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Managing the Strategic Network Relations between Corporate R&D and Business

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Abstract

The present paper addresses the important issue of the management of the strategic network relations between corporate R&D and business. In a large technology-based multinational company (+/- 30,000 employees) an instrument that provides regular feedback to both corporate R&D and business about strategic alignment, based on factors derived from the social capital theory and the competence perspective, has been tested in a longitudinal survey from 1997 through 2002 (696 respondents). It is concluded that a combination of both theoretical perspectives adds to a more in-depth understanding of the mechanisms at work in the complex R&D-to-business relations in large divisionalized companies. The improved network communication based on structured feedback related to the level of R&D competencies as well as the level of R&D flexibility and information lead to better strategic alignment. It was further concluded that a governance structure that effectively balances the short-term orientation (via business unit funding) and the long-term orientation (via technology board funding) is effective to provide strategic alignment between R&D and business.

Key words: R&D and innovation strategy, social capital theory, competence perspective, strategic alignment

1. Introduction

In today's markets, characterized by fierce global competition and increasing customer demands, innovation has become an important strategy for survival and growth. Watson (1993) emphasizes this by stating: *'Companies that want to compete successfully must offer quality beyond competitors, technology before competitors and cost below competitors'*. Over the past few decades, the organization of innovation -in large, technology-based companies mainly carried out by the research and development (R&D) function- went through a number of significant transformations, also referred to as different 'generations' of R&D. R&D activities, until mid-1950s, were mostly intuitive and based on intellectual curiosity (Bush, 1980). In the late 1950s and 1960s, R&D efforts adopted the basic procedures of project management. In the 1970s and 1980s industrial R&D became more oriented upon the company's business objectives and strategies, a phase known as third generation R&D (Roussel et al., 1991). From the 1990s onwards the fourth generation of R&D emerged, characterized by growing complexity, multiple projects, tied to a long-term strategy and combined into R&D portfolios (Zbignew and Pasek, 2002). From the start of the third generation R&D however, problems were signalled concerning a lack of alignment between corporate R&D and business strategy. These problems were also

described in literature as the R&D-marketing gap (Souder and Chakrabarti, 1978). Managing the strategic network relations between R&D and business in large multinational companies clearly requires an understanding of what factors influence them and how these factors can be influenced by management metrics. The first objective of this study is to improve our understanding of the mechanisms that determine these relations by answering the following research question:

R1. Which factors determine the strategic network relations between R&D and business.

The second objective is to gain insights in how these factors can be influenced by management metrics. This requires a longitudinal study design, in which the effect of specific metrics can be monitored by answering the following research question.

R2. How do these network relations develop over time?

To answer these questions, the present paper builds on two main theoretical perspectives, the social capital theory (Leenders and Gabbay, 1999; Lin, 2001) and the competence perspective (Penrose, 1959; Wernerfelt, 1984; Barney, 1991). For this study a measurement instrument was developed that provided regular feedback to both corporate R&D and business in a longitudinal survey design from 1997 through 2002 in a large technology-based multinational company.

We have structured the paper as follows. Section 2 describes the theoretical foundation of the study which provides the basis for the development of the conceptual model. From this model a number of hypotheses are derived. Section 3 describes the development of the longitudinal survey and the methods of data collection. Section 4 presents the results of the longitudinal survey in corporate R&D, headquarters, and the business units of the multinational technology-based company. Finally, in section 5 the results are discussed, the conclusions are drawn, and the theoretical and the management implications are discussed, and suggestions for further research are provided.

2. Theoretical Framework

In order to analyse the internal relations of large divisionalised firms, we define the firm in network terms. Nooteboom (1999) defines a network as a pattern of more or less lasting linkages between nodes, where the nodes represent different organizational units. These units may be firms or divisions within firms. The linkages may be uni- or bidirectional, representing flows of products, forms of control, lines of cooperation and communication. The present paper is directed to the strategic alignment within the R&D-headquarters (HQ)-business unit (BU) network (see figure 1). We consider corporate R&D, headquarters and the business units as the nodes, and the information, (project plans, requirements, project results, and services) and governance structure (modes of control and coordination) as the linkages in this internal network. Of course, the firm as such is also part of an external network, the internal nodes having external linkages with the environment, represented as a link of corporate R&D with knowledge sources, such as universities and institutes, and of the business units with their B2B customers.

