 1986).

Health was made a major theme throughout the festival and educational material was featured in a number of areas within the site, including the area containing allotment and other vegetable gardens. The term 'health fair' was used to denote the range of activities rather than a single static base, and the objective

was to provide active learning. Activities included static displays providing information on a range of health matters; dynamic displays consisting of health-orientated activities such as aerobic dancing, yoga, meditation and sports and public participation involving physical fitness testing and interactive computerized lifestyle assessment.

Of the 3.3 million people who attended the International Garden Festival 250,000 were estimated to have attended the static part of the fair, and most of them made use of the computerized life-style assessment; 11,000 actually took a fitness test. Software was especially developed for computer analysis of lifestyles and fitness and this has subsequently been in steady demand from both home and abroad (Hussey et al., 1987; Ashton & Seymour, 1988). 12 computers offered a range of self-operated programs which included a dental health game, an actuarial assessment of longevity and an interactive lifestyle analysis. The life-style analysis provided a printout for each individual giving advice on their life-style. The areas included in the program were diet, smoking, weight, stress,. alcohol intake and heart disease risk.

The static health fair with its life-style appraisal and fitness testing was staffed by previously unemployed young people who were employed under a job creation program as health promotion assistants. The assistants received a two-week induction training which consisted of: (a) education on major health problems and the relationships to life-style; (b) instruction in fitness testing and the interpretation of results; (c) advice on communication and presentation to the public. The static health fair was constantly manned using a rota system and the fitness tests used assessed stamina, grip strength, flexibility and body fat. The data were entered on computer (Commodore 64) and scores were generated by comparisons with the norms and percentiles of the Canadian Public Health Project (Canadian Public Health Project, 1979).

Twelve months after the initial interview a sample of 234 people who had completed a questionnaire at the time of their initial contact were sent a further questionnaire to complete themselves. There was a response rate of 67 percent and the major finding was that there appeared to have been actual changes in behavior in the three main topics of the health fair (i.e., diet, smoking, and exercise: 24 percent had an improved diet, 20 percent were taking more exercise and 6 percent were smoking less or had stopped smoking).

An important aspect of health promotion, which this program illustrates, is the value of initiatives that combine mass coverage with an individual approach. This satisfies the requirements of public health while keeping the satisfaction and quality which goes with an individual service. In this case it was possible by using a combination of unskilled workers and high technology microcomputers; high-tech and high-touch, thereby putting the knowledge base on computer, but providing a human interface.

One way in which the success of the Garden Festival Health Fair can be assessed is by its expansion to employ 130 people working from five mobile

double-decker buses by the time the festival ended and their continuing work with large numbers of the public in work places, shopping centers, and at public events.

## The WHO Healthy Cities project

It is fair to say that many streams of consciousness and endeavor have flowed together to create the Healthy Cities project. During the 1970s around the world health activists were beginning to use the WHO Health for All Strategy as a framework in which to view their own local initiatives, many of which had a community development emphasis and had their origins in the students movement of the late 1960s and the related feminist and green movements.

In Britain the Mersey Regional Health Authority had adopted a Health for All framework in 1984 and a network of local authorities with health committees was established which became increasingly interested in the philosophy and framework offered by Health for All.

The notion of "healthy cities" was first proposed at a conference in Toronto in 1984 as a result of a paper presented on the subject by Professor Duhl from Berkeley, California. The WHO Copenhagen representative, Dr. Kickbusch, saw the potential of the idea and on her return to Copenhagen she decided to initiate a pilot project of European cities. A multi-disciplinary steering group was convened and I was asked to coordinate the project from Liverpool University on behalf of WHO, drawing on the local experience and expertise developed on a result of developing a Health for All strategy in the Mersey Region.

The original idea behind the Healthy Cities project was that by bringing together a small number of European cities to collaborate in developing new public health initiative based on Health for All, it would be possible to promote models of good practice which were seen as relevant by other municipal administrations and would be picked up and copied (Ashton et al., 1986; Ashton, 1989b; Ashton & Seymour, 1988). The city was seen as being an appropriate focus for such an initiative because 75 percent of Europeans and a majority of the worlds population live in large towns and cities, and have the possibility of working together as the building blocks of a new public health movement. If it was possible for cities to play a leading role in public health 100 years ago, then why not today? In addition, it has become increasingly apparent that it is the lifestyles of city dwellers, divorced from the rhythms of country life and unconscious of the impact of their way of life on global eco-systems, which poses the greatest threat to the world environment and in turn to the health and continued survival of the human species.

Although many strands of contemporary work contributed to the thinking behind the Healthy Cities project, the experience of developing a health promotion strategy in the Mersey Region led to an emphasis in the project on the three central elements of the Liverpool work: (a) agenda setting; (b) conscious-

ness raising; (c) developing models of good practice. At the outset the healthy cities project was envisaged as having 5 major elements:

1. the formulation of concepts leading to the adoption of city plans for health which are action-based and which use Health for All, health promotion principles and the 38 European targets as a framework;
2. the development of models of good practice which represent a variety of different entry points to action depending on cities' own perceived priorities. These may range from major environmental action to programs designed to support individual life-styles change, but illustrate the key principles of health promotion;
3. monitoring and research into the effectiveness of models of good practice on health in cities;
4. dissemination of ideas and experiences between collaborating cities and interested cities;
5. mutual support, collaboration and learning, and cultural exchange between the towns and cities of Europe.

In order to achieve these objectives, participating cities agreed to undertake seven specific tasks:

1. to establish a high-level intersectoral group bringing together the executive decision-makers from the main agencies and organizations within the city. The purpose of this group is to take a strategic overview of health in the city and unlock their organizations to work with each other at every level;
2. to establish an intersectoral officer or technical group to work on collaborative analysis and planning for health in the city;
3. to carry out a community diagnosis for the city down to the small-area level, with an emphasis on inequalities in health and the integration of data from a variety of sources including the assessment of public perceptions of their communities and their personal health;
4. the establishment of sound working links between the city and the local institutions of education both at a school and higher education level. Links at the school level can be explored as partnerships for learning, at the higher education level as partnerships for research and teaching. These latter links should not be confined to medical training establishments, but should include any department or institution with an interest in urban health-related phenomena. Part of this work involves the identification of appropriate urban health indicators and targets based on the Barcelona criteria: (a) that they should stimulate change by the nature of their political visibility and punch through being sensitive to change in the short-term and being comparable between cities; (b) that they should be simple to collect, use and understand, be either directly available now or available in a reasonable time at an acceptable cost; (c) that they should be related to health promotion;
5. that all involved agencies should conduct a review of the health promotion potential of their activities and organizations, and develop the application of

health impact statements as a way to make health promotion potential in different policy areas explicit. This includes the recognition that within a city there are many untapped resources for health, both human and material;

6. that cities will generate a great debate about health within their cities, which involve the public in an open way and which work actively with the local media. This might include the generation of debate and dialogue using, for example, the interfaces which exist with the public (such as schools, community centers, museums, libraries, and art galleries). A city's own public health history is itself often a powerful focus for debate and learning. Part of this work is the exploration of developing effective health advocacy at the city level;
7. the adoption of specific interventions aimed at improving health based on Health for All principles and the monitoring and evaluation of these interventions. The sharing of experience between cities and the development of multiple cultural links and exchanges underlies this work and is seen as promoting one fundamental goal of the World Health Organization, ie the promotion of world peace and understanding without which all health is threatened.

Nobody could have predicted the extent of the positive reception to the Healthy Cities project world-wide. By 1989 hundreds of cities in Europe, North and South America, and the Pacific had adopted the Healthy Cities model and there was considerable interest in it in Africa and Asia. It quickly ceased to be a project and became part of a world-wide movement focused on urban health, life-styles, and the environment.

Information collection, analysis, and dissemination is clearly a central part of the Healthy Cities approach and the project has stimulated a great deal of activity at the local level which focuses on inequalities in health, small area databases, and the development of methodologies that enable the public to be much more involved in the information process than has traditionally been the case.

An outline list of suggested indicators for Healthy Cities was drawn up at the first Healthy Cities Workshop in Lisbon in 1986 (Figure 1) and a great deal of work is currently under way around the world to explore their feasibility.

It is still too early to be able to comment on the value of this approach but it is becoming clear that even a preliminary analysis of quite traditional data may be sufficient to illustrate the extent to which inequalities in health are concentrated in small areas of urban conurbations (Liverpool City Planning Department, 1986). Duncan would not have been surprised.

## Conclusion

Using computer analysis of the 1981 Census and locally collected data, Liverpool City Planning Department has defined five standard data zones for the city that

Figure 1: Suggested indicators for Healthy Cities.

1. - Demography.
2. - Quality of the physical environment including pollution, quality
   - of the infrastructure and housing.
3. - State of the local economy including unemployment levels.
4. - Quality of the social environment, including levels of
   - psychosocial stress and quality of social support services,
   - strength and nature of local culture(s).
5. - Personal safety.
6. - Aesthetics of the environment and the quality of life.
7. - Appropriate education.
8. - Extent of community power and participation,
   structure of government.
9. - New health promotion indicators, eg participation in physical
   exercise, dietary habits, alcohol and tobacco use.
10. - Quality of health services.
11. - Traditional health indicators (mortality and morbidity).
12. - Equity.

bring together spatially separate populations which share characteristics such as income level and housing tenure type (Liverpool City Council, 1984). However, it is clear that we need to develop the social dimension of health as defined by the WHO if we are serious about Health for All, and have to integrate this with local environmental and medical profiles that link on the one hand to lifestyles, and on the other to a true understanding of the ecological interactions of city dwellers, to establish effective policies. In this work, both Duncan of Liverpool and the informatics approach developed in the International Garden Festival Health Fair are likely to throw some light.

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# From medical knowledge to patient information: an AI system for counseling patients

A. Van Schoonderwalt

*This article is about the creation of an artificial intelligence (AI) system for counseling patients. The implementation of a prototype of such a system was based on elementary knowledge about two dental diseases (caries and paro) and related oral conditions. First, the advantages of computerized counseling and the prospects of AI programming techniques will be explained. Subsequently, the development of the specific application, in relation to underlying considerations, is described.*

## Advantages of computerized counseling

Counseling patients by computer has several advantages. First, compared with mass media (such as brochures, lectures) artificial intelligence (AI) systems are better capable of tailoring answers to the individual user. An important advantage, as information in written material and lectures is often general in nature. Second, computerized counseling can save time. Once the system is developed, it can be used to serve many individual patients. Third, computerized counseling leaves the patient anonymous, who therefore might give more truthful information about his/her self-care behavior; the factor of social desirability, that often plays a role in personal contacts, can be ruled out. And last, the computer is very 'patient with a patient'. In contrast, experts and doctors often have difficulty tuning their level of expertise to the knowledge level of the patient.

## Prospects of AI programming techniques

In communication, it is important to put 'knowledge to work' (Wenger, 1987). For this reason we developed a so called 'process-model'. Within the counseling process, relevant knowledge becomes active when necessary. The system should, therefore, have a high degree of responsiveness to the input of the user

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(Brownston et al., 1986). Furthermore, modifiability and expendability of the system are important. Since the knowledge implemented in the system is separated from the control structures of the program, it can be modified without a lot of programming. Expendability means that the knowledge-base of the system can gradually be enlarged. When experts for instance decide that another dental disease should be added to the system's knowledge base, the relevant aspects of this disease can be added without easily. One only has to know in which format the knowledge has to be encoded in the system.

## Development of the computer program, and underlying considerations

For the development and implementation of the AI system prototype we selected elementary dental knowledge about two dental diseases (caries and paro), and related oral processes. The reason for this choice was that this domain is relatively small, and causes and effects of these two diseases are relatively well-known. The system was implemented in KEPPS, a language developed at the LKS (Laboratory for Knowledge Systems) in Nijmegen.

*The knowledge domain: a process-model.* It was important to identify general structure in the knowledge that should be captured in the system. As an example, the following relationships that apply to paro and related processes were recognized, and integrated into the system:

a. dental plaque is one of the *prior conditions* for paro (prior condition);
b. degradation products in the oral cavity *leads to* paro effect (cause);
c. paro *leads to* impairment of the parodontium (effect).

Moreover, a disease or process could be described as a kind of definition of a dental term; for example, paro *is* inflammation of the parodontium, or, caries *is* impairment of dental elements.

The system can make forward as well as backward inferences. With regard to forward reasoning: when prior conditions are fulfilled, and an agent of a process or disease is active, the system concludes that the process or disease will continue. The system then projects what will happen in the oral cavity if we allow the process or disease to progress. For example: paro leads to impairment of the gums; impairment of the gums leads to mortifying gums; mortifying of the gums leads to retraction of gums. The inferences stop when the system reaches an oral situation with irreparable loss of a function of a dental object. For instance, because mortifying is an irremediable process, the system concludes that the support function of the gums is lost and that further damage of healthy elements threatens. The only remedy in such a situation is a curative act carried out by the dentist. This information will can used as a kind of warning to the patient.

In addition to this warning a user might want to know how destructive processes can be stopped. To provide an answer, the system uses backward reasoning. For example: toxic products leads to paro; and degradation of carbohy-

drates leads to toxic products. So the system will conclude that a user has to prevent degradation of carbohydrates, and then will continue by searching its knowledge base for factors that lead to degradation of carbohydrates.

Furthermore, the system is capable of providing information on how negative consequences can be restrained by stimulating processes that have positive effects. For example, the system 'knows' that the opposite of impairment is 'strengthening'. As a result, the system looks for information on how a patient might strengthen his/her gums. The inferences stop when the system reaches self-care behavior, or preventive actions that must be carried out by a dentist (e.g., massaging gums is self-care; removing dental plaque is self-care; removing scale has to be done by the dentist). This information will be presented as an advice to the patient. In addition, the system will recommend to stimulate related positive and prevent related negative processes that can be going on in the oral cavity under certain conditions.

The system can display all the inferences made, in order to give the user the change to 'see the knowledge at work'. For example, when the user introduces the fact that he has just eaten a chocolate bar, the system will find in its food table that chocolate bars contain a lot of sugar. The system informs the user: "Chocolate contains a lot of sugar. Degradation of sugar in the mouth leads to forming of acid. Acid leads to solution of calcium. Solution of calcium weakens the enamel. Enamel is the protection of your teeth. This process is called demineralization."

*Relevant patient variables.* Medical counseling explains the causal relationships between self-care behavior and prevention of certain diseases. It is assumed that knowledge of elementary dental processes in itself is sufficient to lead to improvement of self-care behavior, which, of course, is the primary goal of counseling. The desired behavior must, however, be feasible for the individual patient. In this context, Siero (1988) mentions three determinants that influence a persons behavior: motivational, social, and structural factors. With regard to dental care behavior, motivational factors are, for instance, a person's attitude towards a denture. Social factors derive from the influence from the social environment on a persons dental self-care behavior, such as ideas from others about bad breath. Structural factors enable or hinder the desired behavior (e.g., the financial situation of a patient).

In order to gain insight in the kind of information that naive computer users expect from computerized counseling, we arranged a mock-up dialogue with ten individuals. In this small experiment we found that they want to relate the dental knowledge directly to their own every day dental situation. For instance, they ask the system to give a prognosis about the preservation of their teeth, considering their level of self-care behavior, or assess the effectiveness of commercially available dental care products like chewing brushes and dental floss.

Patient variables are important for the system to decide which information is relevant and which certainly is not. When the system 'knows' a person rarely consumes sugar but nevertheless suffers from caries, the advice to cut down on

sugar is 'false'. Instead, the system had better advised this patient e.g., to strengthen his enamel by using fluor. Patient variables, therefore, are non-technical entrances in the domain model. For example, when a person highly values fresh breath, the system can present self-care behavior that leads to fresh breath and, in addition, supports a good over-all dental situation. In this manner, the technical domain knowledge can be combined with the every-day dental situation of patients.

*Conversational structures of the system.* Experimental research shows that the conversational competence of a system has great influence on the acceptance of the program by (computer-naive) users (e.g., Pinsky, 1983; Van de Pol, 1987). We, therefore, developed an interface that conducts a human-computer conversation based on some features of human-human conversation. Coherence is important here. According to Springorum (1981) human-human conversation is by definition coherent. The sequence in the inferences made by the domain-model is however not always coherent. We, therefore, have to guide the inferences by the notion of discourse context and topics.

The included dental knowledge can be divided in two general contexts: the caries- and the paro-context. Each context has its own related processes or discourse topics. The system does not cross-talk from one context to the other, but maintains a kind of global coherence by sticking its information to one context until this context is sufficiently developed. Within a context there is a kind of partial ordering on which the topics are ideally presented. For instance, when the system wants to discuss caries, it might be useful to discuss the forming of acid first because this process explains relevant aspects of caries.

## Concluding remarks

In the previous, the development of an artificial intelligence system for counseling patients was described. But during its development and implementation, there are some additional aspects to take into account. For example, there has to be a moment on which the system is tested by patients and experts. Feedback whether the provided information is sound and understood by the patient, is essential. Furthermore, it is important to have insight in the mis-conceptions people can have about the knowledge domain, so that the system can make corrections.

