The impact of The Netchain Laboratory: gaming for insight in netchains

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Abstract:
The netchain laboratory is a new place to experiment with netchains. It focuses on the institutional and socio-economic environment of netchains, and on governance mechanisms in particular. The integration of social and societal factors in the institutional economics theory is studied using real humans playing a role in a simulated netchain. This paper describes the approach on the laboratory and some current experiences. It ends with a discussion on the impact of laboratory for practice in real-world netchains.

Introduction

Fiercer global competition, rapid technology change and choosier customers are forcing firms to seek more efficient production and distribution structures. In recent years, industries have shown increasing collaboration on issues of product development, quality guarantee systems and improved logistics. (Hendrikse, 2003) The concept of netchains (Lazzarini *et al*, 2001) describes these collaborations. It brings together the production-flow and transaction cost oriented approach of Supply Chain Analysis (chains) with the social structure and learning approach of Network Analysis (networks).
Hendrikse (2003) presents a research agenda for the unanswered issue of governance in chains and networks. The netchain laboratory aims to contribute to the answers of the questions: Which coordination mechanisms are used in chains and networks, and why? And: How are relational contracts enforced?

This paper presents the way in which the netchain laboratory tries to answer these questions and results already achieved. It starts with a description of the problem field. This is followed by the methodology used: simulation gaming. Then it describes the theories used in the conceptual framework. The conceptual game is the operational model behind any of the simulation games. This is followed by some games we are using with their experiences and future planning. The paper ends with a discussion on the impact of laboratory for practice in real-world netchains.

Problem field

Doing business is an activity between humans. Individuals represent their company in negotiations, daily operations, conflicts, et cetera. The interaction between these individuals in a chain or network determines the overall conduct. It is the sum of all individuals what determines the overall outcome. Ridley (1996) describes in his book "The origins of virtue" how individual interests can be lowered to make the group stronger, which is in the interest of the individual in return. Game theory offers a mathemathical insight in the difficulties and chances of cooperation. (Axelrod, 1984) Limitations to the action space of the individuals come from the structure of the business environment. Technical limitations, legal systems, societal values and more are beyond the influence of the individual and thus a given structure that limits the number of possible ways of conduct. The conduct leads to a performance both on the individual level, the level of the organization the individual represents and the overall netchain performance.
The focus of netchains implies that we are no longer interested in the best performance of the individual company but concentrate in the best overall performance of the netchain. Questions arises how to keep all the businesses "in the boat" and prevent free-rider behavior. Divisions of profits and costs, risk and responsibility is where governance comes into play. The netchain laboratory focuses on coordination mechanisms, relational contracting, communication and information asymmetry, and aims to contribute to theory on governance. With this theory practice in netchains could be understood and redesign issues could be analyzed better.

Methodology

Frequently used research methods for netchains include questionnaire surveys, simulations and case observations. These methods put emphasis on the quantification of netchain results and empirical testing of model outcomes. (Omta *et al*, 2001). Questionnaire surveys and case observations both are not suited for experiments with configuration or other determining factors in a netchain, as these methods are used to describe an existing or changing situation. Simulation aims to model the real world and predict outcomes of different configurations, technical innovations and incentive schemes, but is hardly able to simulate the complexity of relations between real human beings.

Simulation gaming opens perspectives for this field of research. It combines modeling the real world in a simulation with the social complexity caught in the gaming aspect. The netchain laboratory uses simulation gaming as its main methodology.
Meijer and Hofstede (2003, 1) made an overview of existing simulation games for netchains in the agro and health care sector in the Netherlands. The simulation games of the netchain laboratory proved to be a new extension to the existing simulation gaming method. Most simulation games taking social dynamics in account do not use a 'bounded world model' like these games do. The netchain laboratory games rely on explicitly defined simulations of the real world.

Conceptual Framework

Facilitating research on governance mechanisms and relational contracting, the netchain laboratory uses a conceptual framework of theories. This section describes the theories or concepts used. They stem from economy, management studies and sociology.