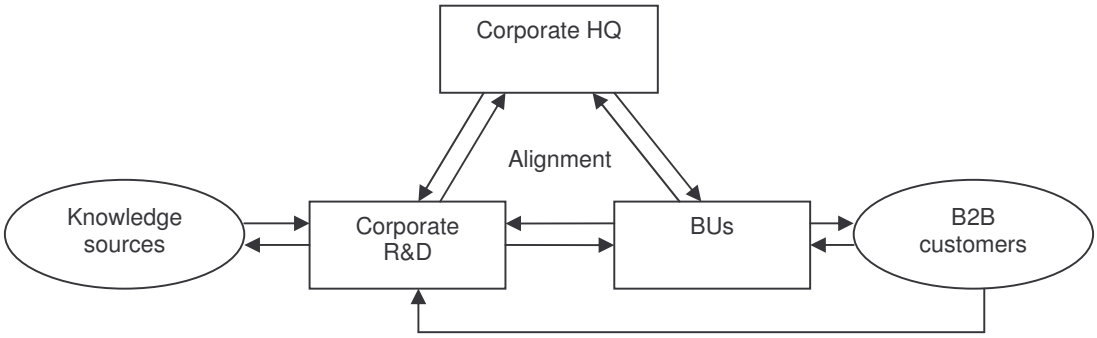

Figure 1. Strategic alignment and the internal (R&D-HQ-BU) and external network relations in a multinational corporation

In order to gain insight in what factors determine these relationships three aspects have to be considered: 1. what kind of a network is it; 2. what is the content of the relations in the network (what is exchanged) and 3. what is the quality of these relations (how does the exchange take place).

Following Heide (1990) we consider the relationships within the intra-company network to comprise of collaborative interactions between functional units as well as by formal control of superiors. The governance of the latter type of relations are characterized by unilateral exchanges, which rely on bureaucratic and authoritarian structures that confer power to impose rules and instructions. The governance structure of collaborative interactions are characterized by bilateral exchanges, in which parties collaborate by means of jointly developed plans directed toward the achievement of certain goals. To analyse the second aspect, the content of the exchange between R&D and business, we turn to the competence perspective on firms (e.g. Penrose, 1959; Wernerfelt, 1984). This theory implies that the firm is made up from a number of competencies, based on resources, embodied in a configuration of various forms of capital (financial, human, social), which to a greater or lesser extent is idiosyncratic to the firm. It is these unique competencies that provide firms with a basis for profit. From this perspective we derive the company's R&D competencies as the main factor determining the content of the strategic relations between R&D and business. As to the aspect of *how* (the quality of the relationship), we turn to the social capital theory, which stresses the importance of relationships among individuals and organisations or organizational units. Trust is identified by many authors as one of the key factors influencing relations. According to Ring and Van de Ven (1992) trust plays a key role in any organizational relationship. Trust enables partners to manage risk and opportunism in transactions (Nooteboom et al., 1997). Trust helps to reduce complex realities more quickly and economically than prediction, authority or bargaining (Powell, 1990). The quality of the relationship facilitates joint action (Coleman, 1990; Lin, 2001; Adler and Kwon, 2002). Joint action consists of joint problem solving and on joint planning (Claro, 2004). Joint planning in a dynamic environment however, requires flexibility and an adequate information exchange, two factors we derive from the social capital theory as crucial in determining the quality of the R&D–HQ-BU relations. To summarize, we derive from theory three main factors that we expect to determine the relations between R&D and business: the governance structure, the competences that are available and used to carry out R&D projects and the level of flexibility and information exchange, facilitating these processes.

Regularly, in 1997, 1998, 2000 and 2002, structured feedback was given to R&D, headquarters and the business units about these factors. The feedback provided at time T_0 enabled corporate and R&D management to address specific problems with targeted metrics. The subsequent measurement at time T_1 provided information on the effect of these metrics, and led to adjustments and new metrics, the effect of which was measured at time T_2 etc.

H1. We hypothesize that improved network communication based on structured feedback (3 in figure 2) related to the level of R&D competencies as well as the level of R&D flexibility and information exchange (1 in figure 2) will raise trust and thus lead to better strategic alignment and ultimately to better performance.

After the first survey in 1997 the CTO and the top management of the R&D centre decided to set up a global benchmark study to identify best practices in innovation management used by leading companies in other industries. Based on the results corporate R&D decided to include new management metrics which were already common in some other industries. One of these was the introduction of a Balanced Score Card for R&D in 1998, including financial and non-financial indicators (see Omta and Bras, 2000). Another was the system of technology road mapping, which was introduced after the third survey in 2000. The most important metric however was taken by corporate headquarters in 1999, after the second survey namely the change in governance structure, which implied a change in R&D funding from 100% corporate funding to a mixed system of 50% business unit funding and 50 % Technology Board funding. From 1999 onwards the business units could use their 50% to procure their own R&D projects at the corporate R&D centre, or, if they prefer, elsewhere. The other 50% is decided upon by the Technology Board, which consists of the CTO, the directors of the business units and the top management of corporate R&D. The technology Board typically looks after the more fundamental projects in the R&D portfolio, with more risk and a longer time horizon, whereas the business units focus more on projects that are nearer to the market and have a shorter time horizon.

H2 We further hypothesize that a governance structure which balances the control over the corporate R&D portfolio among all parties involved (R&D, headquarters, and the business units) will create better strategic alignment than one in which only one of the parties (i.e. corporate R&D) has exclusive control (2 in figure 2).