The prototype discussed here was developed from scratch. Still, it seems successful enough to state that it might also be useful to equip existing medical knowledge-based or database-systems that have been developed for other purposes (e.g., for diagnosis) with a counseling component.

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# Information for environmental policy

R. Jeltes

*The growing awareness of environmental destruction due to human conduct, the growing claims of pressure groups on policy makers to act fast and adequately, and the changing orientations of Dutch environmental policies make new demands on information provision. In this article, those demands and a number of possible improvements on the supply side are explored. First, a broad analysis of the impact of human activity on the environment is given. This impact and the subsequent reactions of policy makers can be diagrammed in an 'environmental causality cycle'. Second, current Dutch environmental policy is described, with its shift from sectoral to integrated approaches. Finally, the information requirements of this policy and the quality and quantity of the information available are explored and compared.*

## Environmental consequences and political reactions

The concept 'environment' comprises the entire biosphere; that is life, and those parts of the earth and her atmosphere that sustain it[1]. The disruptive pressures of human society on the global environment are growing at an alarming rate. More disadvantageous consequences, extending over larger areas, are being observed. It is realized by a growing number of people that severe measures to limit further destruction are required.

For an overall view of the impact of society on the environment, one can use a simplified image: the 'environmental chain'. It is a sequence consisting of respectively: activities -> emissions of agents and intrusions into the environment -> transport and distribution of agents -> ambient concentrations of pollutants and new environmental situations -> effects on receptors (Adriaanse et al., 1988). Winsemius (our former Minister of Housing, Physical Planning, and Environment) developed the notion of a 'environmental policy life cycle'. Its phases are: recognition of new environmental issues; planning and formulation of policy meant to deal with them; solving of these issues; and last but not least control. At the moment the Dutch national government concentrates mainly on the recognition of new issues and the development of adequate policies. The effort of

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regional and local authorities focusses on the policy implementation and on control and enforcement. Feedback from these phases to the policy makers in charge of planning and environmental policy formulation is essential.

When the reactions of policy makers are added to the 'environmental chain' an 'environmental causality cycle' is obtained (Figure 1).

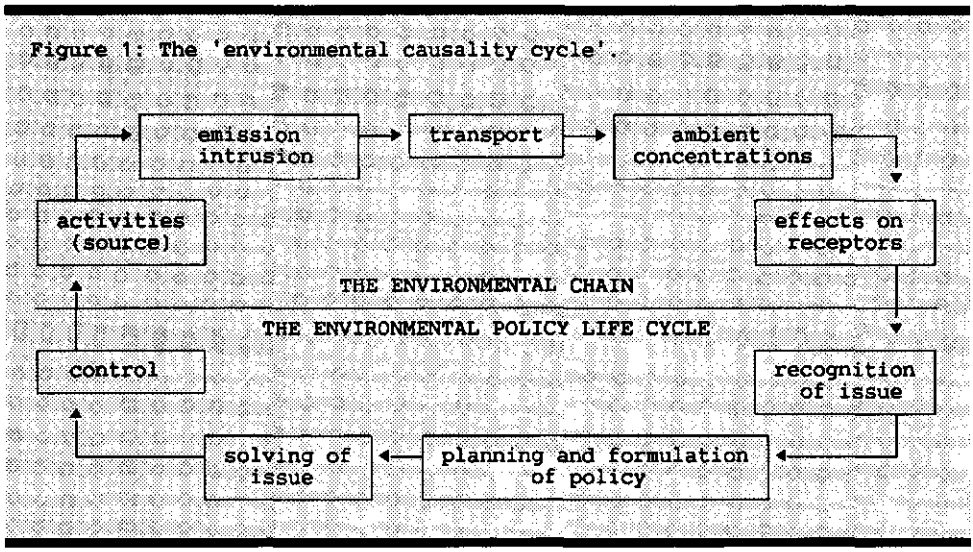


Figure 1: The 'environmental causality cycle'.

## Environmental policy in The Netherlands

Dutch environmental policy used to consist of loosely inter-connected sectoral approaches, with separate laws being developed for different environmental compartments. In the second half of the 1970s, it was recognized that this sectoral approach had its disadvantages. The solution of a problem in one environmental compartment, often without recognition of related aspects in other compartments, might lead to unforeseen but harmful effects which sometimes remained unnoticed for quite a while. The need of integrated policy became apparent.

The General Environmental Hygiene Provisions Act of 1979 marks the start of this integrated approach. The coordination of the licensing procedures stipulated by the different sectoral laws was enforced by this act. It was followed by more legislation and measures of an integrated nature. In long-term programs so called 'central environmental issues' (like acidification and eutrophication) are distinguished, on which the integrated environmental policy concentrates. Policy related to a specific issue has to take a whole environmental chain into consideration, and can be directed at sources and/or effects. Source-oriented policy

focuses primarily on target groups, such as industries, motorists, farmers, refineries. The analysis of separate issues and environmental chains often exposes many interrelations. As a consequence, for a number of issues the same target groups can be identified.

In 1988 the National Institute of Public Health and Environmental Protection (RIVM) published an integrated environmental report, named "Concern for tomorrow". This report gives an overview of the present condition of the environment and offers predictions, depending on a number of feasible measures that could be taken, for the future situation. The national policy makers responded with a National Environmental Policy Plan (NEPP) which gives a long-term strategy for environmental policy (Ministry of Housing, Physical Planning, and Environment, 1989). It presents a general treatment of environmental management up to 2010 as well as the prerequisites to comply with the demand for sustainable development. It indicates the main policy features for the period 1990-1994, with explicit attention to environmental issues, policy instruments, cooperation, enforcement, and (priority) target groups.

It is perfectly clear that for further formulation, implementation, and control of the policies proposed in this NEPP more information is required. The collection, storage, and processing of this information, however, is no sinecure.

## Information requirements

Generally, in the course of an environmental policy life cycle, the information requirements converge and become more specific. In the first two phases (the recognition of an issue; and the formulation of a policy on that issue) the need for aggregated information of an indicative nature, like environmental quality indicators, dominates. In the next phases (solving; and control) more detailed information is required. One has to realize, however, that also the first kind of information derives from detailed data (e.g., facts obtained by monitoring or surveys) which are interpreted and interrelated to allow more general statements. Attention has to be given to the reliability and comparability of the methods by which these data have been attained. For development of an integrated environmental policy, horizontal compatibility (e.g., over the whole range of the environmental cycle) and vertical compatibility (which makes aggregation of data obtained at different decision levels possible) of data and information are essential.

Two factors seem to dictate the quantity of information required in the different phases of an environmental policy life cycle: the consensus acquired on an issue, and the sheer volume of efforts needed to implement environmental policy directed at an issue. When scientists disagree on causes and effects (think of the reluctance to consider climate change an environmental issue) uncertainty and a high demand for conclusive information exist. Once an issue is recognized,

the development of a coherent policy asks for resolution on the part of national policy makers, hence for information that allows policy formulation. When the phases of solving and control arise the (regional and local) authorities often need much additional information to support their interventions.

The quality of decision-making depends on the quality of the information acquired. Good information management, therefore, is one of the prerequisites for good decision-making. The supply side has to be adapted as well as possible to the demands from policy makers. Their change from sectoral towards integrated policies had important consequences. Formerly, the information systems available were more or less arranged according to the different environmental sectors or compartments. Nowadays, interrelated systems, which should be able to allow the development of an integrated policy on an issue, are required. Flexibility and a high quality of the information supply are essentials. Extra measures have to be taken to guarantee the accessibility of information and the ability to aggregate the data required for policy development (Adriaanse et al., 1988, 1989).

## The information supply

When analyzing an environmental chain, information is needed on physical planning and economic activities, on emissions (like waste streams) and intrusions in the landscape, transport and dispersion of pollution, ambient concentrations, effects on the biosphere and dose-effect relations. The following is a brief examination of the present situation in The Netherlands with respect to these requirements.

Many base documents (like records containing information on toxic substances, raw materials, technological processes, waste streams, ambient concentrations, environmental technology, environmental standards, the environmental situation in regions) to support policy formulation and implementation exist. These documents allow the creation of reports (like "Concern for tomorrow") with information on issues, causes, effects and target groups, required for policy formulation. But the possibilities of characterizing the overall environmental quality by means of a small number of highly aggregated and representative indicators, which could especially play an important role in the recognition and assessment of environmental issues, are still uncertain.

Information obtained at the regional and local level is in fact among the raw material necessary for the development of national policy. In "Central Data", recently published (1989) by the Ministry of Housing, Physical Planning, and Environment, highly aggregated information about target groups and environmental issues is presented that could be useful for policy development and societal awareness. But improvement of the information supply on target groups seems desirable. A system should be developed, consisting of a network of modules, which gives access to the relevant but scattered information. This

information could be made available in base documents, analogous to those on toxic substances already used for policy development. Target groups in their turn often want information on environmental policies, which has to be collected and stored in a systematic way to allows easy access.

A registration system for emissions, run by the Dutch Physical Planning Agency, exist. But the rapid developments in the field of integrated environmental policy, with new issues coming up continuously, make constant monitoring necessary. The RIVM developed an information system for waste flows. Information about intrusions is present, but 'diffused' over a number of databases. For the transport and dispersion of pollution, models are constructed, using information found in international literature. To permit practical application these models require detailed information.

For environmental impact assessment (EIA), a series of handbooks on effect prediction has been developed. The editing of an international edition is under consideration (Jeltes & Hermens, 1990). Monitoring networks for ambient concentrations in the atmosphere, surface water and ground water exist. Some monitoring stations also collect soil and biotic data. For information on dose-effect relations, international literature is used. Some kind of intermediary in this field might be useful. In the base documents on toxic substances, dose-effect relations are included. Specific information bases or systems especially established for the registration of effects on the biosphere do not exist in The Netherlands, as far as I know. When environmental accidents occur, effects are investigated on an ad hoc basis. In doing so, the approaches for effect prediction as described in Aiking et al. (1988) might be useful.

## Conclusion

Integrated environmental policy puts its own pressures on information supply. One might conclude that much of the information required for this policy is accessible. However, some points (like the information supply on target groups, the information on intrusions, and data on dose-effect relations) ask for further study and/or improvement.

Furthermore, national, provincial, and local authorities will have to clarify their information needs to achieve an information structure that is effective and efficient. In general, it is preferable that information is managed by the its generator. Instead of building new systems, improvements (e.g., of accessibility and compatibility of information) of existing systems will often do. One of these improvements, that indeed left the management of information with its generator, was the establishment of CIMI (the National Reference Center for Environmental Information of the RIVM) which provides meta-information by making sources of information and expertise accessible.

Recently, the Dutch government started preparations for the development of

an outline for an overall (re)structuring of the environmental information supply and exchange. This outline is especially meant for the improvement of the exchange of information among organizations involved in environmental policy making. A study of the information supply for regional environmental policy and management in the province of Utrecht (Kathmann, 1987) could serve as an useful reference.

## Note

[1] Some refer to the biosphere as 'Gaia', a disputed but surprisingly useful notion (Lovelock, 1979).

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# Environmental problems and the use of information: the importance of the policy context.

C.M.J. Van Woerkum and P. Van Meegeren

*Factual information plays a vital role in awareness of environmental problems, and in governmental interventions that this awareness provokes. There is a growing need for new information to define and explore these problems, and to allow consequent political decision-making. This article examines the policy process, making a distinction between knowing and deciding. It will become clear that information and policy, both of which arise when a minimal level of problem-consciousness is reached, are the two important prime movers towards a better understanding and acceptance of environmental problems. Attention is given to information management as a prerequisite of communication management to influence attitudes and behavior, and to the role of communication in a total intervention-mix.*

From 1886 till 1902, Charles Booth conducted a large scale survey on the conditions of the working class population of London. These conditions were largely unknown to the citizens above the 'poverty line', although everyone who was socially aware could have had some knowledge about them. Thanks to the sustained activity of an engaged scientist these conditions became public. From that date onwards there was a public recognition of 'social problems'. The accumulation of information was a important element in the process of dealing with them.

Environmental problems are not unlike the problems Booth studied. Everybody can see there is 'poverty' in our forests, in the air, and in our waters. However, it is only under the pressure of collected facts that the involvement in environmental issues grows. Not until these facts are available, will a process start in which the common citizen takes the problem seriously and asks for political solutions. Knowledge is the incentive, while more knowledge is a part of the answer.

Currently there is a body of evidence on environmental problems and a growing stock of information on possible means to intervene. Several scientists, like Booth, have done their job to make environmental problems vested ones, adopted

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not only by 'radicals' but also by the media, the government, various interest groups, and the educational system. Efforts have not been without some success. The environment is one of the largest concerns in politics and public opinion. But still it is a new 'domain of interest' and therefore a new 'domain of information'. It is challenging to study how knowledge management is organized or should be organized, especially in this field. In this article, all phases of the process will be discussed, from the collection of evidence about the problem itself, all the way to the type information that will lead to the best intervention mix.

## A model

Information processes can be viewed from different angles. One aspect is the interaction between different actors: researchers; policy makers; journalists; interest groups; and private citizens. We take another perspective: the process of coping with environmental problems. It will be made clear that the informational situation at the beginning of the political process, when the problem still is very vague in terms of its magnitude and its causes, does not resemble the situation in an advanced phase, when the solutions are implemented. This is not only a quantitative difference. Of course, the more information is available, the further the process will develop. More interesting, however, is the qualitative aspect in which there is a tendency to exchange information of a different type. This information has to be gathered, integrated, and transferred to the actors who play a role.

In most countries, a key position in this process is held by the government. Environmental issues are public issues par excellence. Although important interest groups, such as industry, no longer view these problems merely as a threat, but also as an opportunity, the general picture is still one that too little happens unless the government stimulates, coordinates and regulates certain processes. The main source of research funds is the government, in line with its policy priorities. The environmental movement has had some campaigns that were oriented directly to certain companies, but its main target is probably the government. In its messages to the public, the responsibility of the government to intervene is stressed heavily. And if industry representatives are talking about production methods which are less harmful for the environment, the underlying motive often is the expectation that, if they do nothing, more severe government regulations will occur.

In all, we can identify the policy process of the government as the leading factor in the entire process. Many messages aim to influence this policy or are affected by it. To understand what is happening, we need a description of this process. A rather elaborate model (Van Woerkum, 1988) has been described previously. Other authors prefer to be more global. It is important to note the contribution of Adriaanse, Jeltes, and Reiling (1989), who divided the process into four phases:

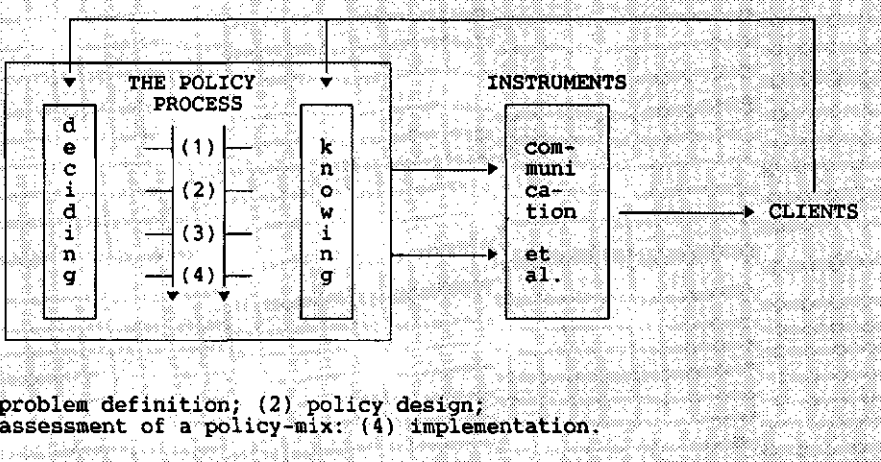
recognizing; formulating; solving; and controlling. These authors made special reference to certain aspects of the demand for information in each of these phases, such as the results discussed, the detail required, or the data sources commonly used.

We also have proposed a four phase description of the process (Figure 1):

1. problem definition;
2. policy-design;
3. assessment of a policy-mix; and
4. implementation.

The model makes a distinction between decision-making and analysis for decision-making, or choice and knowledge, and presents the policy process in which different choices are made on the base of different types of information.

Figure 1: Information and the policy process.




(1) problem definition; (2) policy design;
(3) assessment of a policy-mix; (4) implementation.

A complicated interdependence exist between making choices and knowledge production. In general it can be said that research priorities are guided (up to a certain level) by policy priorities. But policy choices also are influenced by research outcomes. This can be seen in the early phases of the process, when the problem is yet to be defined. It is safe to say that a problem definition is the more probable if (strong) empirical evidence is available.