Dependencies

Lazzarini *et al* (2001) describe a netchain as a set of organisations linked by three types of interdependencies (Thompson, 1967). They call the organisations 'agents'.

- Pooled interdependency: in this case, interdependency involves discrete or autonomous contributions by loosely coupled agents. It supports a situation of knowledge diversity, where specialized agents exchange knowledge directly or indirectly through products or services that embody such knowledge. The connection between agents tends to be mediated by some underlying technology or organisational mode. No agent is directly dependent on another agent, but it cannot function without the input of the group. A good example is the development of the open source computer operating system Linux. No single programmer is on the critical path of the development of this operating system, and no one would be able to have the whole package himself without the input of the group. Linux is a good example of industry and volunteers working together too. (http://www.osdl.org)
- Sequential interdependency: this involves direct relationships between agents ordered in a serial fashion: one agent's input is another agent's output. Sources of value within such a relationship come from inventory management, logistics and the like to optimise production processes and

operations, and from governance mechanisms to reduce transaction costs and appropriate property rights up- or downstream in the netchain.

- Reciprocal interdependency: this means that one agent's input is another agent's output and vice versa. Consequently, agents are mutually dependent on the choices and actions made by each other. This suggests a situation of strong social ties and dense networks.

Governance

Governance is about the organisation of transactions, and a governance structure consists of a collection of rules, institutions and constraints structuring the transaction between various stakeholders. Governance matters because contracts are in general incomplete. Contractual incompleteness is due to the impossibility to specify everything ex ante. (Hendrikse, 2003)

Powell (1990) distinguishes three types of institutions: the market, hierarchy and network mechanism. The three types are extremes on a continuum; in practice, there exist mixed forms. Diederen and Jonkers (2001) place them at the corners of a triangle (See figure 1)

If people or organisations (agents) meet as independent actors to exchange something in return for something else, we call this a market. An important characteristic is the independence of the agents: they are free to exchange and have no obligations against each other. This mechanism functions well if the market is transparent. In most seller-buyer exchanges there is information asymmetry. Costs and risks associated with this asymmetry largely determine the costs of the market mechanism.

Hierarchy uses an exchange relationship where one actor can determine ex post what the other will do, in exchange for some price that has been concluded ex ante. Once a hierarchical relationship has been concluded, people or organisations do not meet each other as autonomous actors: there is a principal and an agent. Costs of the mechanism, known as agency costs, entail overcoming the information asymmetry and tendency for opportunistic behaviour by monitoring and aligning objectives.

The network mechanism governs exchanges by informal norms. Norms guide the behaviour of groups of actors that entertain long-term relationships. In this relationship the return of an exchange is not yet certain in: whether the occasion will occur where the return should be delivered, what the return actually will be, and often who exactly will deliver the return. Hendrikse (2003) calls contracts between organisations that (partially) rely on this mechanism: relational contracts. The fulfilling of such a contract is on his research agenda. Costs associated with networks are caused by the efforts to maintain a relation.

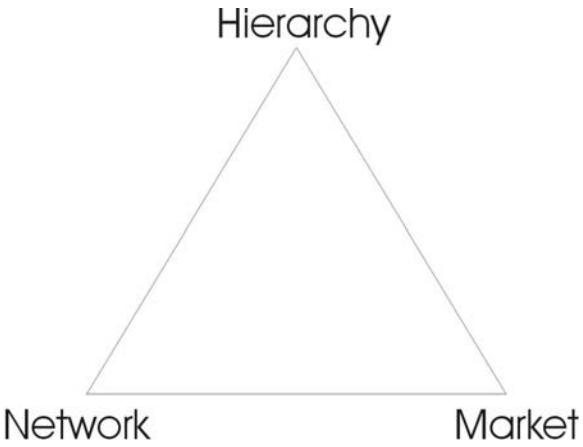

Figure 1: Market institutional mechanisms (Diederen and Jonkers, 2001)

Diederen and Jonkers (2001) distinguish four flows through a netchain: goods, money, information and signals of re-assurance. An exchange between two agents can contain one or more of these flows. The goods and money flows will be present under any governance structure. The information aspect is related to transparency (see below). The signals of re-assurance are related to the network aspect.