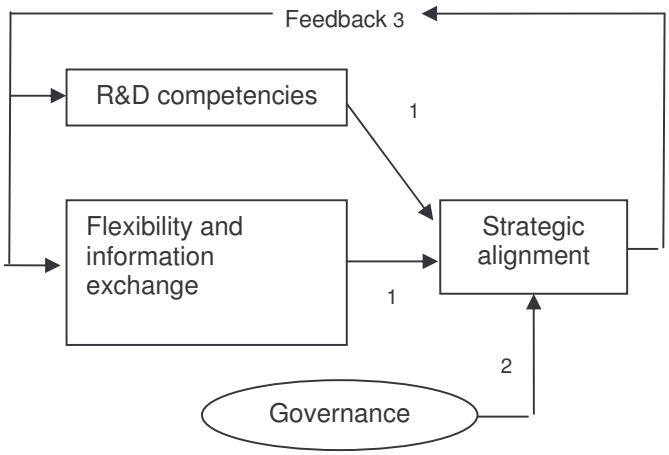

Figure 2. Conceptual framework

3. Research methods and data collection

In order to test the model empirically, the factors as derived from literature were operationalized in a survey questionnaire (see table 1). We use subjective assessment of respondents from all parties in the network (headquarters, business units and R&D) on the level of R&D competencies, R&D flexibility and information exchange and the level of strategic alignment.

To assess the variable of strategic R&D alignment the respondents were asked how well the R&D projects aligned with important technologies and with market needs (4 items). To assess the variable R&D competencies, respondents were asked to indicate the relative importance of six R&D objectives, ranging from basic research via applied research to engineering. Then the respondents were asked to assess the lab's performance on each of these objectives. The variable flexibility was measured in two dimensions: responsiveness and timeliness. Responsiveness was captured by two items: the lab's flexibility to incorporate new R&D projects into the corporate R&D portfolio, and the pace of starting-up these projects (joined planning). Timeliness was measured as the average cycle time of R&D project execution, the number of projects delivered at promised date and the time lag to answer technical questions (joined problem solving). The variable of information exchange was assessed as R&D reporting in the different phases of R&D project execution as well as in terms of the respondents' opinion on the importance of R&D-internal customer communication and R&D-end user communication.

The survey questionnaire was constructed using a panel of 5 experts from industry and Academia. We started out from an initial pool of 61 items (approximately 12 items per factor). These 61-items were subjected to two stages of data refinement. The first stage focused on condensing the instrument by retaining only those items capable of discriminating across respondents having different value perspectives, and examining the dimensionality of the scales and establishing the reliabilities of its components. The second stage was primarily confirmatory in nature and involved re-evaluating the condensed scales' dimensionality and reliability by retesting the scales. Some further refinements occurred in this stage. In the 5 years that the

longitudinal study was conducted the core of the questionnaire (32 questions) has remained unchanged.

Table 1. Operationalization of the factors in the conceptual framework

Strategic alignment
4 questions using seven-point Likert-scales ranging from strongly agree to strongly disagree, Cronbach α = 0.85
- Strategic alignment of R&D to corporate strategy in terms of technologies and market needs.

R&D competencies
2 x 6 questions using five-point Likert-scales ranging from strongly agree to strongly disagree, with no verbal labels for the intermediate scale points, Cronbach α = 0.72
Relative importance of R&D's objectives: 1. expanding the company's technology knowledge base 2. Developing new technology in a product/process area. 3. Offering new technology for cost reduction. 4. Translating existing technology in a new product or process area. 5. Developing new product or process tests. 6. Contributing to the improvement of product or process designs. - The lab's perceived performance per objective. - Objective weighed performance, the lab's achievements weighed for the relative importance of its objectives.

Flexibility
Responsiveness
2 questions using seven-point Likert-scales ranging from strongly agree to strongly disagree, Cronbach α = 0.73
Ease of incorporation of Business Unit's requests in the corporate R&D portfolio and start-up time lag of R&D projects.
Timeliness
3 questions using seven-point Likert-scales ranging from strongly agree to strongly disagree, Cronbach α = 0.68
- The number of projects which are perceived to be delivered before or conform the agreed date.
- The average project cycle time.
- The time lag to answer technical questions.

Information exchange
9 questions using seven-point Likert-scales ranging from strongly agree to strongly disagree, Cronbach α = 0.64
- Regular project progress reports and information meetings between the laboratory and its Business Unit customers to assess - Market and competitor information; - Quality aspects and analysis of complaints; - Staff exchange; - Project communication improvement.

The questionnaire uses five-point Likert-scales for the R&D competencies, and seven-point Likert-scales for the other variables, ranging from strongly agree to strongly disagree, with no verbal labels for the intermediate scale points. The construct validity is acceptable, the Cronbach Alpha of the five dimensions ranged from 0.64 to 0.85 (see table 1), within the generally accepted guidelines for measuring organizational attributes in this type of exploratory study. Several items were negatively worded to reduce response tendencies by the respondents (Cooper and Emory,

1995). These items were reverse-scored for use in the analyses, in order to ensure that a higher assessment in all cases reflects a more positive judgment of the item at issue. The following attributes of the respondents were used as control variables: 1) whether the respondent came from the corporate R&D centre or from the business units or headquarters; 2) from which business unit, in case the respondent came from one of the business units; 3) country; 4) function (product development, marketing or other) and 5) position (director, manager or engineer).