The policy process is managed by a policy agency (ministry of environmental affairs), with a political context (parliament, political parties). However, the policy process is not a matter of politicians and civil servants alone. There is a great deal of communication from the policy-center towards citizens in different phases of

the policy process. In the first three phases, this communication consists of a mixture of:

a. information about policy options and plans;
b. persuasion to gain acceptance for certain options or plans; and
c. participation-oriented communication to invite people to engage in the process of making choices.

Information, offered by research, is an important part of this communication, whether the communication is neutral, persuasive, or aimed at participation.

People and interest groups react to this communication by stating their opinions and preferences (see the left arrow at the upper part of Figure 1) or by giving information about their situation or about their situation (the right arrow above). Individuals often have more expertise about their situation than the so called experts.

In the fourth phase, communication assumes a different position, namely, it becomes part of an intervention-mix to implement a chosen policy. There is growing interest in the question how the different policy instruments (regulations or laws, taxes, subsidies, facilities and communication) can be combined to reach a stated goal. A result of this interest should be an analysis of the effectiveness of official communication campaigns. There is a strong tendency in the theory of persuasion to emphasize the use of arguments in attempts to change peoples' attitudes or behavior. The changes they bring about should lead to more enduring, resistant, and predictable behavior (Petty & Cacioppo, 1986). This type of system links communication management with information management. Research must be conducted to support the arguments needed to construct an effective message.

## Knowing and deciding

The knowing and deciding part of the policy process ought to be brought into harmony. Decisions made must reflect the given evidence. Research should be directed to topics, for which the uncertainties are large and for which it is likely that policy makers make use of the outcomes to solve serious environmental problems. Unfortunately, there are several typical defaults, including:

*Biased policy.* Politicians often give priority to an environmental problem or to a certain solution, not because research indicates that these problems are to be given priority or these solutions are effective, but because of the pressures from interest groups or public opinion. Environmental problems often have great consequences for certain interest groups. Therefore, there are many attempts to influence problem definitions, analysis, and solutions. The left arrow above the circle in Figure 1 can overrule the voice of scientists. Often the outcomes that suit the biased politician receive the most attention, and are not grounded in real scientific evidence. They receive attention at the cost of other outcomes that are

based more firmly on empirical evidence;

*Unfounded policy.* Policy often does not have a sound empirical foundation. Policy makers can define problems and arrive at solutions, guided not by research, but by their eagerness 'to do something'. There often is no synchronization between the pace of policy makers and researchers. After all, too much haste leads to little progress. Again, external political pressure often is the culprit. For instance, a policy maker may choose an untested policy instrument to deal immediately with a problem. The effectiveness of the policy is at stake, but in the short run the problem is solved for the policy maker who has to deal with multiple political pressures. At least something is done: good intentions have been shown;

*Symbolic policy.* Under pressure 'to do something', policy makers sometimes chose (or have to chose) symbolic policy (i.e., policy without a real perspective to solve the problem, or for which money for a politically acceptable solution is lacking). On the other hand, knowledge is often biased too. An important lacuna is research on human behavior. Many environmental issues cannot be solved without changing the behavior of citizens or industries. Therefore we need a better analysis of the nature of this behavior, its main determinants, and ways to influence it.

## Information management and communication management

It is worthwhile, as we progress further in the model, to examine the square in Figure 1 in which communication is depicted as one of the possible policy instruments. Persuasion theory, which stresses the cognitive elaboration of information as a prerequisite for enduring attitude and behavior change, has shown how important it is to use proven evidence and sound reasoning. In our complex world there is much contra-information about everything. Even the environment movement has its adversaries. From a communication point of view, arguments that motivate a proposed behavior or that can help to gain acceptance of environmental laws are critical. Arguments must be checked carefully, but also must have an emotional appeal. If research concludes that by the year 2000 only 20 percent of our forests has a chance to survive, this outcome can be used with more effect than many isolated calculations of the degradation of nature.

A special case of information management occurs in crisis situations, in which a governmental agency must react to a disaster. Chernobyl was such a case, but since then many other crisis situations have occurred, including the recent appearance of dioxin in milk. The ensuing problem of information management has a strong organizational component. Policy must be developed to react very quickly to these cases, using the ideas of several experts of different organizations. In different areas, we see attempts to construct a network that can be activated when needed, and can deliver factual, political statements within a short period of time.

## Communication as an instrument of policy

A firm line cannot be drawn between communication and other policy instruments. They are all parts of one policy-mix; each instrument affects another. The assumption is that communication on its own seldom is a sufficient incentive for pro-environmental behavior because it is likely that knowledge does not lead directly to consistent behavior. Research shows that environmental consequences of behavior do not count much for most people. Other consequences, especially financial ones, are much more important (Nelissen et al., 1987).

One reason given is that the environment is a common good. Individual sacrifice for the environment is good for all, not for the individual alone. Consequently there is no direct relation between personal investment and personal benefit. Furthermore, harmful environmental consequences of consumer behavior are not visible directly. They are not noticeable today but have an effect only after, say, ten years. Research shows that the further away a consequence, the less seriously it is valued (Kok, 1983).

The third reason is that the moral costs of 'not doing what one should do' can easily be avoided. Individuals can easily deny responsibility for certain environmental problems. They can point to big industries, to the failure of the authorities to deal with environmental problems, and to many other individuals who are collectively responsible. In dealing with environmental behavior, the use of knowledge is a matter of 'good knowledge management', but also it is a matter of motivating the target group to act according their knowledge of environmental consequences. This motivation is highly dependent on legal and financial consequences. Therefore, the utilization of environmental knowledge depends on the use of policy instruments that can affect the legal and financial outcomes. The more the target group is motivated externally by legal or financial instruments, and is motivated internally by persuasive communication, the more it tends to act according to environmental knowledge. The importance of sound knowledge management for the utilization of environmental knowledge varies accordingly.

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# IT in municipal environmental policy: automated registration, sure, but what about expert systems?

C.S.A. Van Koppen and D.G. Goldsborough

*Dutch municipalities are confronted with an increased number of prescribed environmental tasks and also with a growing demand, both from the central government and environmental pressure groups, to undertake environmental activities on their own initiative. This development over-taxed the information management of most municipalities. In the past few years, computer technology was introduced to relieve part of this pressure (e.g., by automation of registration systems). In this article we present a classification of computer applications for environmental management, investigate their possible impact on the environmental knowledge and information system, and distinguish a formal and informal knowledge domain. Special attention will be paid to expert systems.*

The development of environmental management by Dutch municipalities, within the framework of national environmental policy, is characterized by two different tendencies. On the one hand, the national government tries to get a firmer grip on municipal policy, thus improving the feasibility of stricter and more uniform regulations. On the other hand, the central authorities stimulate decentralization of environmental management and control in order to achieve an optimal integration with other sectors, and to ensure participation of citizens.

## The environmental tasks of municipalities

Currently the most important environmental task of Dutch municipalities concerns permits and controls within the framework of the Nuisance Act. Other tasks include the collection and disposal of domestic waste, control within the framework of the Chemical Waste Act, the inventory of contaminated soil sites, issue permits and controls of water waste discharges in the municipal sewage system, acoustic monitoring, and determination of noise zones along roads and

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around industrial areas. Apart from these tasks, which mainly result from legislative obligations, there is a broad range of tasks that municipalities may undertake on their own initiative. A few examples are: collecting small chemical wastes; building energy saving houses; carrying out periodic water, air and soil quality monitoring programs; stimulating public transportation; implementing environmental criteria in urban and rural planning; and stimulating information to the public on environmental issues.

As stated in the National Environmental Policy Plan (NEPP) of 1989, Dutch environmental policy will broaden and intensify in the coming years. For municipal authorities, this policy means that many new environmental issues will be raised and that several issues that are currently decided at the local level will be regulated by national laws. Furthermore, a strong emphasis will be placed on internal and external integration of environmental policy, management, and control. It is clear that to achieve these policy targets, municipal environmental management will need considerable enforcement.

## Information flows

A general picture of the environmental information flows among municipalities and other institutions is presented in Figure 1.

A distinction is made between formal and informal flows. Formal information constitutes all information that is attached to prescribed governmental procedures. This information comprises laws and regulations, together with explanatory documents and guidelines that clarify the execution of the procedures, as well as the data needed in the procedures, such as, the household data to be registered with respect to environmental taxes, or industry data with respect to permits.

Informal information constitutes all information that is relevant to environmental policy, but not fixed explicitly in established procedure. It includes, for example, the expertise that environmental officials acquire as a result of reading specialist literature or following courses, and the expertise that is gained by hiring consultants. But it also includes knowledge of the region and its inhabitants acquired in daily life, environmental plans initiated by the local authorities, and environmental advice or information to citizens and institutions provided without legal obligation.

A typical characteristic of formal information flows is that they are controlled primarily by the central authorities. It holds true both for the 'downward' and 'upward' flows of information, despite the fact that the value of the information is determined to a great extent by its interpretation and use at the municipal level. For informal flows, it is less clear-cut who is in control. The flows are partially controlled by the central authorities, for instance, by granting projects to research institutes and consulting firms. Other parts are controlled by the municipal authorities (e.g., by hiring consultants).

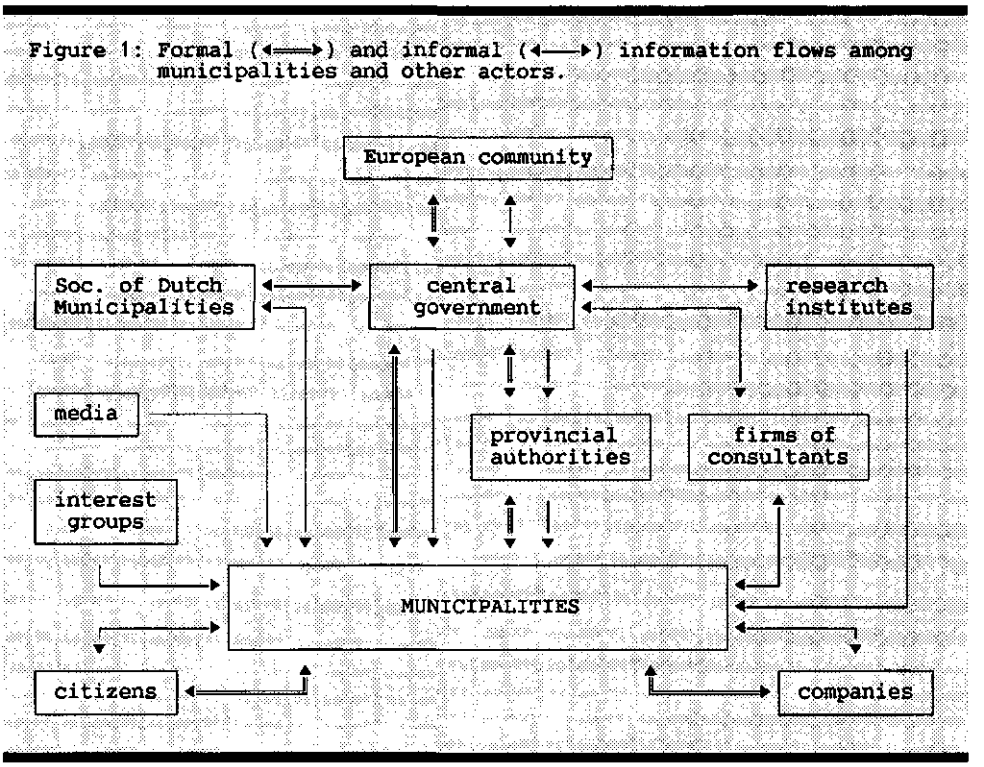


Figure 1: Formal (⟷) and informal (⟷) information flows among municipalities and other actors.

To cope with the increasing number of environmental tasks, an expanding volume of formal and informal information is necessary. In almost all municipalities, insufficient financial means and lack of personnel has led to problems in information management. Serious gaps in the administration of environmental data, and the acquisition of expertise obstruct effective environmental management. An illustration of this point is the backlog in Nuisance Act permits. In 1979 only 24 percent of establishments falling under Nuisance Act criteria had the required permits. A national program to remedy this problem was an important incentive to the automation of data registration. In many municipalities, registration systems were extended to other fields (e.g., industrial data registration aimed at the Chemical Waste Act).

The software involved, however, is very diverse and, in several cases, has been developed by non-professionals. To provide for more standardization of environmental data registration, the Society of Dutch Municipalities developed a "municipal functional design" for environmental management (GFO-milieu) that was introduced in April 1990. It is expected to further stimulate automation.

**A classification of computer applications for environmental management**

Four classes of data processing systems can be distinguished, each with an increasing level of integration.

1. monitoring systems, which register physical environmental data by means of sensors;
2. database systems, designed to store and retrieve all kinds of formatted environmental data;
3. simulation and calculation models, which embody mathematical relations between variables, so that new information can be calculated from environmental data, following predefined algorithms;
4. artificial intelligence (AI) technology systems, which embody relations between entities in the form of rules or other semantic structures, so that new information can be deduced from environmental data based on logical inference and heuristics.

All classes of computer systems can be applied in the formal and informal domains as illustrated in Figure 2.

*Figure 2: A classification of computer applications for municipal environmental management*

| | Formal domain | | Informal domain | |
|---|---|---|---|---|
| Monitoring systems | alarm systems | | multi functional monitoring networks | |
| Database systems | registration systems | | data banks | |
| Mathematical models | calculation models | SDS | simulation models | DSS |
| AI technology systems | small rule-based systems | | expert systems | |

In the formal domain, information processing will be fixed in procedures. Maximizing efficiency in performing them will be the main objective of computer applications. Only those data that are necessary will be processed in a prescribed format and following strictly specified routines. In the informal domain, information processing depends on different and changing needs of users. This distinction demands a certain flexibility and multi-functionality. The functioning of a system should judged primarily in terms of effectiveness, not efficiency. In the rapidly developing domain of environmental knowledge, this statement means that system output should reflect existing knowledge on the required subject as

correct, up-to-date, and complete as possible.

Regarding more comprehensive applications on higher levels of integration, our classification relates well with the concepts of structured decision systems (SDS) and decision support systems (DSS) (Davis & Olson, 1985). SDS is a system that processes registered data according to fully structured and formalized procedures, and thus fits into the formal domain. DSS supports the official, who is responsible for decision-making, with tailored information and 'what if' simulations, and thereby corresponds with the informal domain.

## Examples of computer applications

Monitoring systems are widely used in environmental management in The Netherlands, especially in the form of national and regional monitoring networks. National monitoring networks exist for air quality, water quality, groundwater and rain. All have several functions, varying from momentary quality monitoring to model validation and research on long-term trends. Data processing of monitoring networks is not adapted specifically to municipalities. In most cases, however, the data are accessible by municipal officials. Examples of alarm systems are the bio-monitoring control systems for drinking water, using fish as an indicator for toxicity, and alarm systems fitted with carbon monoxide detectors in parking garages. A monitoring network also can be used as an alarm system, but that is only one of the system's functions.

Registration systems are by far the most important type of computer application within municipal environmental services. Present systems mainly contain data in relation to the Nuisance Act, waste water discharge regulations, and the Chemical Waste Act. In addition, these systems are used for priority ranking and work planning. For these purposes, small calculation models are implemented. The diversity in system design and programming is striking. In many cases, the required input is so numerous and detailed that maintenance of systems demands a great deal of effort. In most cases, the possibility of integration with other information systems is limited. Shortly, more comprising and better integrated systems will enter the market. The GFO-milieu is expected to provide a national standard for these systems.

Data banks set up specially for municipal environmental management hardly exist. An important general data bank on environmental protection is the literature and information sources service (CIMI), which resides at the National Institute of Public Health and Environmental Protection. Mathematical models for environmental management (as one might expect) are used on a large scale. In municipalities, models for air pollution and noise caused by traffic are especially important. A recent application is the so called "traffic environment map". Air pollution and noise nuisance near roads are calculated from traffic intensity and represented automatically on a city map.

Mathematical models can also be very useful in the informal domain. The traffic environment maps, for example, also can be used for city planning, by visualizing the environmental impact of traffic measures. And the production of a series of interactive environmental policy models to enhance the strategic knowledge of environmental problems has been planned. However, these models are directed mainly towards national environmental policy planners.

AI technology, a term used for all computer methods and techniques that sprout from the research on artificial intelligence, can be used in a spectrum of applications. On one side of the spectrum are simple programs, like MILIAM, a program developed in the shell Personal Consultant Plus, which determines whether or not a stock farm meets the air pollution requirements for a Nuisance Act permit.

On the other side, complex knowledge-based systems have been developed, generally referred to as expert systems. True expert systems, that is to say, systems that actually perform at the level of an environmental expert, do not exist in the environmental domain, to our knowledge. However, several systems have been developed that contain specialist knowledge on very restricted environmental topics (Goldsborough & Van Koppen, 1988).