Transaction cost economics

A governance mechanism will be chosen, fitting best a netchain or other type of production network, thus incurring the lowest transaction costs. That is the central thought of Transaction Cost Economics (Williamson, 1985). Williamson (1998) applies his thoughts merely to the axis Market – Hierarchy, and situations where a hierarchy is not possible and government has to take over. Menard (2003) extends the transaction cost theory to networks. Hofstede (2004) summarizes this extension. Menard distinguishes four *hybrid* forms of governance, settled between market and hierarchy, called *trust, relational network, leadership* and *formal government*. These are social concepts applied in a concept of transaction costs. Linking these terms to dependencies leads to the conclusion that the transaction costs associated with these four forms of governance are the minimum costs possible to ensure reciprocal and especially sequential interdependencies.

Social and societal factors

Culture and legal systems.

Williamson (1998) recognizes the importance of culture for the performance of businesses. He introduces a four-layer scheme in which the least changing layer is culture and religion, then comes the institutional environment with legal structure of a country and other formal ‘rules-of-the-game’, then the governance structure (the play-of-the-game) and on the fourth level the continuous conduct of the business with resource allocation and employment. Transaction cost economics plays on the third level, but not independent of the first level.
In the netchain laboratory we play games with different cultural groups. Comparing sessions of the same game leads to insight in differences between cultures.

Hofstede (2001) developed culture dimensions to express differences between cultures. Hofstede (2004) applies this to netchains.

Trust and transparency

Food and business scandals led to a growing demand of transparency from consumers and media. Hofstede *et al* (2003, 1) define transparency as *the extent to which all the netchain's stakeholders have access to the information that they request.* This information availability can be assured in various ways, dependent of the type of the relations, the interdependencies, culture of the agents and the governance of the netchain. A key variable is *trust*: a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another. (Rousseau *et al*, 1998). Hofstede (2003, 2) notices a possible contradiction between trust and transparency. Good friends do not need to tell each other information as long as nothing is wrong. When one agent checks another, this may be perceived as distrust. On the other hand, building a shared information system might be a stepping-stone too to form new trust.

Relations

In many sectors traders will not be complete strangers to each other for each transaction. Some people know each other personally, some might be friends and some may have disputes in the past. Uzzi (1997) describes the situation in the New York fashion industry where personal relations are highly important for the functioning of the netchain. Uzzi speaks of embedded ties versus arm's length ties for the closeness of companies. Strategic information about market movements is spread through the embedded ties, thus favoring the closer relations.
Ng *et al* (2003) give the following research argument as central thought for the relevance of research to these information-sharing relations. They argue "Supply chain networks (netchains, SM) are comprised of reciprocal interactions found at different levels of aggregation. The dynamic behavior of these interactions is influenced by social network relations of strong and weak information ties in which such network relations impact the convergence and exploration of network activities."

Conceptual Game

The netchain laboratory uses one conceptual game for all simulation games developed. Each game is an instantiation of (a part of) this conceptual game, suited for the problem of the specific game.
The structure of the conceptual game is the entity-relationship diagram in figure 2. This is a technique most commonly used for database design. A quick explanation and references can be found online at
http://www.smartdraw.com/resources/centers/software/erd.htm.

The conceptual game describes all operational variables in the set of simulation games the netchain laboratory uses. The variables are all relevant entities and aspects that can be counted or distinguished separately found in the conceptual framework. Some concepts

and theories, like culture and relations, cannot be operationalised in such variables and will be used for the interpretation of game sessions afterwards only.
Figure 2 describes the entities with selected attributes.