To determine the relations in the conceptual model a linear stepwise regression was executed with listwise deletion, using the variables R&D competencies, flexibility, information exchange and change in governance structure as the independent variables and the variable strategic alignment as dependent variable. For this analysis a metric method was used, which is permitted for non-metric data, provided the sample size is larger than 100, which is the case in the present study. To correct for the effect that respondents who participated more often will tend to give a more positive judgment, based on the feedback of the earlier survey, for this analysis the independent sample of the total database was used (N=474), meaning that every respondent was entered only once. Entering the data of the respondents who had participated in more than one year, did not change the conclusions. The years (1997, 1998, 2000 and 2002) were introduced as dummies, and used as a proxy for the change in governance structure, which took place between the second and third measurement. For the longitudinal analysis best fitting curve analysis was conducted per variable, using linear and second order polynomial trend approximation. To analyze the gaps between the assessments given by respondents from corporate headquarters, the Business Units and the self-assessments given by the R&D staff, two-tailed t-tests were used. Non-parametric analyses of group means, using the Kruskal-Wallis test, did not alter the conclusions.

The data were collected in a multinational supplier company of technology-based industrial components for different industries, especially automotive. The company employs about 30,000 employees worldwide, working at 83 production sites in 24 countries. The annual sales volume in 2002 amounted to about US$ 5 billion, with an operating profit margin of about 8%. In 1997, 1998, 2000 and 2002 the questionnaire was sent to corporate headquarters, the scientific staff of the corporate R&D laboratory and the higher management of the business units. The total study population consisted of 696 respondents, 483 from the headquarters and the business units and 213 from the corporate R&D centre. Because of their limited numbers (3 to 5 per survey), respondents from corporate headquarters are ranked among those of the directors function of the business units. The average response rate was 67% for the corporate R&D staff and 44% for the HQ/BU staff.

4. Results

4.1 Strategic R&D Alignment as a function of the internal network relations

Table 2 shows the results of the stepwise linear regression executed on the independent sample (N=474), using R&D competencies and flexibility and reporting as independent variables strategic alignment as the dependent variable and R&D/business unit, business unit, country, function and position as control variables.

Table 2. Strategic alignment as a function of the firm's R&D competencies, flexibility and information exchange Stepwise Regression Analysis with Listwise Deletion, independent sample, N=474

	β
Change in governance structure	0.28***
R&D Competencies	0.24***
Timeliness	0.23***
BU Assessment	0.19***
Responsiveness	0.11**
Director Assessment	0.09**
Information exchange	0.08*

F-ratio 59; R2 (adj) 38.2%***
*p < .05; **p < .001; *** p < .000

Table 2 shows, that 38% of the total variance in the dependent variable of strategic alignment can be explained by the independent variables and a number of control variables. The most important factor coming out of the analysis is the change in governance structure. The shift of the locus of control of the R&D portfolio from R&D exclusively to a joint responsibility of R&D and business comes out as the most important factor determining strategic alignment. R&D competencies (carrying out the right research domains and doing this the right way) and the dimension of timeliness of the construct of flexibility are the next important factors determining strategic alignment. The control variable of the respondent coming from R&D or from the business turns out to be the next factor: as we will show in the longitudinal trend analysis, it is especially the respondents from the business units that have become more positive about the level of strategic alignment over the years, so their judgments contributed more than that of the R&D staff to the changes in perceived strategic alignment. The second dimension of flexibility, responsiveness, turns out to be the next factor determining strategic alignment, followed by another control variable: that of the director position of the business units, who changed their opinion on the alignment of R&D to business strategy more strongly than the other respondents from the business units. The level of information exchange comes out as the last factor contributing to strategic alignment. In contrast to the previous factors, which come out as very significant (change in governance structure, R&D competencies, timeliness and BU respondents $p < .000$, responsiveness and director assessment $p < .001$), information exchange comes out at $p < .05$.

4.2 Longitudinal trend analysis

Since the regression analysis indicated, that the background of the respondents (whether they come from corporate R&D or from the business) is the most important control variable, these two groups are shown separately in the longitudinal trends. For the sake of clarity of presentation, we selected per variable one item that is most representative for the outcomes on that variable.