It follows from this survey that the significance of the application of computers in the formal domain, and especially the application focused on efficiency of management, is obvious. Undoubtedly the number of applications and their size will grow in future, with special attention being paid to standardization and integration. With respect to the informal domain, one must conclude that the significance of computer technology is much less obvious. When, for instance, simulation models are used by municipal officials, this application tends to be restricted to a formal setting. The model is used as a prescribed calculation routine. The crucial factor in the informal domain, to our view, is the enhancement of up-to-date environmental knowledge. For this reason, the discussion will now focus on the application of expert systems in the municipal practice. Expert systems are designed to supply specified knowledge, and operating as integrating system, they can provide comprehensive access to simulation models and data banks. It will be interesting to investigate the extend to which they can fulfill this purpose in the environmental management of municipalities.

## The potentialities of expert systems

Although no operational expert systems exist within the domain of environmental management in The Netherlands to date, several fields of application show promise:

1. presently, data banks only play a minor role in environmental control, but in the future, a considerable growth can be expected. However, non-experienced users will have great difficulties in consulting these data banks, usually

because they are not familiar with the query language and have insufficient knowledge of the scope of the data bank and the appropriate references. Use of a specialized intermediary, who is familiar with the data bank and with the search profile of the user, in many cases, will be too expensive or time consuming. Expert systems may be used to correct this problem by assisting the user in finding an optimal search profile and query format. An example of an application which meets this description is FIFE, an intelligent interface to the FACTS data bank, which contains technical information on accidents with hazardous substances (Wagenaar, 1987);

2. a large number of environmental problems facing municipal officials cannot be solved by simply following prescribed regulations. Specific expertise often is needed. For instance, municipalities confronted with cases of soil contamination require expertise on topics, such as transport, chemical reactions of contaminants in the soil, and possible effects of contaminants on people, animals and plants. An expert system that improves the accessibility of simulation models and other scientific environmental expertise can meet these expertise requirements to a fair extent. The structure of such an application may be exemplified by the description of RISC, an expert system designed to identify soil contamination related hazards to public health and the environment (Goldsborough, 1988);
3. environmental regulations often are complex, subject to frequent adjusting, and must respond adequately to a variety of situations. Expert systems allow the coupling of procedural knowledge with knowledge of the underlying problem and the technical measures that can be taken. An example is SEPIC, an expert system for determining the appropriate form of private sewage systems (Hadden & Hadden, 1985). The system incorporates domain knowledge and procedural knowledge required for the evaluation of requests for permits for the construction of private sewage systems.

It is self-evident that the development of the mentioned expert systems for use by municipalities is bound to several prerequisites. The technical realization of expert systems is hardly a bottleneck; presently enough tools are available for programming AI applications. The total costs of realizing a system can stand in the way of development: expert systems for the tasks mentioned in the examples call for investments that exceed $ 100,000. For applications that are used on a large scale this investment should not be a problem. A critical success factor will be the integration of systems with the existing organization, as underlined by a recent study of 128 Dutch organizations on the success and failure of expert systems (Working Group Project Selection Expert Systems, 1989). To realize successful integration of environmental expert systems with municipal management, local authorities must be involved in the definition and development of these systems. Furthermore, because expert systems are decision support systems that leave the responsibility to the decision-maker, municipal management must be supported by sufficiently qualified environmental officials.

## Epilogue

In the discussion of the influence of automation on organizations, those who believe it will lead to centralization are opposed to those who believe that the introduction of computers can bring about decentralization. When this discussion is applied to the issues mentioned earlier, one can observe that the formal domain is moving towards centralization. One motive for this evolution is the wish of the central authorities to carry out a more stringent environmental policy. This is accompanied by more, and increasingly complex, governmental regulations. Another motive is brought forth by automation itself. Due to increased standardization, integration, and expansion of registration systems and calculation models, the information provision of environmental management will become increasingly more uniform. Control over this process lies clearly in the hands of the central authorities.

Although this centralization will be the most effective approach to several environmental issues, for many other issues, such a development neither desirable nor necessary to our view. Expertise level at the municipal level is clearly advancing due to the expansion of personnel in the environmental services and the employment of environmental specialists. In order to support this expertise, special attention should be paid to the informal domain of information provision. While automation applications fit formal information flows particularly well, other types of computer applications could be of great value in the informal domain. The use of data banks, simulation models, and expert systems can stimulate decentralization by supporting an optimal information stream to municipalities, thus aiding officials to handle regulations in a flexible and effective manner, and to take responsibility for initiatives when needed.

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# Videotex as a medium to provide environmental information about consumer products

P. Van Meegeren

*Concern for the environment is rapidly growing, not only within the public at large, but also within the Dutch government. Lately, this government has launched many extensive environmental information campaigns, most of which try to change consumer behavior. At first sight the possibilities for using information technology (IT) as an aid in these efforts seem promising: a lot of people and products are involved. The situation simply calls for the instalment of videotex services that allow consumers easy access to information about the environmental consequences of consumer products, one might think. But is videotex still such a promising medium at second sight? To answer this question the article addresses three issues, successively: (1) the influence knowledge of environmental consequences exerts on consumer behavior; (2) consumers' motivation to search for information about these environmental consequences; (3) the characteristics of videotex, when compared with two other media used to provide environmental information.*

This article is based on two assumptions. First, the assumption that in the near future most households will own a videotex terminal. At the moment, this is not the case, but developments are going fast now the Dutch PTT (Post, Telegraph, Telephone) has taken initiative with Videotex Nederland. Second, the assumption that reliable information on environmental consequences of a product will be made available. At the moment, for many products these consequences are not known, or are indistinct.

## The influence knowledge exerts on behavior

Knowledge of harmful environmental consequences of a certain product does not yet mean that this product will not be bought or used. This is illustrated by the results of a recent Dutch study that investigated reletionships between awareness

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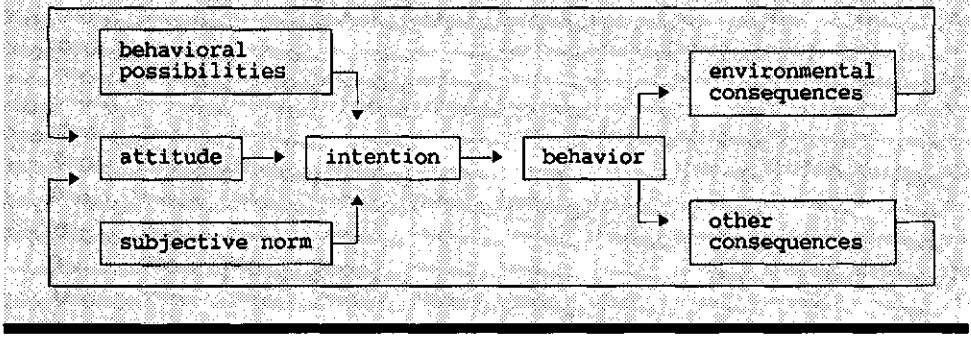
of environmental problems, and three pro-environmental behaviors (the use of detergents without phosphates, not using one's car during free time, and the purchase of beverages in returnable bottles). It was found that about 39 percent of the persons interviewed were well aware of the most important environmental problems. From these, 29 percent practiced none of the mentioned pro-environmental behaviors, whereas only 6 percent practice all three (Nelissen et al., 1987).

This discrepancy between knowledge and behavior can be explained with theories from social psychology (see Van Meegeren, 1989). A simplified model, derived from these theories, presents the determinants of environmental behavior (Figure 1).

Figure 1: The determinants of environmental behavior.




'Behavioral possibilities' refers to personal skills and opportunities (such as provided by the existence of public transport) to perform a certain behavior. An 'attitude' results from an individual's evaluation of expected (positive and negative) outcomes of a behavior. When a person expects important positive outcomes that prevail over the negative ones, a positive attitude towards the behavior is established. A 'subjective norm' results from the individual's evaluation of the opinions on the behavior, hold by important others. The three aspects (behavioral possibilities, attitude, and subjective norm) together create a person's intention. How much weight each factor obtains in this process varies: for some, opinions of others weight heavily, while others are less vulnerable to social pressure.

When we look more specifically at the purchase or use of a consumer product we can distinguish between 'environmental consequences' and 'other consequences' (which include views on price and performance). Consumer research tells us that in developing an attitude, other consequences (especially financial ones) are often much more important than environmental consequences (Nelissen et al., 1987). A first explanation for this observation is that individuals consider the environment to be a common good. Unfortunately, therefore, most pro-environmental consumer behavior lack direct linkage between personal

benefits and personal costs (such as better performance versus higher product price). To promote pro-environmental consumer behavior, a strong personal incentive (like the one a cheap product can provide) would be required.

Second, the harmful environmental consequences of most consumer behavior are only visible in time. And, as research shows, the further away a consequence, the less serious it is valued (Kok 1983). And third, the moral costs for not showing pro-environmental behavior can often be avoided easily. In many instances individual consumers can suppress their feelings of guilt by pointing at big industries, legal authorities, and other consumers, thus denying responsibility (Schwartz, 1977).

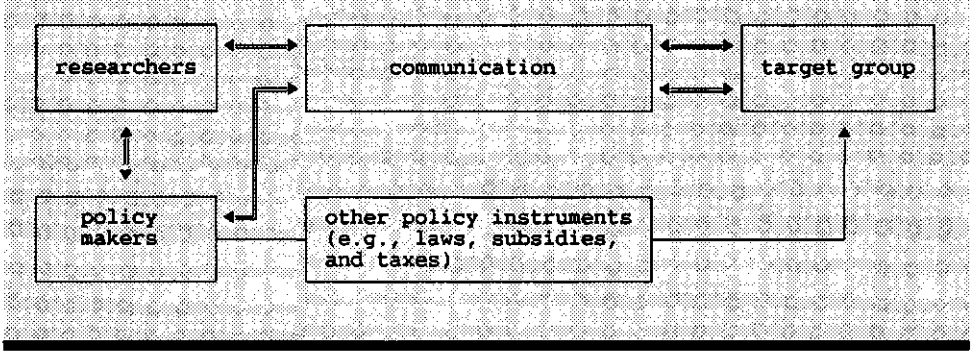
Furthermore, even if a person establishes a positive personal attitude towards a specific pro-environmental behavior it is not certain that this behavior will be put into practice. Different opinions of others might be very persuasive, or the product a consumer intends to buy might not be available.

The conclusion that can be drawn is that, for most consumers, provided information on the serious environmental consequences of a product will only lead to behavior change if an alternative product can compete on aspects like price, performance and availability. When a 'harmful' product has significant advantages on these aspects the provision of environmental information (be it by videotex or any other medium), that tries to change consumer behavior, is likely to fail. The situation calls for more effective instruments, such as laws (e.g., to prohibit the use of certain products) or financial measures (e.g., to raise higher taxes on certain harmful products).

At this point is interesting to look at knowledge and information systems (KIS) theory. This theory would consider knowledge to be the key factor in the efforts to find and implement solutions for environmental problems. Processes like generation, integration, consolidation, and dissemination of environmental knowledge are regarded as essential, and will eventually lead to utilization. The latter brings us back to the individual consumer whose behavior has to change. As we have seen, knowledge on the environmental consequences is just one of the factors that influence consumer behavior. Often, other factors (such as time and money) carry more weight. It is true that KIS theory does not neglect these factors, but it does not give them the attention they deserve.

When knowledge is not being used, KIS researchers tend to look for explanations in the dysfunctioning of the system. Solutions advocated usually concentrate on better 'knowledge management' (e.g., measures to enhance the linkages between the different actors in a KIS, and to enhance coordination (and synergy) within the system). But establishing pro-environmental behavior is often, as we have seen, not so much a matter of good knowledge management as trying to motivate people to act according to their knowledge on environmental consequences of their behavior. Since for many this motivation depends largely on legal and financial consequences an extension of the KIS perspective, by integrating policy instruments, is required (Figure 2).

Figure 2: A model for the KIS perspective in a policy context.




If a target group is to perform pro-environmental behavior, it is essential that the efforts to reach external motivation (through legal or financial instruments) and the efforts to reach internal motivation (through persuasive communication) are well-tuned. Only when attention is given to both, will good knowledge management pay off.

**The motivation to search for environmental information**

Videotex, as a medium to provide information on environmental consequences of certain products, assumes consumers actively searching for this kind of information. In order to get the required information they have to make contact with the database, formulate a specific question, and master the controlling software to get the right answer to the question. It is likely that only a minority will be motivated enough to take these steps.

"Why only a minority?", one might ask. A valid question, since a growing number of people recognize environmental pollution as a major problem. In a market survey of June 1989 about 54 percent of the Dutch population expressed their concern for environmental problems. Whereas in the previous survey of 1987 environmental problems held rang eight, in 1989 it topped the social problems listed (NSS Marktonderzoek, 1987 & 1989).

These results might provoke the conclusion that the time is right for the introduction of videotex services that provide environmental product information. Yet, I think this conclusion overlooks the important difference between passive and active involvement. My assumption is that, even among the 54 percent that expressed their concern for environmental problems, many will satisfy their interest, not by searching actively for specific environmental information, but (more passively) by lending an ear to the scattered information they receive, on occasions, from the mass media. Recent experiences with the Milieutelefoon and

an information campaign on nuclear radiation seem to confirm this assumption.

The Milieutelefoon is a telephone-service that provides callers with answers to their questions on environmental issues. During november 1989 about 60 people a day called. This means that (if we assume that no one called twice) approximately 15.000 persons a year, or about 0.15 percent of the Dutch population over 18 years, used the Milieutelefoon. Considering the fact that 54 percent of the persons interviewed by NSS expressed their great concern for environmental problems, we have to conclude that most of them remain passive.

In 1987, a year after Chernobyl, the Dutch government started an information campaign on nuclear radiation, aiming at the general public. Market research showed that in the beginning of 1987 about 28 percent of population was concerned about nuclear energy problems, whereas 34 percent was concerned about health care problems, and 27 percent was concerned about environmental problems (NSS Marktonderzoek 1987). The information campaign included a number of announcements on the TV, the radio, and in the newspapers, of a free leaflet that could be obtained in post offices and libraries. As a result of the campaign 5.0 percent of the population obtained the leaflet, and 3.3 percent actually read it (Midden et al., 1988). When compared with the percentages revealed by the NSS market research, the statement that the public's involvement is mainly passive seems justified.

The experiences with this campaign and the Milieutelefoon suggest that, even of those highly interested in environmental issues, only a minority will actively search for further information. The relevant question is: will this minority be big enough to justify the introduction of videotex services that provide environmental information about consumer products? When we look at the results from the information campaign on nuclear radiation, abdicate more pessimistic points of view, and take into consideration that the public's interest in environmental issues is growing, about 5 percent of the consumers could be considered as potential users of such videotex services. This would make up a potential user group of approximately 500,000 persons. This looks promising, but the final decision has to be made after a careful analysis of its cost-effectiveness in comparison with the cost-effectiveness of other media available. Such an analysis goes beyond the scope of this article. Nevertheless, in the next part I will elaborate on some characteristics of videotex services, when compared with two other media.

## Videotex compared with telephone services and product information on labels

Telephone services and videotex services will attract mainly the same category users: the minority of consumers that actively search for environmental information. But videotex is only useful for consumers with a clear question, such as: "what are the environmental consequences of this product?"; or "what are good alternatives?". On the other hand, a telephone service might also be used by

concerned consumers without such specific questions. The personnel operating the service can guide the communication process, and help to formulate the right questions. Furthermore, direct interaction makes it possible to take the personal circumstances of a consumer into account. This is especially important for more complex decisions. Finally, telephone services make it possible to add some persuasion to the provided information. The Milieutelefoon, for example, is not only designed to inform callers, but also to activate them.

But a telephone service, when compared with a videotex service as a medium for delivering environmental product information, also has its disadvantages. Telephone service users will have to give up some of their anonymity, what might prevent those afraid to ask 'silly questions' from calling. Furthermore, a telephone service has, compared to the videotex system, a small capacity in dealing with usage peaks. And finally, the operation costs of a telephone service exceed those of videotex services, due to the fact that the personnel answering questions has to be available full time.

All in all, I think a combination of both media seems promising. The cheaper videotex service can be used for consumers with a clear, relative simple question. The more expensive telephone service can be used for consumers who need guidance and help (e.g., in formulating the right question, gaining insight, or making the right decision).

Product information on labels is a way to confront consumers with the environmental consequences of their behavior. As the information comes with the product it is directly available for the interested consumer. There are several options. First, a simple symbol might be used to indicate that a product has no serious harmful environmental consequences (consequently, only a distinction between 'good' and 'bad' products is made). Second, more complex symbolic information, to express to what extent a product has harmful environmental consequences, might be used (with categories ranging from 'very harmful' to 'not harmful'). And third, information about the environmental consequences of production, use, and disposal of a product might be put in words.

The direct availability of the information makes labels useful for both, consumers with an active and a passive interest in environmental issues. This makes the target group, when compared to videotex services, much larger. Furthermore, as the information on the labels is rather limited, consumers might be encouraged to search actively for more information. Therefore, instead of being competitors, it is more likely that product labels will stimulate the use of videotex services.