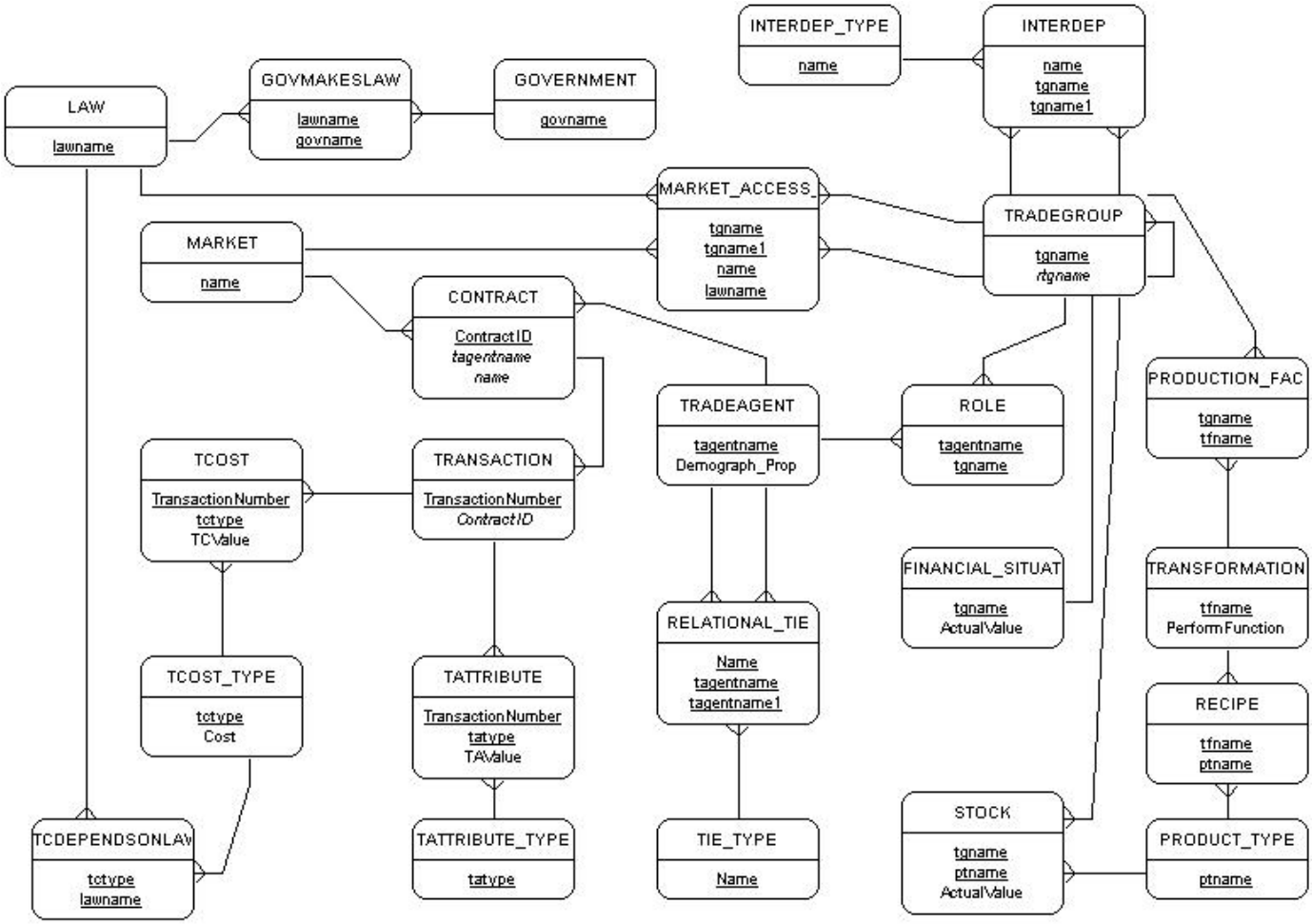

Figure 2: Data model of conceptual game

Table 1: variables of conceptual game

Variable	**Description**	**Relation**	**Theory**	**S/C/P**
Contract	Agreement between two Tradeagents about one or more Transactions in a Market.	Defines transactions Belongs to seller Tradeagent Belongs to buyer Tradeagent Takes place in Market	Governance	Conduct
Financial_Situation	Bank account	Is property of Tradegroup	Economics	Performance
Government	Law making agent	Makes one or more Law	Legal systems	Structure
GovMakesLaw	Defines which Government made a Law	Is done by Government. Makes Law.	Legal systems	Conduct
Interdep	Interdependency between two tradegroups	Tradegroup is first party. Tradegroup is second party. Is of an Interdep_Type	Interdependencies	Structure
Interdep_Type	Type of Interdependency between two Tradegroups. (Pooled, Sequential or Reciprocal)	Defines type of Interdep	Interdependencies	Structure