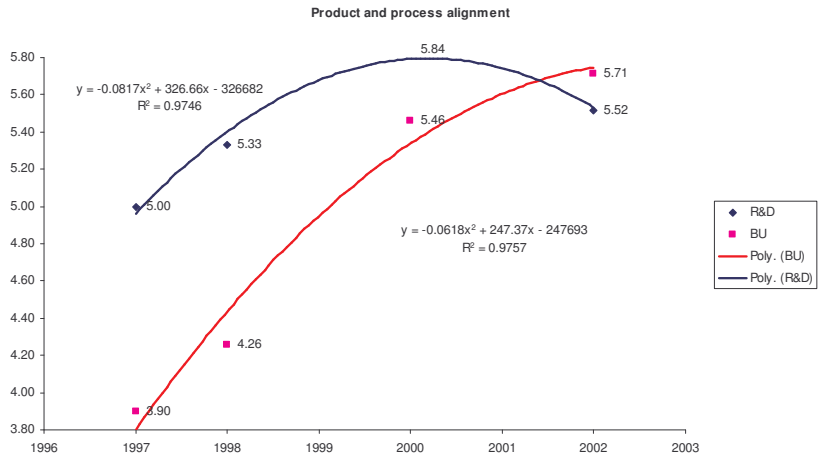

Figure 3. Strategic alignment of corporate R&D to Business, product and process alignment
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

Figure 3 shows that the BU assessment regarding the strategic alignment of the corporately funded R&D projects improved considerably over time. Where in 1997 a considerable gap exists between the BU assessment and the R&D staff self assessment, this gap has totally disappeared in 2002. The BU assessment clearly rises in each successive measurement, but the greatest rise can be observed between 1998 and 2000, that is after the change in governance structure form 100% corporate to a mixed system of 50% business unit and 50% technology board funding, took effect.

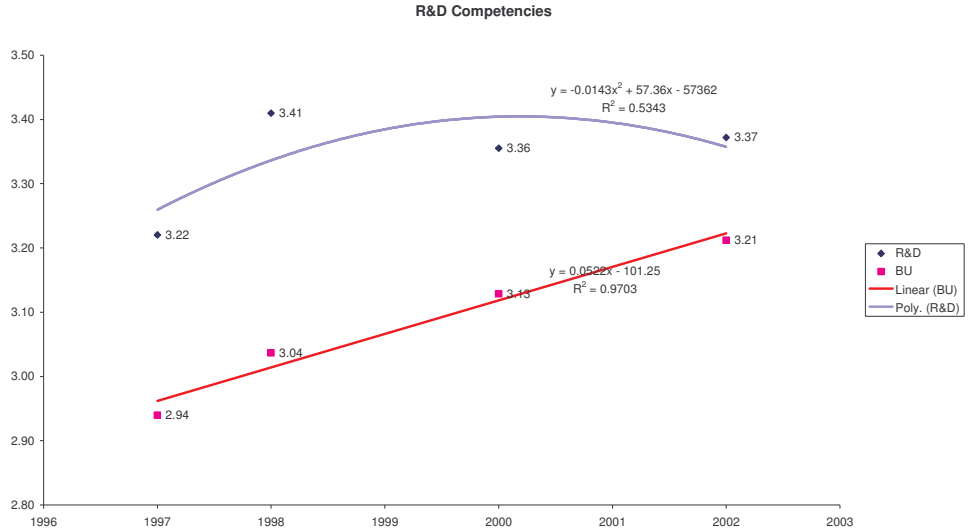

Figure 4. Overall competency level of corporate R&D
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

As was explained in section 3, the variable R&D competency is composed of two elements: an assessment of the importance of different R&D objectives and the assessment of the R&D laboratory's perceived performance on each of these objectives. Figure 4 combines these data in the overall competency level. The longitudinal data show a steady progress in the laboratory's

overall competency level as perceived by its customers, and the R&D staff self-assessment remained constant. This means, that after four successive surveys, the gap between the BU assessment and the R&D staff self-assessment has gradually disappeared.

The results on R&D responsiveness show a similar pattern as those for strategic alignment and R&D competencies, namely a clear tendency of rising Business Unit assessment, and closing of the gap between Bu and R&D assessment. In the item shown in figure 5 (ease of incorporation of BU projects in the corporate R&D portfolio), the gap between the BU and the R&D assessment has even reversed, indicating that The BU customer assessment has become higher than the R&D staff self assessment. This means, that it has become much easier for BU customers to get their projects incorporated in the R&D portfolio.

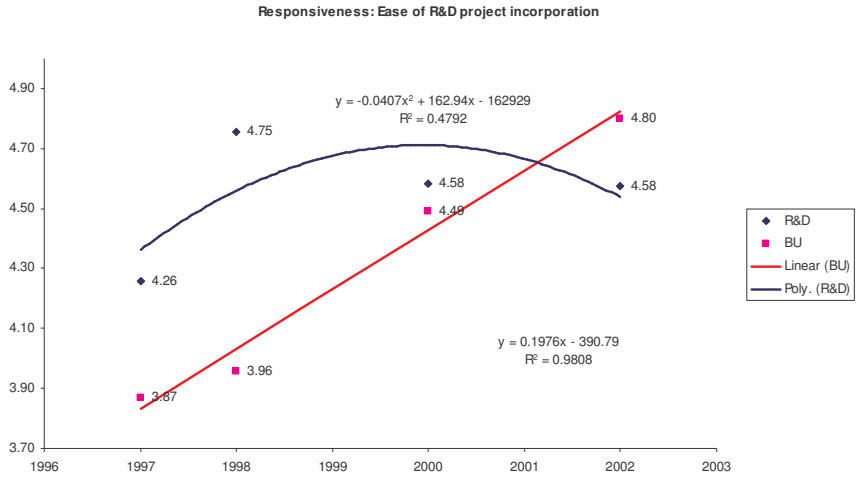

Figure 5. R&D responsiveness, ease of incorporation of R&D projects
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