## Conclusions

The following conclusions can be drawn:

1. for most consumers knowledge of environmental consequences of a certain product will only lead to the purchase of an alternative product if it can

compete on the aspects: price; performance; and availability. The influence of communicative interventions alone on consumer behavior is, therefore, rather limited;

2. the KIS perspective tends to concentrate on knowledge and communication as the key factors to change consumer behavior. It is advisable to extend this perspective by integrating policy instruments that often have a bigger impact, such as laws and financial measures;
3. an estimation of the potential number of people that will use environmental videotex services must be limited to the minority that actively search for information on the environmental consequences of their behavior. Although this minority is still small, it is growing. At the moment it might include around 500,000 persons, what already seems to justify the introduction of these videotex services (assuming that in the near future many households will own a videotex terminal);
4. other media (e.g., TV, newspapers, and magazines) are needed to stimulate the use of environmental videotex services. There is a potential of interested consumers who need encouragement to search for additional information. One way to stimulate them might be to provide environmental product information on labels;
5. as videotex services will only reach those who actively search environmental information. More conventional media use (such as focussing the public's attention on environmental issues through TV programs or newspaper articles) will remain essential to reach the less motivated and less active consumers.

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# The Ecodisc: an interactive tool for environmental education

R.N. Tucker

*In 1986 the British Broadcasting Corporation (BBC) launched the interactive videodisc package "The Domesday Project", which received the sort of publicity one would expect from a project which had involved 14,000 schools, 13 Universities, the might of the BBC and Philips, and a great deal of money. The package was dependent upon a particular configuration of equipment. The software which controls the videodisc and the statistical data is stored on the videodisc itself and has to be down-loaded into the memory of the special video-disc player. The BBC invested in the new system and began a series of productions based on this technology, one of which is the Ecodisc, an environmental education program about a nature reserve. Subsequent experience, however, has shown that the system has gone the way of most machinedependent developments and failed to make great market penetration. Yet, the world of education and interactive media is not without ingenuity. Many developers have discovered ways of either taking the controlling software off the videodisc or building their own software round the visual database. But it is not the purpose of this article to dwell on the technical aspects of the system since the content of the program is already appearing on other carriers, such as the CD-ROM (Compact Disc - Read Only Memory) version recently produced by Apple Computers and the ITU (Interactive Television Unit of the BBC). Rather its purpose is to consider some of the didactic implications of interactive media in general and the Ecodisc in particular.*

## What is a videodisc?

A videodisc is a 12 inch disc with a mirrored surface into which a series of indentations are cut. When these are scanned by a fine laser beam they act as an analogue of the electrical signal which makes up a scanned video image. It is also possible to read data and convert it to an electrical signal. In this way computer programs, text, statistics, etc, can be read into a computer and handled. Since only the laser beam touches the surface of the disc there is no wear and an image can

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be read constantly as a still image. For moving picture the information is read at the standard television scanning of 25 pictures per second. The standard laservision disc has a capacity of 54,000 still pictures or about 36 minutes of moving pictures. Each picture or 'frame' has an identifying number. It is thus possible to locate any one of the images with the use of a numerical control device or a computer.

## What is interactive video?

Since the first linking of a computer to a videodisc player the term 'interactive video' has been defined in many ways. Each writer attempts to fix a particular definition, most of which are doomed as the range of applications broadens and the technology develops. It has to be recognized that there is a spectrum of applications which have their proper degree of interactivity. Unfortunately there are many poor products - the worst of which are expensive electronic versions of boring handbooks. These tend to present page after page of text in a style which has been characterized as 'Press the Space-bar Learning'. Claims that this is interactive because the reader 'has to do something' must be doubted since the user cannot change the sequence of information. On the other hand, at its highest level of interactivity the flow of information (the reaction of the computer) is wholly dependent upon the input of the user.

In industrial or military training, specific goals (particularly behavioral or skills goals) have to be built into the interactive program. In education, we may have the luxury of having less goal-oriented programs. Here, hypermedia systems are enabling us to break away from algorithms and tree patterns into associative linking coupled to simple artificial intelligence. Examples of courseware which works on a recognition of how firmly the learner has grasped a concept rather than his/her ability simply to give the right answer to questions already exist. What interactive learning seems to offer with the present technology is what educational technologists and even programmed learning developers were struggling to express many years ago. The theories of knowledge mapping being enthusiastically demonstrated with string nets as little as five years ago can now be a concrete reality with the latest software. The new media offer a potential for a fundamental change in the learning process. This change is based on the notion of authorship.

## Authorship

When we view a film or videotape we are subject to the order and time sequence of images determined by the maker of the program. It is possible to stop a videotape or even a film projector - but this is rarely done. In interactive systems, no matter how goal-oriented, some part of the structure of the program is

determined by the user, who might even be required to contribute material. The learner assembles a unique linear chain of information, and becomes in this particular sense an author. Naturally, in highly goal-oriented training programs, this authorship is limited; after all one would not feel confident with an aircraft maintenance engineer who had authored his own uncontrolled course. But, in other situations, authorship by the learner can be more fully exploited. For this we need to construct new intellectual and didactic tools (see e.g., Ely, 1989 for a taxonomy of educational objectives in the interactive domain). The perception of single images and sequences will be subject to the same scrutiny as at present but the notions of authorship, production and control will have to be considerably revised.

**Who's in control?**

The technological future may be confusing but it won't be dull. If the new media give the learner a creative role in the making of the learning material, then some of our present notions about creating a standard course for lots of different people may have to be altered. We may have to think more about how we can provide all the necessary elements of learning to the students in such a way that they can make the best use of them. Up to now we have been able to delude ourselves that we have control over the learning process - forgetting of course that the most powerful switch in the whole mechanism is the one inside the head of the learner. Once we begin to use interactive systems we have to come to terms with the new role of the learner.

Yet it must be stressed that any changes of role will be relative, rather than total. I am not suggesting that interactive programs will allow full authorship to the student and take away the directive or controlling role of the teacher. Reality is always somewhat different from the promises of the theorists and developers. Just as it was always possible with 'tree' or algorithmic structure to have far more branches than we could ever use, so with the newer 'neural' programming or author languages, limitations have to be introduced in order to make it possible to write the programs in the first place and in the second place to make them sensible for learners to use.

By the same token we must beware of the salesmen's promises about the new hyper systems. They will allow just about any sort of link between one piece of information and another. The trick will be to find just which links, in the context of which method, are most appropriate for a particular learning situation. So, if a disc itself has no specific didactic structure, it is incumbent on the teachers (or on a larger scale, publishers) to provide that 'shell' of specific objectives methods and evaluation. In this respect, the Ecodisc is a fore-runner of the generic materials which are beginning to appear in many countries as resources for learning around which lessons can be built. What has already been proven by program-makers is

that the new types of software allow for much more flexible lesson materials - giving the learner the chance to play a more active part in the learning process - and that effective results can be achieved in much less time than was previously required with systems which had been designed by computer programmers rather than learning technologists.

## Potential versus market

It is still worth noting that the economics of a saleable technology will always predominate over the best intentions of the academic researcher. Our duty as educationalists is to establish the sort of research and development which will allow us to get the very best out of the existing software and exert some pressure on the developers of the next range of applications. But the big question is: will education be given the chance it deserves? Such is the speed of technological development that frequently the results of research on applications are irrelevant by the time that they are produced. When one considers that at some point research must be pragmatic, that it must look at what is happening in real situations and not just in research projects, there has to be a phase in which we study these new media in real and large-scale learning situations. The influence and attractiveness of the new technologies is so great that we in education cannot stop commercial intrusions into our world. In fact I would argue that we have to be just as commercial.

There are a lot of interactive applications being produced. Most are in industry or the military where the investment can be recovered through gains in training. In the educational world there are many experimental applications being developed in universities and colleges. Some of these do little more than show that interactive media are possible. But even considering those which demonstrate exciting learning potential, there are virtually no products for schools coming on the market. Producers won't risk large scale runs because there is no client base. Potential users won't buy the equipment because there isn't enough software and in any case there is no standard configuration on which all the programs run. This log-jam will have to be broken soon or some of the technologies will have been scrapped for the lack of a market.

## The Ecodisc

Given the foregoing generalities, it is worth considering the Ecodisc in detail. As mentioned earlier the technology, and especially the controlling software, has been superseded. Feedback from users led the BBC to make the newer programs in a different way. And yet this program is particularly worthy of study. It is a commercial product, not an experimental prototype being paraded by the

research unit of a University. It is a program specifically constructed for education and has been used over a sufficient period to allow some evaluation. It is also competing in the British schools against other programs in the same subject area. The Ecodisc started life as a standard linear television program in an educational series. Thus it betrays many of the extended linear elements of film. The subsequent decision to made a videodisc required much more shooting of stills, especially for the surrogate walks and helicopter shots. The whole process took two years to complete. The user is now presented with an interactive program in which they can walk around a nature reserve, listen to different experts on the various aspects of flora and fauna, exercise a range of observation and statistical techniques, and even play the role of the manager of the nature reserve.

Does the structure of this program justify its educational claims? In one sense one could say that 'there is no structure' and close the discussion at this point. Indeed, there is no overall didactic structure. The program is no more goal oriented than the nature reserve itself. Just as in a actual visit to the reserve one has to decide what one will study and what background information one needs, so one has to impose a structure onto the elements which go to make up the reserve. Yet the reality of the situation is that a great deal of structure has been built into the disc. For purely practical reasons the user's choice has to be limited in both time and place. In every section there are limitations to the number of images which might be used, there are limitations to the number of choices which can be made. As such it is not far from reality - one can only work with the available information. On the other hand there are some advantages, it would be an adventurous visitor who experienced the underwater sequences and the ability to switch from summer to winter at the click of a button is denied to us in our reality. It is worth at this point to look at the functions offered by the program. The following text is taken from the handbook accompanying the disc (Anon, 1987):

> The Ecodisc is an interactive videodisc which brings together a vast collection of information in the form of photographic stills, film sequences, graphic displays and data, all under the control of a computer program. It is all about a real nature reserve, Slapton Ley in South Devon. The purpose of the disc is to enable you to experience the reserve: to see what it looks like, to find out what lives there and to appreciate the ecological complexity of the area and the problems associated with its management. The videodisc provides you with the tools to explore and experiment almost as if you were actually there.
>
> There are a number of interconnected activities:
>
> PLAN
> You can experience the problems related to the management of the reserve by taking the role of the Nature Reserve Manager. There are many different actions you can take within the reserve itself and you have various ways of

liaising with local and specialist groups. You have to formulate a plan which safeguards the future needs of the reserve and satisfies as many of the conflicting local demands as possible.

VIEW
You can see various films introducing you to the whole reserve or to various parts of it.

WALK
You can walk backwards and forwards around the area in different directions. You can choose your own route or follow a pre- determined route. You have a map and compass to help and you can look down from the helicopter whenever you want.

SAMPLE
You can find out in more detail about the populations of plants and animals by going into the reserve and sampling. You are able to investigate the vegetation of the woods and reedbed, the fish in the lake and the birds and mammals inhabiting the reserve. You use the most appropriate method of sampling for the species being studied.

WATCH
Whereas WALK lets you see the reserve today, WATCH enables you to look at what might happen over the next fifty years if there is no further active management of the reserve and it is left to follow a natural succession.

With these possible entry points there are already a large number of possible routes through the material. Added to these are some more precise functions which appear to take the user through to a deeper level of information.

A further function called INFo is available throughout. This gives you the extra information you may need at particular times. Through it you can always obtain HELP on how to use the program and it will EXPLAIN about the surroundings. In some places you can obtain DETAILed views of the surrounding vegetation types. You can also get help with IDENTIFYing the various plants and animals. When you are planning you can get DATA on the various organisms. INFo will be where to look if ever you are unsure about what to do or how to do it, or if you require additional information.

You should take on the role of Nature Reserve Manager. Information about your role is available at the start of PLAN, as is information about the views of various groups who have an interest in the reserve. Various film introductions to the reserve are available in VIEW. As well as listening to the views of the interest groups you should also find out more about the reserve by WALKING

> around, or by WATCHING or SAMPLING. When you are ready you can put forward a PLAN. That plan will be looked at by everybody involved and they will send you their views. It is up to you either to change your plans or carry them out as they are.

The virtual standardization of information handling is an important feature in the learning process and serves to lower any barriers to use which might arise from technophobia (more readily found in teachers than in students). It is clear that, though the various sections are limited by the capacity of the disc, there is so much data and so many possible uses that no single user is likely to make use of all the information. Even though one suspects that, in use, there are a limited number of end results from such a disc, the particular pathway to that result can vary enormously.

It may be because the program originated within the British educational ethos that it seems to many in other countries to lack that essential structure which is felt necessary for proper learning. This paper will not enter into the merits of different philosophies, as they are each dependent upon a social, historical and political context. Variations in these contexts may make the integration of interactive media more or less acceptable. Still it is safe to say that we learn most by doing or when our insights and abilities are challenged, for which interactive media give excellent opportunities. For instance, the program can be used to teach observational and research skills which will be required for actual field study. It has the advantage of introducing the learner to the techniques whilst allowing him/her to learn more about the Slapton Ley reserve. The exercises can in no real sense duplicate the field work. Time is compressed and information is presented in a limited and sometimes idealized form. What is learned is the necessity of a systematic and painstaking approach to taking measurements. The actuality of fieldwork is discovered later.

The makers of the program are at pains to point out that there is no 'right' answer to the problems of managing a nature reserve. Indeed with this disc, it is not possible to come up with an answer which satisfies many people or doesn't have some sort of detrimental effect. By limiting the actions which may be taken by a manager (just as such a manager in real life is limited by financial and political factors) the producers have created something which is almost as frustrating as reality.

## The medium is the message

This often quoted and often misused 'bon mot' from Mcluhan (1965) has an important bearing on the didactic functions of interactive media. Ideally there should be as direct a contact with the information as possible, supported by using the power of interactive media to provide as many back-up and help facilities as

possible. Because the control of what appears on the screen is in the hands of the user, there should be as few intermediaries or distancing elements in the design of the production as possible. When the user asks for advice, that advice should be given directly back to them not to a (seen or unseen) interlocutor. The parts of the Ecodisc which came from the original film, the local experts explaining their terrains, shows the convention of the expert talking to the interviewer rather than the viewer. When it comes to our relationship with the 'guide', he speaks directly to the viewer and uses phrases such as "You have chosen to do .....". When the user goes into the office the letters are there to be read, no-one intervenes to read them to the user. Another recent disc on environmental education in the British IVIS (interactive video in schools) project has met with criticism in that it shows children carrying out field studies and experiments. We, the viewers, are at least one remove from the materials. On that IVIS disc we watch others doing rather than being asked to do things ourselves.

## Conclusion

The Ecodisc, with all the limitations of its origin and its system dependence, can be seen as a simulated environment in which both the objective and subjective worlds can be found. The data is both objective in the context of the observations of flora and fauna. The extramural influence such as the wishes and opinions of the pressure groups are largely subjective in themselves but must be handled as objective data. Because there is no fixed model, and the balancing forces in such a nature reserve are not fully understood, the learners have to make judgements based on just that mix of hard and soft information - balancing the environmental and the political pressures - which can be found at the heart of all environmental problems. The silvered disc mirrors the real world in a way which when brought within an existing didactic framework can be a powerful tool for learning.

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# Small and medium enterprises: knowledge management in industry poses special challenges.

C.A. Coehoorn, E.E. Van de Lustgraaf, and N.G. Röling

*The agricultural sector, from which much of the early impels for the study of knowledge processes sprang, shows two unique qualities that allow and stimulate public support. First, it includes a large number of enterprises that produce the same commodity and have similar technology and information needs. Second, the individual farmer cannot exert any influence on price-setting: farmers, therefore, do not compete. Consequently, obtaining exclusive rights on technology produced by agricultural R&D is not an issue for individual farmers (Nelson, 1982). The success of the agricultural model encourages its implementation in other sectors, although these sectors have other characteristics (Rogers et al., 1976). Industry, and its subsectors, are characterized by differentiated products, processes, and markets. Information needs, therefore, are heterogeneous. With industrial entrepreneurs being competitors, differentiated access to technological knowledge, or more precisely exclusive rights on certain technologies, is of vital importance for the individual firm. These aspects obviously hold disadvantages for the development of an information transfer system and strong incentives to engage in firm-owned R&D, what hampers the formation of a political constituency for public support of industrial R&D[1]. This article presents an attempt to examine the consequences of these characteristics of industry for building an institutional knowledge system for small and medium enterprises (SME). Our approach compares the 'ideal-model' elaborated by Droogh et al. (1990) with experiences resulting from the Innovation Centers (IC) that were established by the Dutch government in 1989.*

## An 'ideal-model' for an industrial knowledge system

In an interesting study Droogh et al. (1990), inspired by the agricultural knowledge transfer model, tried to develop an organizational model for the knowledge transfer in a small region[2]. They distinguished three main principles responsible

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for success:

1. concerted action by all relevant participators;
2. an active attitude from the knowledge suppliers; and
3. adequate linkage between know-ledge supply and demand.