Law	Rule in the game	Is made by Government Determines TCost_Type	Legal systems	Structure
Market	Place where Contracts are made	Is provided access to via Market_Access_Right. Is place where Contract is made.	Governance	Structure
Market_Access_-Right	The right of a Tradegroup to access a Market	Give Tradegroup access. Gives access to Market	Governance	Structure
Product_Type	Type of Product in game	Is stocked in Stock. Is processed in Recipe		Structure
Production_Facility	Resource to process Stock material in other Stock material	Belongs to Tradegroup. Can perform Transformation_Function		Structure
Recipe	Rule what goes in a Transformation_Function and what comes out of it.	Defines input and output of Transformation_Function. Uses Product_Type		Structure
Relational_Tie	Social tie between two Tradeagents.	Is of type Tie_Type Couples two Tradeagents.	Social	Performance
Role	Defines tasks and responsibilities of Tradeagent in Tradegroup	Belongs to Tradegroup. Is fulfilled by Tradeagent.	Governance	Structure
Stock	Storage of a particular Product_Type for a Tradegroup	Belongs to Tradegroup. Stocks Product_Type		Performance
TCDependsOnLaw	Defines the influence of a Law on a TCost_Type	Law of influence. TCost_Type influenced	Legal system	Structure
Tie_Type	Type of relational_tie between two Tradeagents. (Family, friends, like to do business with each other, etc)	Defines type of Relational_Tie	Social	Structure
Tradeagent	One person making transactions in a role. Among the attributes are demographic properties.	Fulfills Role. Is seller in Contract Is buyer in Contract. Has Relational_Tie(s)		Structure
Tradegroup	Organisation of tradeagents fulfilling roles with one combined performance and shared resources.	Tradegroup is part of larger Tradegroup. Consists of Roles. Has Interdep. Has Production_Facility	Governance Social, Interdependencies	Structure
Transaction	An agreement on exchange of something between two Tradeagents in a particular Market	Happens in Market. Belongs to Contract. Costs TCosts Is specified by TAttributes	Transaction costs, Governance	Conduct
TAttribute	Specification of a transaction	Is of TAttribute_Type. Belongs to Transaction		Conduct
TAttribute_Type	Types of TAttributes in the game. (Diederen and Jonkers, 2001: Goods, Money, Information and Signals of re-assurance.)	Defines type of TAttribute		Structure
TCost	Costs involved with a Transaction.	Is of TCost_Type Belongs to Transaction.	Transaction costs	Conduct
TCost_Type	Types of transaction costs with their price per unit. (Diederen and Jonkers, 2001: Searching, Bargaining, Contracting, Monitoring and Enforcing Contracts)	Defines type of TCost. Is dependent on Law	Transaction costs	Structure
Transformation_Function	The transformation process a Production_Facility can perform on Stock using Recipe	Is done in Production_Facility. Uses Recipe		Structure

The variables are grouped in three groups: structure variables, conduct variables and performance variables, following the approach of Viaene and Gellynck (1995). Following the theory of transaction cost economics, the structure of a netchain should match the conduct of business in the netchain. The performance is the result of it. Variations in the conduct and performance of a netchain point to other influences that are important next to the structure present in the netchain.

Table 1 lists the variables, their relations and place in structure, conduct, performance model.