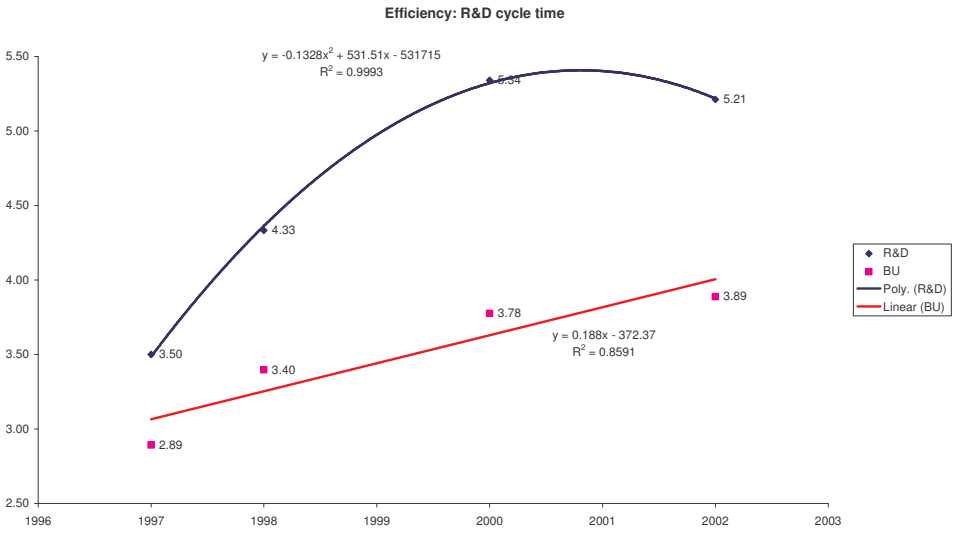

Figure 6. Timeliness of Project Execution, R&D cycle time
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

The results on timeliness show a positive, but much weaker trend in BU perception than on the former aspects. Figure 6 shows a representative item: the assessment of R&D project cycle time. The trend in the Business Units assessment clearly indicates that the feed back has had its positive effects, but the improvement is only moderate. The gap between the BU and R&D assessment however, has become wider over time, caused by the fact that the self assessment of R&D staff has risen more strongly than that of the BU customers. A possible explanation for this unexpected finding is that after the first survey R&D management has put a lot of effort into improving R&D timeliness by introducing a balanced score card for R&D (see above). R&D staff probably expected that the business units would appreciate their efforts, but the business units apparently just looked at the results.

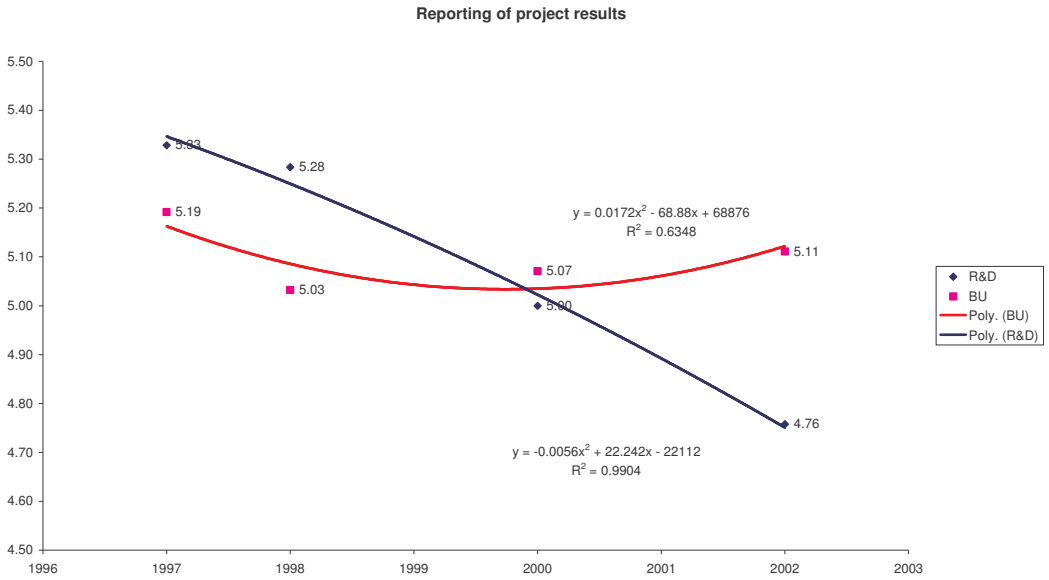

Figure 7. Information exchange, reporting of R&D project results
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

The results on the variable information exchange show an unexpected tendency. The BU assessment on the item clear reporting of project results' remains more or less stable at a level of 5, which indicates a fairly positive judgment on a 7 point scale. The R&D staff self assessment however, declines steadily over the years.