These principles were derived from successful agricultural knowledge systems (elsewhere in this volume, e.g., Röling & Engel, similar and other criteria are determined).

In formulating their model, Droogh et al. also considered some relevant characteristics of the individual firm. As a result of staff shortage in the SME, the entrepreneur often does not recognize the existence of (specialized) knowledge problems. And when he does, lack of time usually does not allow an intensive and systematic search for information. As a result, the typical small entrepreneur only uses information that hits him (so to speak) 'by accident'[3], and only uses this information for manifest problems, while ignoring latent problems. In other words, many entrepreneurs adopt a passive attitude. This has been confirmed in various other studies of innovative behavior (e.g., Docter & Stokman, 1987; Nooteboom, 1987). A second characteristic of SME identified by Droogh et al. is that information transfer takes place through personal contacts. Small entrepreneurs do not have the time, nor the capacity to read leaflets and other documentation (such as to introduce relevant institutional knowledge sources). This characteristic was also confirmed in other studies (e.g., NOBIN, 1983; Nooteboom, 1987). A third important factor in the design of a transfer system identified by Droogh et al. is the reluctance of relevant organizations to cooperate, due to fear for the loss of function and identity. Their autonomy makes it difficult to motivate them to become components of a system.

Taking the specific regional situation and the general principles considered earlier into account, Droogh et al. came to an 'ideal-model' that included three elements:

1. an information-desk function;
2. a consultancy function; and
3. a knowledge pool function.

The main role of an information-desk is reference and coordination. At the desk an entrepreneur presents a problem and will be referred to the organization that can respond best to the problem. Essential for the information-desk function are quality, autonomy, and a good overview of available serving organizations. Coordination involves recognition of discrepancies in the knowledge transfer network.

Firm consultants have various tasks. By visiting firms and functioning as partners to discuss ideas and problems, they establish good relations with entrepreneurs and can signalize problems that are neglected. Consultants often use the knowledge network to provide possible solutions to firm problems. In doing so, weak spots in the network (where it is not capable to solve existing problems, are identified.

The knowledge pool consists of graduates (from local high-level technological and administrative schools) who can temporarily work on certain firm projects that, at the moment, are not carried out due to lack of time or qualified staff. These supply employees can solve problems, introducing new knowledge and strengthening contacts with the other elements of the knowledge network. Often, they are backed by the staff of their former school, advisors, and (ex-)entrepreneurs.

Information-desks, consultants, and the knowledge pool form a dynamic whole and stimulate, in cooperation with the existing knowledge suppliers, the local SME. Droogh et al. (1990) stress that "only when entrepreneurs themselves become concerned with the establishment of a knowledge network, will enough involvement emerge for the network to have a chance of success".

**The case: the Innovation Centers (IC)**

In April 1987, a committee established to advise the Dutch cabinet on technology policies, concluded that industrial SME lagged in respect to innovativeness, due to insufficient use of available technological knowledge in product development. The committee recommended strengthening of existing infrastructure by establishing a new decentralized network that would initiate and stimulate knowledge transfer to SME. Although centrally coordinated, this network would operate at the regional level in close proximity of the entrepreneurs. Between december 1988 and november 1989, after approval of the congress, a network of Innovation Centers (IC) was established (including 18 general centers) with one specialized center, and a coordination center.

The IC are 'intermediate', or change agency organizations that aim to intensify the transfer of technological knowledge to SME. In typical 'top-down' thinking, as identified elsewhere in this volume (e.g., Röling & Engel), SME could be seen as the 'adopting subsystem', consisting of various sectors. The main target sector is industry (with approx. 45,000 firms). In addition, IC services are intended for all firms in construction, wholesale, trade, retail, commercial services, welfare, and other services that state a need for technological knowledge. The total target group is estimated at around 110,000 firms.

The Ministry of Economic Affairs, responsible for the network, pointed out that the IC, instead of producing knowledge, are only responsible for its dissemination. Their central task will, therefore, be brokerage between knowledge suppliers and adopters at the individual or group firm level. Identified knowledge suppliers are public funded research institutions, other (usually large) firms, and commercial technology consultants. An IC should act as a non-specialized, first line information and consultancy service. In addition to this task, IC are supposed to stimulate cooperation and knowledge exchange at the regional level by establishing contacts among SME, developing regional networks, and projects. More-

over, IC assist in implementation of national information campaigns.

The services offered will be provided either on the initiative of the IC or upon request of firms. In principle, services rendered are free of charge, with a maximum of two days per year. For services requiring more effort (with an eight day maximum) a fee comparable with normal commercial tariffs, will be charged. IC staff include a managing director and (depending on the region) three to nine advisors, as well as administrative staff[4]. Advisors must have a broad technological background, with commercial and management experience.

In addition to their regional function, the 18 general IC function as a national network for the exchange of technical information, to profit from their joined knowledge potential in this field. This network is coordinated by a central office in The Hague, and facilitated by mobile, automated information exchange (using laptops). Furthermore, the experience of various advisers in certain technological fields is incorporated into an automated information network that allows colleagues easy access. However, as far as we know, no serious attempts are made so far to convert this person-bound experience-based knowledge into an expert-system. Central office handles most of the financial administration, provides training courses for consultants, manages the automation services, and takes care of national PR and marketing. A special department, with access to files of the Patent Office, provides patent information[5].

Each regional IC is headed by a board of representatives from regional entrepreneurs and knowledge suppliers. Board members participate on personal title and are appointed by the minister of Economic Affairs after regional nomination. It is assumed that through these board members, and their social contacts, regional user control will be realized. Each year the IC board develops a business plan that gives past and future knowledge transfer activities tailored to the region in question. The Ministry of Economic Affairs, taking this business plan into consideration, provides annual financial support to cover operational costs. For the entire IC network, it has reserved about Fl. 37 million annually.

Eventually, it is intended to link IC with foreign organizations for technology transfer. Such cooperative arrangements already exist in areas bordering Germany and Belgium.

## The IC compared with Droogh et al.'s 'ideal model'

We will now compare systematically some of the ideas developed by Droogh et al. with the notions underlying the Dutch IC network.

*Segmentation.* Both, the 'ideal model' and the IC, have an one-to-one approach: consultants visit individual firms; at information desks the references are provided to individuals; and knowledge pool members work for individual firms. However, IC also organize some group level projects. It is obvious that a one-to-one approach is very expensive and cannot be expected to cover all SME in a region.

However, neither in the model nor with the IC, a clear choice is made with respect to the priority categories to be reached. Which SME are most deserving assistance, by what criteria?

Presently, the IC are intensively looking for an answer to this question (personal communication with several regional IC directors, 1990). In essence it is, as Kaimowitz (this volume) points out, a political choice with (sometimes far-reaching) economical and social consequences. The problem can be approached from two angles:

1. what SME are most deserving assistance, according to the economic objectives at regional or national level; and
2. how can SME be segmented into more or less homogeneous categories with respect to information needs and effective communication patterns.

Answering the first question is outside the competence of the authors of this articles. We only want to refer to Gibb (1987), who makes it clear that priorities can differ per region (e.g., they might focus on enhancing high quality employment, new business generation, youth programs, or long-term unemployment).

With respect to the second question, many attempts have been made. Segmentation variables that relate to psychological characteristics of entrepreneurs (Brockhaus & Horwitz, 1986), innovative behavior (e.g., Docter et al, 1989; Dosi, 1988), technological aspects (Pavitt, 1984), and technology information needs and information search strategies (McKinsey, 1987) have been identified. For this article the last approach seems most relevant.

Unfortunately, segmentation based on information needs and search strategies, although in theory quite elegant, has in practice proven to be unproductive, due to the fact that the required data for selection were not ready available. The only available data are firm size and branch code, which bear no direct relationship with innovativeness, information needs, search strategy, or whatever other important variable. The IC, therefore, do not have clear instruments for segmentation of their 'market' or analysis of clients' needs. To solve this problem, IC appear to combine the available information with personal experiences and insights (e.g., on technological practices and information needs in certain branches, or technological and organizational problems at certain levels of firm size) (personal communication with several IC directors, 1990). However, such an approach is vulnerable to demands of the SME that are aware of their technology needs and ask for assistance.

*Competition.* As we saw, industry differs from agriculture because firms that produce similar products in the former sector are competitors, whereas those in the latter are not, with the exception of recent developments in a few highly specialized domains (Verkaik & Dijkveld Stol, 1989). Competition makes it hard to serve large homogeneous groups with uniform information and technology packages. Economies of scale do not apply.

But matters are never that absolute. Companies might be competitors, but still cooperate. Enterprises in related branches, working on related products, or

operating in different markets, might gain from collaboration. Some of the IC are actively exploring ways of increasing and improving such collaboration and try to obtain a brokerage function, especially where enterprises can add value to each others' products. In the model of Droogh et al. little is said on this subject. The same holds for the effects of competition on the aspiration to 'own' knowledge, and the concomitant reluctance to exchange it. Both Droogh et al. and the IC (personal communication with several IC directors, 1990) appear to notice few problems in this field. One explanation is that much of the knowledge used by SME is produced by polytechnic schools, without a clear commercial purpose.

*Collaboration and linkage between relevant institutions.* One of the powerful aspects of the agricultural model is the high integration between (and even redundancy of) various specialized functions in the knowledge system. Although Droogh et al. consider this to be one of the success factors of the agricultural case, it receives little attention in the final 'ideal model'. In fact, to avoid conflict, emphasis is put on limiting the number of organizations involved.

The IC model also pays little attention to the factor of concerted action by all relevant parties. One problem is that employers' organizations, so far, have not seemed very enthusiastic in supporting the IC. And, as we know from the agricultural model, users' keen self-interest in, and pressure on knowledge system institutions is probably the best way to bring about synergy. But often (Docter et al., 1989), emphasis is on institutions that receive public funding (e.g., Chambers of Commerce, IC, the Institute for Medium and Small Business), whereas private institutions (such as the employers' organizations) are neglected, even though their political aims and ability to exert countervailing power could be essential for the operation of the system.

*Interpersonal and active transfer of knowledge.* Both models pay considerable attention to this aspect. Both install consultants that visit firms personally. Furthermore, Droogh et al. make use of a pool of experts and specialists who can solve problems 'on the job', thus generating applied knowledge for specific circumstances of a firm. This method is not incorporated into the IC: they have to find useful knowledge in external institutions. Besides, the approach of Droogh et al. can lead to job opportunities for higher educated people in SME when the pool of specialists also include recent graduates from polytechnic schools or technical universities. This has consequences for the information search behavior of most SME (a more active attitude will result, as pointed out earlier) and, therefore, might lead to structural development of the SME.

A further important observation is that focus on technology transfer is often underpinned by philosophies that perceive technological innovation as a 'deus ex machina', and emphasize the 'breakthrough' function. This neglects the fact that information and technology only will support innovation if they fit a specific need or potential. Hence, professional agencies involved in information and technology transfer should pay considerable attention to the equivalent of marketing research and testing.

*Technology transfer versus learning to innovate.* Buys (1987) has made an important contribution by distinguishing between two strategies for stimulating innovation: (1) transfer of information and technology to firms; and (2) teaching firms to innovate by using available external information. In agriculture this distinction has also been made, for example by Röling (1986), who observes that especially small farmers often require considerable assistance in terms of mobilization, organization, and training before they can 'pull down' available services and technologies. One often finds technical government agencies involved in transfer, with non-governmental organizations (NGOs) focussing on mobilization, organization, and training. Buys (1987) re-ported on an interesting experiment in which the second strategy was elaborated for SME. It involved consultants that focussed on enhancing the SME's capacity to learn to innovate and use existing external information. The learning process involved changes, such as formulation of a business innovation plan, the installment of a committee responsible for innovation, and training in external information use.

Both approaches (technology transfer and learning to innovate), are complementary. Both, therefore, need considerable attention, especially if one wants to effectively reach those firms that experience disadvantages from being small, or not having resources to plan innovation or closely monitor external developments. But in reality, the two models discussed in this article pay little attention to teaching innovation. IC typically focus on technology transfer. Experience from agriculture suggests that the main default from this approach is that assistance is provided to those who need it least. If the IC would choose to focus on SME that cannot help themselves, they will probably even notice that their present transfer strategy is counter-productive.

*Constituencies.* As a result of experiences in the 'war on poverty' in developing nations and the US during the 1970s, it is now commonly recognized that human service organizations' clientele cannot be regarded as passive 'receivers', but must be seen as active 'constituencies' exerting effective demand (Röling, 1988). In the absence of such constituencies, as is often the case in developing nations, human service organizations simply do not work. They become self-centered bureaucracies with incentive structures that do not support the performance of the functions for which they were created. With this in mind, the question can even be raised whether authoritarian political systems would ever allow effective human service organizations to function.

It, therefore, seems necessary for new service organizations to put considerable thought and effort into development of target groups' constituencies, while avoiding undue influence of non-representative elites. So far, these principles have received little attention. The IC do have entrepreneurs in their executive councils, but it is unknown to what extent they represent client interest groups. Such bodies (e.g., the employers' organizations) have not yet shown much sympathy for the IC. Could it be they are dominated by entrepreneurs that do not need the services provided by the IC? The potential role the branch organizations can

play is still left to be explored.

## Conclusion

The efforts made by Droogh et al. (1990) and those represented by the establishment of the IC, show that the systematic development of an effective knowledge system for industry, and especially for SME, has been taken very seriously indeed. The present article has explored the extent to which the two models (the 'ideal' model presented by Droogh et al. and the model underpinning the IC) make use of some of the principles for effective knowledge management that emerge out of comparative analysis. A number of points follow from this investigation.

There is a deliberate attempt to identify and improve weak spots, with evaluation being built in. Thus some conditions for self-learning have been created. However, much remains to be done, in terms of developing throughout the whole sector of awareness of the importance and nature of the knowledge system and its management. Only when a certain 'corporate ideology' emerges, can the various parties be expected to be well aware of their own roles in the system and the way in which they can add value to its performance (Röling, 1990). Such a corporate ideology creates the conditions for effective coordination and joint management of the system. At the moment, it still is difficult to stimulate all relevant parties to work together, especially because of perceived threats to territory, competence, and identity.

A second problem we have identified is the absence of attention to effective demand by active constituencies. When such demand is not exerted, it is difficult for knowledge system institutions to be client oriented, an essential condition for its focussed functioning. To a large extent, the system cannot function as a system in those circumstances when pressure to achieve synergy is not exerted and elements do not add value to each others' performance.

But, both models have very substantial achievements. Strong is the emphasis on flexibility and situation specificity by decentralization to the regional level, while maintaining the link to advantages of specialization possible at the (inter)national level. The emphasis on interpersonal communication and networks, also among clients, for sharing information and new ideas is strong and promising.

Above all, the conscious and deliberate attention to knowledge and information systems and knowledge management in industry, and its large scale implementation through the establishment of IC as hubs of regional systems, opens exciting perspectives on new research and development in the area of knowledge management. Much remains to be done, but it seems that the conditions have been created that allows progress.

## Notes

[1] Some publicly based research institutes (apart from universities) exist in The Netherlands. With respect to the SME, the most important is TNO, which operates in the field of applied (technological) research and development. As far as the authors know, however, it cannot be said that the industrial (SME) community forms a political constituency that influences for example research topics, in the way agricultural users control research programs.

[2] Kennemerland, in the North-west of The Netherlands, around Alkmaar.

[3] Contact with necessary information occurs through contacts with clients, subcontractors, suppliers, and casually contacts at business exchange meetings.

[4] Integrated in the IC is the Government Industrial Counselling Service (RND), a provincial public organization which had almost 80 years of experience in the field of industrial counselling. This allowed a 'flying start' for the IC, which are technologically upgraded compared to the RND. About half of the personnel comes from the former RND.

[5] Apart from the central IC (called ICN), another national IC, the Specialized Innovation Center for Inventions (ID-NL) has been installed. This center aims at the stimulation and commercialization of inventions, and thus continues a major part of the work previously carried out by the Invention Center Foundation. In 1990 the Centers for Micro-Electronics (CME) will be integrated in the IC network. These centers are directed towards the stimulation of the effective application of micro-electronics by SME.

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# Research in Unilever: strategy, organization, and innovation

S. Bruin and C. Okkerse

*In industry, research is a tool like marketing and manufacturing. Whereas academic research aims at advancing science, industrial research aims, first of all, at advancing the profitability and growth of a business. The purpose of this article is to provide some insights on how Unilever, one of the world's major multinational companies, manages its research and development (R&D). The article starts out with an overview of the Unilever organization; its size, nature, strategies, and design. A reflection on industrial R&D follows, concluded by a discussion on some of the characteristics of the Unilever R&D system.*

## The Unilever organization

Unilever came into existence in 1930 through the amalgamation of two enterprises already operating in many countries: the Dutch Margarine Unie and the British Lever Brothers. Today it is one of the world's largest concerns, employing around 300,000 people in some 75 countries, and providing a wide range of products and services. In 1988 it had a total turnover of about $ 30,981 million, and a return on employed capital of 14.5 percent.