Netchain laboratory experiences

Trust and tracing game

This simulation game focuses on the relation between information asymmetry, trust and transparency. Participants (Tradeagents) play the role of single representant of producers, middlemen, retailers and consumers (Tradegroups) in a netchain of products with a hidden quality attribute. Sealed envelopes with coded cards quality card (high or low) inside and three different colours on the outside make six product-types available in the game. Meijer and Hofstede (2003, 2) describe the game in more detail. The incentive structure (a.o. Transaction_Costs) behind the game is the so-called Trader's Predicament: a Prisoner's Dilemma-like matrix of consequences of the actions of a seller and buyer. The game uses sequential interdependencies between the tradegroups, because of the dependence on the honesty of the seller to guarantee quality throughout the netchain. Relational ties taken into account are existing friendships, colleagues and reputation (willingness to do new transactions with another).
Until now the Trust and Tracing game is played in 15 sessions, mostly with Dutch groups, but with international groups and American groups as well. Conclusions draw from these sessions are:

1. Culture is a major denominator for the attitude towards transparency. American groups tend to trace upfront, Dutch trace afterwards or not at all.
2. The use of closed envelopes as model of products is recognised as realistic.
3. Relations within a group have major consequences for the governance structures emerging during the session. Friends often favour each other, an example of embedded ties. Reputable people get traced less.

Costa Rica Game

Bargaining power within a Mango or Plantain netchain in Costa Rica is the topic of this game. Participants (Tradeagents) play the parties (Tradegroups) involved in the real-world netchain (overall Tradegroup), including producer associations, multinationals, independent exporters, local retail and Western retail organisations. The game puts the participants in a situation where they have to choose for one of three markets to make contracts. Each of the markets represents a corner of the triangle in figure 1 with the associated number of transactions and transaction costs. The producer and end consumer market are accessible for selected Tradegroups only. (Market_Access_Right).

The game is in the test and validation phase in The Netherlands at the time of writing (March 2004). Field sessions in Costa Rica are scheduled for September and October 2004. Current sessions show differences in the behavior of multinationals compared to independent producers in choice of the market they are in. Strategic alliances between close friends occurred in multiple sessions.

Other cases

A cooperation of the netchain laboratory and the agro technology and food department of Wageningen University should deliver a netchain capable version of the tracking and tracing game. This game focuses on the quality of information management throughout a chain, and is currently restricted to a linear chain. Depending on the chosen attributes of a transaction (like shipping method), the quality of the product decreases faster or slower. (Stock perishes)
The cooperation builds on past experiences with the current game and the conceptual game presented here. The project will be ready for use in April 2004.

Discussion and implications for the real world

The netchain laboratory provides a new place to experiment with netchains. Diederen and Jonkers (2001) consider four sets of exogenous variables relevant for Chain and Network Studies: enabling technologies, consumer market dynamics, spatial constraints and the institutional and socio-economic environment. The netchain laboratory limits itself to the last set of variables and specializes in governance issues between agents in a netchain. The ability to experiment with alternative configurations of a netchain, different incentive schemes and groups of different cultures proved to yield relevant results yet with the Trust and Tracing game. Future games and developments promise new insights in this complex field.
Decision makers in netchain can profit from testing a new design in a laboratory. The use of real traders or managers in a simulated model provides a method to get feedback on a future situation before a costly implementation takes place. Major consultancy firms use simulation gaming for this purpose. Ivo Wenzler (2003) lists the results of 12 cases using this method and finds very good results. The availability of the lab to the field of chains and networks is a new addition.
The impact of the laboratory may go beyond a place for experimenting. The conceptual model integrates many theories and makes aspect systems comparable in one major scheme. The possibility to discuss the consequences of changes in one aspect system on the other parts should lead to a better general understanding of issues in chains and networks. This alone can contribute to better decision-making. Omta *et al* (2001) notice the many isolated parts in science, management and policy making in chains and networks. The laboratory could help to integrate them.
Hutte and Van der Woerd mentioned in their book “Het bedrijfsspel als leersituatie” (The management game as learning environment, SM) in 1965: “It is the hope of the authors that the integration of economy, management education and social psychology will be served by this publication.” Almost 40 years after these words, the netchain laboratory finds itself facing the same task.

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Note: Parts of this paper have been accepted for publication at the 6th International Conference on Chain and Network Management in Agribusiness and the Food Industry, Ede, the Netherlands, 27-28 May, 2004. This includes parts of the conceptual framework and an earlier version of the conceptual game and the netchain laboratory experiences.