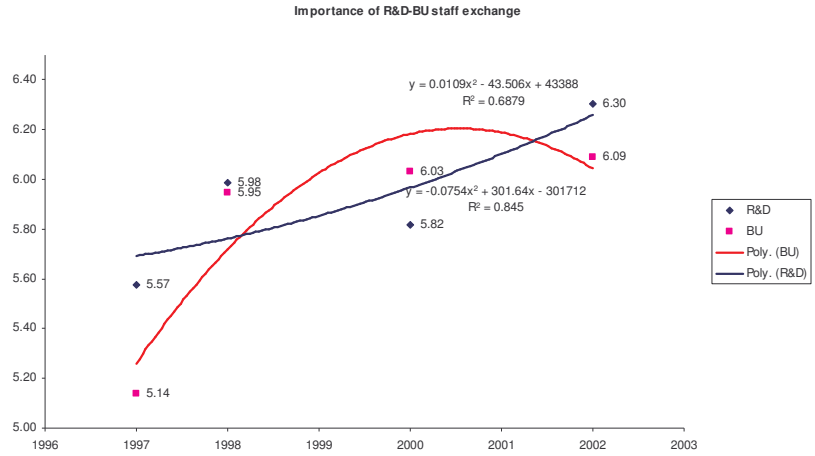

Figure 8. R&D-BU communication, the importance of staff exchange
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

We think this result can be attributed to the fact that the total number of employees of the company, including the R&D staff was reduced in the period under study. For R&D this meant that they could no longer provide the business units with regular detailed update reports on every project, and expected that this would be perceived negatively by their customers in the business units. Apparently these customers did not feel so, thereby indicating that good is good enough.

The questions assessing the importance of direct contact of R&D staff with both internal (BU) and the external (end user) customers show two distinct trends: the divisions clearly value regular contacts with the R&D Center, and their opinion on staff exchange as a means to foster communication has improved over the years (see figure 8). In contrast to this, figure 9 shows, that in the case of direct communication of the R&D staff with the end-users, the gap between the R&D Center and the BU's widens over time. The BU's are clearly not in favor of the idea of R&D staff having regular contact with end-users, independent of the Business Units, their main fear being, that R&D staff will offer solutions to end users, before a commercial price can be negotiated.

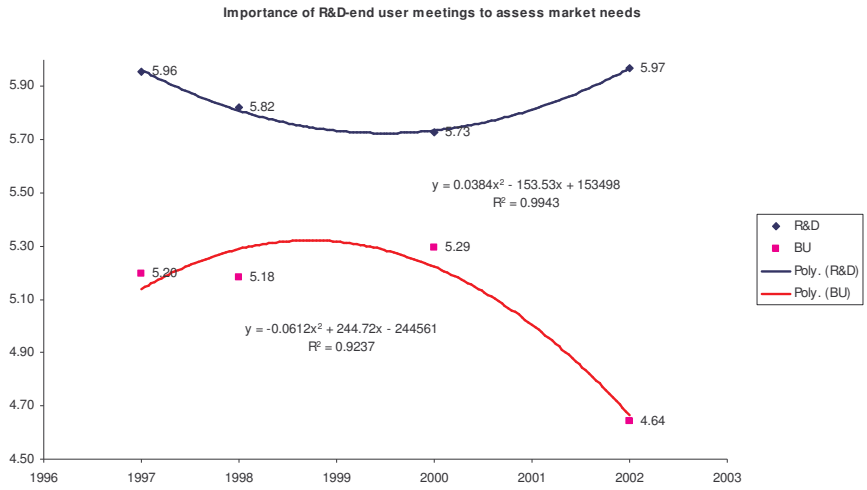

Figure 9. Importance of regular discussion of corporate R&D with end users
Blue line = perception of corporate R&D staff; Red line = perception of HQ/BU customers

5. Discussion and Conclusions

Regarding our first research question: *Which factors determine the strategic network relations between R&D and business?* it can be concluded, that the present study delivered a number of interesting results. The linear regression analysis clearly indicates that these relations are indeed dependent on the factors we derived from theory: governance structure, flexibility and information exchange (from social capital theory) as well as R&D competencies (from the competence perspective). From the longitudinal trend analysis, used to answer our second research question: *How do these network relations develop over time?* it can be concluded, that the variables that came out of the linear regression as the ones most strongly connected with strategic alignment, R&D competencies, and flexibility (responsiveness and timeliness) all show a similar trend over time of increase of BU appreciation and reduction of the initial gap between BU assessment and R&D staff self assessment. It must be remarked however, that the factor information exchange which was the factor least contributing (although still significantly) to strategic alignment, showed no improvement over time. However, since all respondents indicated that communication between R&D and business is important (see figure 8), We think this finding should not be interpreted as a signal that information exchange is not relevant, but rather as an indication that there is an optimum level of information exchange, above which it is not productive to add more. These findings support our first hypothesis: *Improved network communication based on structured feedback related to the level of R&D competencies as well as the level of R&D flexibility and information exchange will raise trust and thus lead to better strategic alignment and ultimately to better performance*. Concerning the hypothesized link between improved strategic alignment and company performance, it is worth noting, that sales figures of the company under study 2 years after the respective surveys show a rise of 22% from 1999 through 2004, although such figures have to be interpreted with some caution, for the obvious reason that they are influenced by many more factors than R&D to business alignment.