The companies which make up Unilever supply branded products for household use, most of which are manufactured in the country where they are sold. Despite its size and international significance, Unilever is little known among the public at large as its companies mainly engage in brand marketing. The spread of activities over many countries and the wide diversification of operations make an important contribution to the strength and stability of the concern. Unilever's key areas of activity, which correspond with so called 'Product Groups', are indicated in Table 1.

Unilever's organizational form is molded by its management philosophy, culture, and history. And, of course, by its complexity, size, opportunities, and problems. In both the head offices in Rotterdam and London several management groups concentrate on the broad outline of concern policy. However,

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D. Kuiper & N.G. Röling (Eds.). (1991). *The edited proceedings of the European Seminar on Knowledge Management and Information Technology.* Agricultural University, Department of Extension Science, Wageningen, The Netherlands.

Unilever's fundamental strength lies in its operating companies. Their high degree of autonomy, with the preservation of their own character, is one of the most typical features of Unilever. Each company has its own management, predominantly made up of nationals, which is responsible for organization, personnel management, production, sales, cost control, purchase of raw materials, and transport. Unilever is convinced that this high degree of decentralization is the best way of developing the qualities which determine a company's success - such as ingenuity, initiative, and responsibility.

Table 1: Sales by Product Group (1988).

| Product Group | Sales (x 1,000,000 $) |
|---|---|
| Detergents | 6,762 |
| Edible Fats | 6,192 |
| Foods & Drinks | 5,380 |
| Frozen Products | 3,849 |
| Personal Products | 2,947 |
| Chemicals | 2,630 |
| Packaging Material | 2,321 |
| Agro | 900 |
| Total: | 30,981 |

Yet, Unilever makes sure that its total strength is greater than the sum of the individual units. It created central Functional Divisions and Departments which support the various Product Groups and individual companies and which act as an adhesive, binding the whole company together. These Functional Divisions and Departments exist in such areas as finance and accounting, taxation, personnel policy, research and engineering, and legal affairs. Others benefit from their skills and resources, and as the services are provided on an international basis, substantial economies of scale can be achieved. All provide expert service at a level and of a quality that smaller operating groups within Unilever would be unable to afford. The head of each Division or Department is a member of Unilever's central Board of Directors.

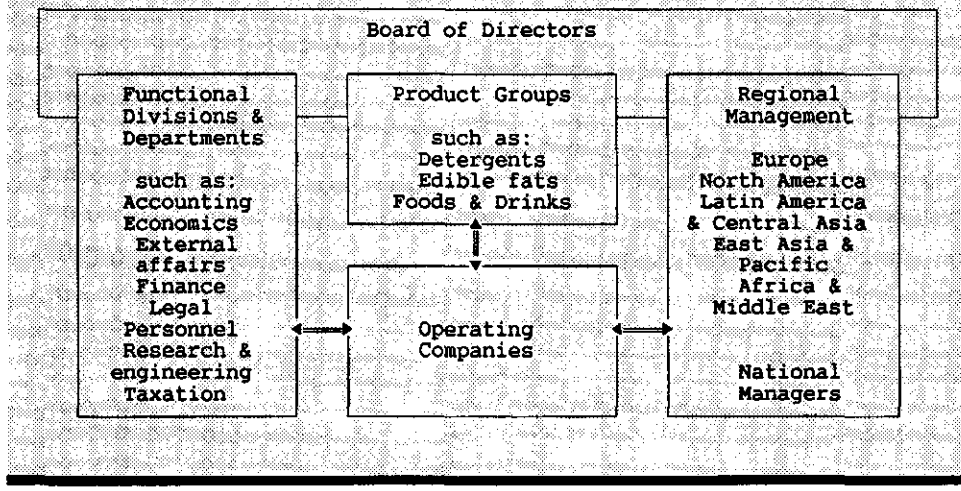
As indicated there are eight Product Groups, which actually operate as policy groups. They are headed by a Coordinator, a Board member who oversees the development, production, and marketing of different types of products in a special domain. It is his task to supervise the central policy for the entire Product Group.

Regional Management Groups, also headed by Board members, are organized on a geographical rather than a product basis. In each European country, a National Manager is responsible for contacts with government, industrial and

external relations, finance, taxation, and the provision of services. These National Managers report to the appropriate Regional Director. Outside Europe things are organized somewhat differently, which is beyond the scope of this article.

The responsibilities of, and the interactions between, the Functional Divisions/Departments, the Product Groups, and the Regional and National Managements shapes a matrix structure that enables Unilever to meet most developments and challenges swiftly (see Figure 1).

Figure 1: Lines of contact in Unilever.




The formulation of Unilever's objectives and overall policy is the responsibility of the Board of Directors, which consists of about 20 members coming from the different management groups. It is responsible for long-range projection and annual plans, large investment projects, approval of financial policy, and the appointment of top management.

## Industrial R&D

In industry, the main reason for conducting R&D is the discovery and development of improved/new raw materials, products, and processes that might lead to cost-savings or maintenance/increase of sales. Yet, the specific characteristics of R&D are determined by the nature, size, and strategy of an industry. Some do not engage in R&D because they do not need to, e.g., trading companies. Others are fully dependent upon R&D, e.g., the electronic industry. Unilever spends a

relatively high sum of money on R&D in comparison with its competitors. The reason is clear: its business strategy rests upon maintaining leadership in the fast moving consumer goods area by giving added value through R&D and marketing. In the following we will concentrate on the technical R&D in Unilever, although R&D also occurs in other areas (e.g., market research and sociological research). A morphology of R&D types is presented in Figure 2.

Figure 2: Types of R&D.

| ASPECT | BASIC RESEARCH | APPLIED RESEARCH | DEVELOPMENT |
|---|---|---|---|
| Objectives | general direction only | rather specific | specific |
| Nature | mono-disciplinary oriented | multi-disciplinary oriented | production oriented |
| Duration | long term (> 10 years) | medium term (2 - 10 years) | short term (< 2 years) |
| Changes of success | low | medium | high |
| Organization | relatively simple | complex | relatively simple |
| Location | universities, institutes, laboratories | industrial laboratories, pilot plants | factories, pilot plants |

Applied research and development are essential. Industrial research, however, also needs to monitor closely the advances of related scientific basic research. To make this possible, therefore, a certain percentage of an industrial R&D budget should be devoted to basic or non-targeted research (say 20 percent). This type of research can either be contracted out to universities or institutes, or can be carried out in industrial laboratories. In essence, an industrial R&D organization should only carry out that type of R&D itself for which it wants exclusivity in products and processes, preferably protected by patents.

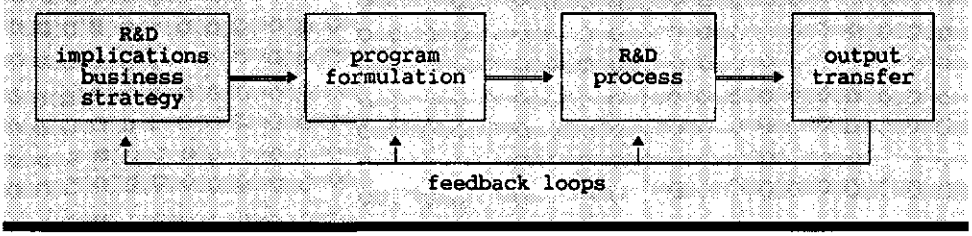
So, two interfaces are essential. At the science interface, basic research is required to understand the work going on in the scientific community. At the market interface, structured market-pull analysis and applied research to develop products or relaunch them is required to fulfil the needs of the market. Consequently in each industrial R&D organization you need skills both on the science interpretation side and on the market interpretation side, not necessarily combined in the same person. This illustrates the complexity of management of

industrial R&D. But there are several other factors which should be added to this:

a. industrial research is multi-disciplinary because the end result is a product or a complete process;
b. chances of success are relatively low;
c. costs are relatively high and productivity difficult to estimate;
d. judgement of time scales is difficult. Too optimistic or pessimistic estimates can have grave undesirable effects, e.g., on credibilities;
e. market needs do change and fluctuate with characteristic periods of say one year, while changing human expertise profiles in research take considerately more time, say three - five years.

These factors reinforce each other and require, for an industrial R&D operation to be successful, its integration into the formulation and execution of the business strategy it serves. The Unilever philosophy on this aspect is clear and fundamental: without proper and timely business input no proper and timely R&D output can be attained (Figure 3).

Figure 3: Industrial R&D system.




The actual R&D process is only a small part of the total R&D system. We think the most critical step remains the formulation of the 'best' R&D program. For commercial success this is even more important than scientific excellence. Still, you have to have all four steps indicated in Figure 3 right to be successful. The implication of this is a need for effective and structured communication between business management and R&D.

## The Unilever R&D system

The total R&D expenditure in Unilever is about $ 500 million, half of it is spent on central R&D carried out in two Unilever Research Laboratories (URL) which fall under the Research and Engineering Division. The other half is spent on research in the Development Departments of individual companies. The total number of personnel in central R&D is about 3,700, of which 1,000 graduate

scientists/engineers. Around 90 percent of the central R&D budget comes from the Product Groups, the rest is directly allocated to the Research and Engineering Division.

We will now turn to the R&D of the Edible Fats Product Group (EFPG) for a further elaboration of the process indicated in Figure 3. Taking the business strategy as a starting point, the environment (e.g., consumer and marketing trends, action of competitors, and news from the technological front) allows determination of general strategic directions in which to put research money and the R&D implications. These decisions are made by the Coordinator (the head of EFPG), based on inputs from policy groups, ad hoc innovation study groups (installed by the Coordinator), and company chairmen. A major decision involves the allocation of the budget over three types of R&D activities: technology base research; and the transfer of existing technology; product/process development. Another important decision regards the part of the research which will be done centrally in the Unilever Research Laboratories, and the part which will be done decentralized by the operating companies themselves. Our EFPG spends around 20 percent on technology base research, 25 percent on transfer of existing technology, and 55 percent on product and process innovation. About 80 percent of the R&D activities are carried out in the central laboratories.

For the actual R&D program formulation so called 'interface units' have been set up. A tool used to set priorities within a relatively homogeneous sub-area of research is the research sensitivity study approach explained Figure 4. It is used with caution as experience has taught us that too strict application tends to result in an R&D program dominated by short-term projects usually of a cost saving nature.

Figure 4: Research sensitivity studies.

A. Formation of business research team for sub-area;
B. Debate business strategy;
C. Identify possible changes for:
   - new or improved products,
   - cost savings;
D. Define business key objectives;
E. Evaluate key objectives in terms of:
   - value to the business (= a),
   - research investment required (= b),
   - changes of success (= c);
F. Rank according to sensitivity factor (S), with S = a x c / b;
G. Reject all key objectives with S < 5;
H. Consolidate, set priorities, and phase program.

The R&D program formulation leads to R&D key objectives in business languages. They still have to be translated into projects that provide tasks for scientists, with targets which relate to time ('milestones'), required manpower and

expertise, and proper reviewing and control mechanisms. The process itself should be cost-effective and efficient. Key points are:

1. is the project team led by a champion who can confer enthusiasm and a sense of urgency into the team;
2. is the project team crystal clear about the project objectives and the business needs that spawned the project;
3. has the project team the right expertise to crack the scientific issues;
4. is scientific information from outside (universities, institutes, contract laboratories, consultants, suppliers, etc) and from in-house background/expertise groups available and fully used.

In targeted research there is always some risk that the project team works somewhat blinded by its own objectives. Therefore some degree of freedom must be given to team members to follow 'own' ideas in order to stimulate unconventional/innovative approaches (say five - ten percent of time could be spent on this). The transfer of R&D output to the companies is the final essential step of successful research. We have developed several tools to structure and facilitate this process:

1. lead companies are used to speed up transfer of new product technology into a first application. A lead company participates in the project team and often its chairman personally guides the strategic direction of the project when market implementation is getting near (say within one - two years);
2. application units have been set up to transfer successful product technology from one company to another with adaptations necessary to fine-tune it to the new market situation.

## Conclusion

The essential standpoints of this article can be summarized in four statements:

1. industrial R&D is a very complex activity, requiring sophisticated organization;
2. the R&D function should be totally integrated into the business;
3. program formulation is the most critical step;
4. R&D is expensive, has relatively low chances of success and long time scales.

# Knowledge management and IT in Hendrix Voeders Holland

A. Swinkels and H.J. Veerkamp

*Turbulent and fast moving markets demand flexible organizations capable of accurate and effective handling of knowledge and information. This article describes some essential parts of this knowledge and information management in Hendrix Voeders Holland, a Dutch feed factory. It concentrates on the Support System, an information technology (IT) application that allows the agricultural advisors to store and retrieve market information in a structured and uniform way, facilitates the information exchange with 'headquarters' (e.g., gives the managers access to this information), and makes immediate feedback and action possible. This system was rewarded with the IT Star Award in a worldwide competition of BP Companies. Special attention is given to a part of the Support System: the Daily Reports. In 1989 it was evaluated thoroughly, and the results of this survey are summarized.*

Hendrix Voeders Holland is part of the business group of BP Nutrition. It manufactures compound feed, employs 700 people, and serves a market of livestock farmers, which is distributed among 175 independent dealers, each with their own region. The dealers cooperate intensively with the Hendrix technical advisors. These advisors (120) are specialized per species (broiler, layer, dairy cattle, beef, and pig), and are responsible for good technical and financial results at the client level. The advice is provided on a individual level through a high frequency of visits. The advisors are supervised by a commercial area manager and sector managers that are responsible respectively for the commercial results in their area and the technical results in their sector (Figure 1).

## The collection and distribution of information

Hendrix has increasingly decentralized the collection and distribution of information on several grounds: it was impossible for one central person to judge

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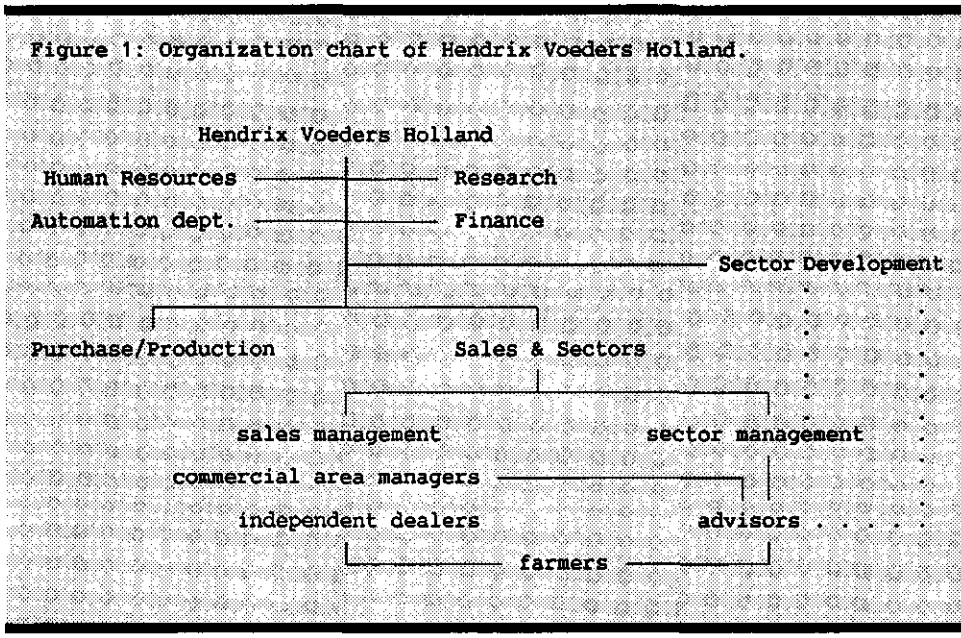



the relevance of all the information collected; central storage created the need for additional supervision and administration, and in respect to utilization, was not very efficient; and the decentralization of information management meant greater responsibility and motivation for those involved. The sector managers were seen as key figures in the management of information and knowledge.

Every three years, sector strategies are formulated. To implement such a strategy, sector management annually develops a technical program or plan. This program includes not only feeding, but also housing, health care, and farm management. Developing the sector strategy and the concomitant technical programs, therefore, demands many types of expertise and various sorts of information. This information might cover a broad variety of aspects: market structure in The Netherlands and worldwide, economic indicators (e.g., cost prices), technical results from research, the position and activities of competitors, the influence of national and EEC politics and legislation, or strengths and weaknesses of the current Hendrix approach (e.g., the results of Hendrix clients). The needed information can be obtained: (a) by searching literature (e.g., journals, books, publications of research centers and databases); (b) through personal contacts inside Hendrix (e.g., with other departments, managers, researchers, advisors and dealers); (c) by using the Support System for market information; or (d) through personal contacts in agricultural networks (e.g., with institutes, governmental bodies, universities).