Although the introduction of a Balanced Score Card for R&D, and the system of technology road mapping certainly had a positive impact, it was clearly the change in governance structure in

1999, that implied the change in R&D funding from 100% corporate funding to a mixed system of 50% business unit funding and 50 % Technology Board funding, that had the largest impact on strategic alignment (see table 2 and figure 3). This metric shifted the locus of control from the R&D centre exclusively to a joint responsibility of R&D and business. This finding supports our second hypothesis that: *a governance structure which balances the control over the corporate R&D portfolio among all parties involved, R&D, headquarters, and the business units, will create better strategic alignment than one in which only one of the parties (i.e. corporate R&D) has exclusive control*. In management literature and practice there has been a fierce debate if the shift from corporate R&D funding to business unit funding, introduced in many technology-based companies in the 1990s, would not destroy the long-term R&D orientation of these companies. It is concluded that a system that effectively balances the short-term orientation (via business unit funding) and the long-term orientation (via technology board funding) is very effective to provide strategic alignment between R&D and business.

Studies on the management of innovation that build on the competence perspective has proven useful to gain insights in the strategic role of technology in the evolution of firms in competitive, dynamic markets. However, they fail to provide a basis for understanding the internal relationships among R&D and business, which are crucial if a company wants to pursue an effective innovation strategy. We conclude that a network perspective, based on social capital theory that provide the tools to analyze the quality of the internal relations, adds to a more in-depth understanding of the mechanisms at work in the complex R&D-to-business relations in large divisionalized companies.

References

Adler, P.S. and Kwon, S.W., 2002. Social capital, Prospects for a New Concept. AcadeyAcademy of Management Review, 27 (1), 17-40.

Barney, J., 1991. Firm Resources and Sustained Competitive Advantage. Journal of Management, 17(1), 99-120.

Bush, V., 1980, Science, the endless frontier. Arno Press, New York.

Claro, D.P., 2004. Managing business networks and buyer-supplier relationships: how information obtained from the business network affects trust, transaction specific investments, collaboration and performance in the Dutch potted plant and flower industry, Wageningen University and Research Centre, Wageningen.

Coleman, J.S., 1990, Foundations of Social Theories. Harvard University Press, Cambridge MA.

Cooper, D.R. and Emory, C.W., 1995, Business Research Methods. Irwin, Homewood, IL.

Leenders, R.Th.A.J. and Gabbay, S.M. (Eds.), 1999. Corporate Social capital and Liability. Kluwer Academic Publishers, New York.

Lin, N., 2001, Social capital, A Theory of ocial structure and Action. Cambridge University Press, Cambridge.

Nooteboom, B., 1999, Dynamic Efficiency of Networks. In: A. Grandori (Ed.), Inter-firm networks: Organization and industrial competitiveness. Routledge, London.

Nooteboom, B., Berger, H. and Noorderhaven, N., 1997. Effects of trust and Governance Relational Risk. Academy of Management Journal, 36, 794-829.

Omta, S.W.F. and Bras, J., 2000, Design and implementation of the balanced score card in industrial R&D. In: T. M. Khalil and L. Lefebvre (Eds.), 9th International conference on the Management of Technology, Miami.

Penrose, E. T., 1959, The Theory of the Growth of the Firm. Basill Blackwell, Oxford.
Powell, W.W., 1990. Neither market nor hierarchy: network forms of organization. Research in Organizational Behaviour, 12, 295-336.
Ring, P.S. and Van de Ven, A.H., 1992. Structuring Cooperative Relationships between Organizations. Strategic Management Journal, 13, 483-498.
Roussel, P.A., Saad, K.A. and Erickson, T.J., 1991, Third Generation R&D. Harvard Business school Press, Boston, MA.
Souder, William E. and Chakrabarti, Alok K., 1978. The R and D/marketing interface: Results from an empirical study of innovation projects. IEEE Transactions on Engineering Management., 25(4), 88-93.
Watson, G. H., 1993, Strategic Benchmarking, How to Rate your Company's Performance against the World's Best. John wiley and sons, New York.
Wernerfelt, B., 1984. A resource-Based View of the Firm. strategic Management Journal, 5, 171-180.
Zbignew, J. and Pasek, F., 2002, Linking strategic planning with R&D portfolio management in an engineering research centre, 5th International Conference on Managing Innovation in Manufacturing. Milwaukee, Wisconsin, USA.