The most important databases used are Agralin, CAB, FSTA, Agricola, and

also CRIS (USA) and Agrep (EEC). The experiences with these systems are that:

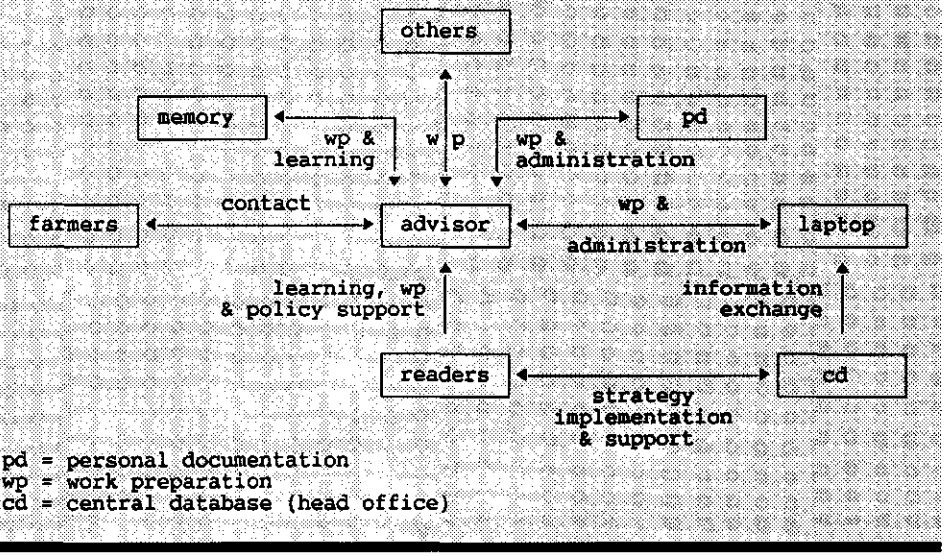
1. they provide valuable insight concerning research on new subjects (first screening);
2. the first screening is a starting point for investigation;
3. they provide a valuable check on completeness of information;
4. it is important to know which persons and organizations are involved in a certain subject; and
5. the information is not always recent enough (three - six months).

If the information was updated more regularly, the usage of these systems would increase and the user would be motivated to make better use of it.

## The Support System for market information

The Support System supplies reader groups (e.g., sector management, sales management, and commercial area managers) with valuable market information. It also informs the advisors and their clients of information by providing feedback. It is an IT application which includes comprehensive software packages (called subsystems), laptops used by the advisors, and a central database at the head office. Figure 2 presents the Support System with regard to the most relevant functions and information sources in the everyday work of the advisor.

Figure 2: The Support System.



Before the introduction of IT, a preliminary analysis revealed major possibilities for improvement. With many advisors in the field, one can expect to receive questions concerning a great number of different specialist areas during the day. Both head office personnel, as well as the advisors in the field, experienced difficulties in reaching each other by phone. The limited office staff was not always accessible. As a result, advisors often could not reach the right person and messages were not always transferred properly.

Until recently, advisors were obliged to send daily reports to the head office in Boxmeer. They used a standard form that left space for the so called 'personal touch'. The gathering, distribution, and monitoring of these forms was very time consuming. The forms had to circulate between a number of departments. By the time valuable information reached its final destination, it had often lost its actuality, or even worse, it was too late to react. Furthermore, the advisor must monitor the trend of his customer's commercial and technical results for a longer period. In spite of a lot of goodwill, all this activity happened in a rather unstructured manner. The collected information was hardly comparable. There were a lot of data, but little information. Also much of the advisor's valuable time was spent on administrative tasks at the farm that, in fact, were more or less standard calculations to monitor the farmer's technical and financial results.

In developing the system, the following objectives were formulated:

1. simplify the administrative procedures;
2. establish/enhance good telecommunications;
3. make information comparable;
4. build-in flexibility; and
5. build-in security.

The IT system was introduced gradually since 1987 and was fully operational in 1989. Much effort was invested into introducing the system and training the users. Eventually everybody adopted the system and learned to work quite comfortably with it. As far as the objectives are concerned, the following observations can be made:

*Administrative procedures.* Monitoring clients' technical results is fundamental for the Dutch feed industry. Previously, calculation of technical results was rather labor consuming. Today, the number of calculations has risen from 4,000 to 10,000 a year, but the workload is less. Similar results have been achieved in other areas (e.g., solvency calculations);

*Communications.* The installment of good communication facilities places the organization in a position of easy collection, consolidation, and distribution of information. It also provides the advisors with electronic mail and access to centrally located systems. Information that took an average of two weeks or more to arrive in the past now is available within a day;

*Standardization.* The reports are now standardized on a great number of items, which makes reporting easier. Prose was no longer needed, only short and simple abbreviations. Information has become comparable. Of course, user friendly

(help) screens are available when needed;

*Flexibility.* This system gives tremendous opportunities to react pro-actively on all kinds of events. Not only does the system give a great number of possible standard queries, but the advisor is also able to question the database on all available information;

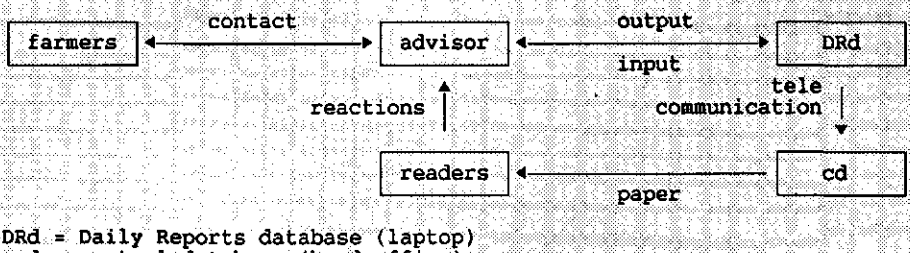
*Security.* Connecting advisors to the central database and providing them with all kinds of customer information implies a security risk. We did our utmost to prevent unauthorized access to the system and restricted advisor information to personal clients. Access controls such as identifiers and passwords were implemented.

## A Support Subsystem: Daily Reports

The history of Daily Reports has already described briefly, including software packages in the Support System. Besides the technical and financial subsystems (software packages), the advisors requires the ability to monitor clients' activities in a more qualitative way with regard to advice provided, objectives formulated, activities of competitors, health of animals, building situation, quality aspects of feed, farm management, and contact with others.

Figure 3 shows Daily Reports, which is part of the Support System (Figure 2).

Figure 3: Daily Reports with related information flows and sources.




For the advisor, contact with farmers leads to typing his daily reports (input), which are stored in the laptops database. Next, these reports are sent to the central database at Boxmeer and hence forwarded to the readers. If necessary, reactions are sent to the advisors, for which different means of communications are used. The advisors themselves can receive information (output) from Daily Reports database by using selection menus.

In 1987, at the start of the Daily Reports subsystem, the following objectives

were formulated:

1. to allow advisors manage a database containing information to support them in anticipating developments in their everyday work;
2. to inform different reader groups within the organization that have a stake in information from the database;
3. to accomplish an effective form of communication between advisors and the reader groups in order to anticipate and direct each others work performance and work program;
4. to control the effectiveness and efficiency of the advisor's work, both by the advisor and the reader groups.

Two years later, in the fall of 1989, an evaluation was conducted. The main goal was to evaluate objectives 1 and 4 (especially self-control), and to identify potential improvements. A questionnaire was distributed among a random sample of advisors, and was followed by an indepth interview. In total, 36 percent of the advisors (N = 43) in three different species (pigs, cattle, and poultry) participated. The combination of the two methods had revealing results. An outline of the most remarkable ones follows.

*Characteristics of the advisor.* All advisors showed a high level of loyalty to the organization. Daily Reports' structure was suitable for advisors in different species and with different levels of routine. The support provided by Hendrix to learn to work with Daily Reports and provide assistance is experienced as very good. All advisors acquired the primary skills necessary to operate Daily Reports' software, in spite of limited computer experience. Advisors in different species did have different patterns of usage. For a major part, this difference could be explained by different frequencies of visiting clients and by different tasks. The age of advisors also explained some differences. Less experienced advisors used Daily Reports' output more frequently and were more satisfied with it. They typed the Daily Reports more for themselves than for readers, contrary to the more experienced advisors. With regard to possible improvements, it was found that more attention must be paid to the advisor's level of experience. Also it was found that more involvement of direct supervisors and superiors in feedback to the advisors is needed.

*Output (information from laptop to advisor).* Advisors experienced the output procedures as easy to use and the Daily Reports as a quick and compact retrieval system with good reviewing possibilities. The preparation and analysis of selected data took little time. Advisors showed a satisfactory usage frequency (56 percent used the output procedures, an average of eight times a week). On the other hand, there was still some lack of awareness of all output possibilities. As a consequence, unrealistic expectations existed. Also, the level of advanced skills was moderate, which might be an explanation for the modest satisfaction with output results (mentioned by 49 percent of the advisors). An explanation for these outcomes might be found in the training program, which has been conducted.

*Input (information from advisor to laptop).* The software package was perceived

as straightforward, and an aid in structuring reports. Many advisors saw the input as an additional evaluation of their everyday work. However, Daily Reports lacked profoundness because advisors used only a few criteria for content and layout, using on average eight lines of 55 characters divided in three or four topic codes (the report is divided in topics, each headed by a code). Furthermore, the reporting structure caused both the advisor and the readers to be addressed by the same text, in spite of their different information needs. The amount of time spent on Daily Reports, compared to the time spent on other subsystems of the Support System, was too long for some advisors. This response was partly due to insufficient typing skills.

*Role of Daily Reports in everyday work.* Daily Reports had a qualitatively important role in work preparation, and in the continuity and progress of everyday work. they were partially adopted and integrated in work preparation and administration activities, where they competed with diaries, note pads, visiting schedules, client archives, memory, contact by telephone, and personal contact.

*Communication between advisors and readers.* Advisors perceived Daily Reports as a potentially good means of communication. They were convinced that they had many experiences in their everyday work that were useful for their readers (49 percent of the advisors mainly typed the text for the readers and 35 percent mainly for themselves). The advisor's input requires better adjustment to the information needs and wishes of the readers. Also communication could be improved by increasingly enlarging the readers' reactions and speed of reacting. Finally, more attention to integration and coordination with other means of communication was needed.

## Conclusions and future plans

The general conclusion was that Daily Reports has proven to be an asset, both for advisor and reader. But the two years of experience with the subsystem also proved that further improvements could optimize its use. As a result of these conclusions and concomitant recommendations a plan was launched in which detailed norms and actions were formulated for the short and long term use of the Daily Reports.

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# The Department of Extension Science

The seminar from which these proceedings result, was organized to celebrate the 25th anniversary of the Department of Extension Science. It seems therefore justified to inform the reader on its activities.

## Objectives

The Department of Extension Science is one of the around 70 departments of the Wageningen Agricultural University. It is an academic management unit designed to produce:

1. trained people who can plan, implement, manage, and analyze extension programs, and who can systematically consider the contribution of extension to the realization of policies in agriculture, development, health promotion, and environmental protection;
2. publications and other knowledge products which contribute to the advancement of the international body of knowledge concerning extension science;
3. publications and other knowledge products which enhance the understanding of professionals, managers, policy makers, and clients with respect to extension approaches, strategies, policies, and systems;
4. consultancy and other services with respect to the use of extension as a policy instrument to reach societal objective (policy, management, analysis, implementation, evaluation).

## Means

The Agricultural University provides the Department with some 9 full-time staff positions. The Department itself employs two additional part-time staff members, while third parties support a varying number of additional researchers, consultants, and trainers, usually no less than 10.

The Department is located on the second floor of a modern building, occupying offices and seminar rooms in two wings. The building has collective facilities, such as a major social science library, a canteen, photocopying machines, and so on.

## Teaching program for Dutch students

The Department does not offer its own degree but provides service teaching to

students who graduate in widely varying fields in agriculture, public health, environment, social science, and management science.

The undergraduate teaching program of the university basically takes 4 years (5100 student hours of which 1680 must be optionals, such as extension science). Students take an average of 900 student hours more on subjects they choose to augment their basic diploma. Many choose extension for this purpose. The Department offers an introductory course in extension (80 student hours) for Dutch students which is attended by some 600 students from different Dutch universities annually. About 200 students continue to take additional courses offered by the department. Of these, about 100 complete a major course program of 1000 or more student hours, including writing a thesis.

The Department has recently designed a one-year (1680 hours) program for students wanting to augment their regular programma with a solid, structured block of extension science. This allows e.g. non-resident Ph.D. candidates to work on dissertations.

In addition to the regular academic training program, the Department is involved in various post-academic and other courses for adult learners.

**The international masters course**

Together with a number of other departments, the Department is engaged in an international english language M.Sc. course on the 'Management of Agricultural Knowledge Systems" (MAKS). It is a two-year course which caters for a yearly intake of about 12 students from all over the world. The Department is responsible for the management of the course and its secretariat (one full-time staff member, one academic assistant, and one secretary) is housed in the Department. Students who successfully complete the course are eligible for admission to the doctoral program.

**International connections**

The Department has a strong international outlook and is engaged in several international activities. Various staff members regularly go on consultancy missions for national and international organizations, both government and NGO. Members of the Department actively participate as teachers and committee members in the International Course on Rural Extension (ICRE) and the International Course of Development Relevant Research in Agriculture (ICRA), both held in Wageningen. Two members of the Department are members of the technical committee screening the programs and projects of NOVIB (a Dutch NGO focussing on developing countries). They also actively participate in the Research Project on the Research-Technology Transfer Linkages of ISNAR, the

Hague.

The Department is involved, with others, in a major university collaboration project with the Faculty of Agriculture of the University of Bénin, West Africa. The Department has one full-time staff member located in Bénin. It is engaged in building similar linkages with the University of Zimbabwe in Harare. Consultation is underway for a collaborative program with the University of Tras-os-Montes-e-Alto Duro (UTAD) in Portugal.

**Brief historical overview**

The Department grew out of the work of Dr A.W. Van den Ban, who had studied the use farmers make of extension advice, using research methods developed in the diffusion of innovations research tradition (1963). He became the first professor and head in 1964. At first, the Department only served a small group of agricultural students who saw a future in agricultural extension. It did not take long, however, for various groups of students (health promotion, home economics, rural development, environmental protection, public relations, and others) to discover that extension approaches, strategies, and methods could be extremely useful to them in their professional careers. Soon the clientele of the Department grew rapidly, encompassing a wide array of students from different Dutch universities.

During the period of strong expansion in the late sixties and early seventies, the Department grew in terms of staff, facilities, and teaching programs. Van den Ban wrote the basic introductory text in extension education which has been used for years throughout The Netherlands and has now been edited and translated in english for international use (Van den Ban, A.W., & Hawkins, S. (1988). *Agricultural Extension.* London: Longman). Van den Ban was one of the founding fathers of the vigorous health education programs of the Dutch government, provincial and municipal authorities, and various private organizations (e.g., the Heart Foundation). He stepped down voluntary in 1983, when he was 55, to devote the last 10 years of his career to international development. He is presently working in a rural development project in Tanzania.

He was succeeded by Dr N.G. Röling. He holds a Ph.D. in communication from Michigan State University and has done research in Nigeria (4 years) and Kenya (2 years) and is engaged in a number of international missions every year. Where Van den Ban had emphasized the development of the teaching program, Röling was explicitly appointed to stimulate the research program. Together with the Departments of Agricultural Education and Philosophy of Science, a research program called "Knowledge Utilization in Agriculture" was developed and funded by the University.

During Röling's professorship, the substantive focus of the Department shifted from extension methods and approaches to the systematic use of extension as a

policy instrument, be it for information, persuasion, or education and empowerment. Furthermore, instead of on extension alone, extension was increasingly considered as part of a larger 'knowledge and information system' (together with research, specialists, clients, and others). In 1988, Röling published this approach to extension science (Röling, N.G. (1988). *Extension science: information systems in agricultural development.* Cambridge: Cambridge University Press). The approach has also been incorporated in the new Dutch language introduction to extension (H. Wapenaar, N. Röling, and A.W. van den Ban (1989). *Basisboek Voorlichtingskunde.* Meppel: Boom). The emphasis on knowledge and information systems led the Department to focus on knowledge management and its tools, and on the contributions of information technology to knowledge management.

In 1989, Röling stepped down voluntarily (at the age of 52) as head of the Department and professor (the two go together in The Netherlands). He is now senior lecturer and devotes himself to knowledge systems research and its application to support institutions for rain fed agriculture. He was succeeded by Dr C.M.J. Van Woerkum (43), the former research coordinator and specialist in communication as a policy instrument. To a larger extent than Röling, he is interested in Dutch networks related to public policy formation and instrument deployment, especially in the field of environmental protection, now a major survival issue in the densely populated Netherlands. Van Woerkum is the author of a widely used text on the programming of extension (Van Woerkum, C.M.J. (1987). *Massamediale voorlichting; een werkplan.* Meppel: Boom).

**How can the Department be reached?**


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