Towards Organisational Redesign in EDI Partnerships

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Eburon

TOWARDS
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IN EDI PARTNERSHIPS

(Naar organisatieherontwerp in EDI-samenwerkingsverbanden)

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Preface

This dissertation is about the influence of electronic data interchange (EDI) on the redesign of organisational structures in a partnership. The research comprises a theoretical analysis, resulting in a conceptual framework, and an examination of two empirical cases.

This dissertation would not have been completed without scientific and less scientific support. In the first place I would like to thank the Ph.D committee, and especially dr René Wagenaar and my supervisors prof. dr ir Jo van Nunen and prof. dr ing. Frans van den Bosch. René Wagenaar initiated this research and provided useful comments on draft chapters throughout the process. Jo van Nunen inspected the theoretical considerations and remained alert for practical relevance. Frans van den Bosch played a very important role in later phases of the process, especially concerning the research approach and theoretical directions. I look back with pleasure to the friendly yet professional discussions that I have had with them.

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Hans van der Heijden

1. Introduction

1.1 Introduction

Electronic Data Interchange (EDI) can be defined as the structured and standardised interchange of data between computer applications over an electronic transmission medium. Frequently, although not necessarily, EDI is implemented between different organisations. A common example of an EDI message is a purchase order from a purchase department to one or more suppliers.

EDI offers a number of advantages over other means of communication. For example, EDI is faster and more reliable than media such as fax and mail. These advantages enable a range of opportunities to the organisations implementing EDI. In particular, these opportunities point at the possibilities of redesigning parts of the organisation. In this first chapter, it will be demonstrated that the relationship between EDI use and the design of the organisation is a relevant, yet relatively unexplored research area. The aim of this dissertation is to contribute to this body of knowledge.

This chapter serves as an introduction to the dissertation. Firstly, EDI is defined and its advantages over other means of communication are outlined. The subsequent section discusses a number of classifications that express the opportunities for EDI in organisations. Some relevant prior research is discussed next. This leads to the formulation of the main research problem and the research questions. The remaining part of this chapter describes and justifies the research approach, and gives an outline of the rest of the dissertation.

1.2 Electronic Data Interchange

This section will provide an introduction to EDI. A number of concepts is introduced that will be used throughout the dissertation. In the first part, the definition of EDI will be discussed. Next is an introduction into the stages of EDI integration. Finally an overview of the advantages of EDI over other means of communication is given.

1.2.1 EDI definition

Electronic Data Interchange (EDI) and EDI systems have been subject to a variety of descriptions and definitions. A list of definitions and descriptions of EDI and EDI systems is given in the text box on page 3. The list is not intended to be exhaustive.

Important components of these definitions are the following:

1. *Electronic Interchange*

The transport of data over an electronic transmission medium is central to the concept of EDI. EDI is a communication technology. The focus on communication is opposed to information technologies that primarily aim to process or store data, such as expert systems and databases. Specifically, electronic data interchange takes place by sending and receiving *EDI messages*.

The electronic transmission medium can be proprietary or it can be offered by a third party. Third parties provide their services under the heading of *Value-*

Added Networks (VANs). Besides transmitting data, a VAN may provide additional services, such as encryption and message storage.

> EDI: The electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data. (UN definition)
>
> Systems of this type [...] automate routine transactions between specific buyers and sellers. These are generally the systems that have been categorised as 'electronic data interchange'. (Benjamin et al., 1990:31)
>
> Electronic Data Interchange (EDI) represents one type of inter-organisational information systems, for the transmission of documents such as purchase orders and invoices between business partners, using computers and standard transaction formats. (Bouchard, 1993:365)
>
> Electronic Data Interchange is the inter-organisational, computer-to-computer exchange of business documentation in a standard, machine-processable format. (Emmelhainz, 1993:4)
>
> An EDI system is an information system which exchanges electronically structured and normative data between computers of transaction-related organisations. (Van Heck, 1993:9)
>
> [...] the computer-to-computer exchange of structured data, normally known as EDI (Hofman, 1994:106)
>
> Electronic Data Interchange (EDI) [...] refers to the exchange of documents in standardised electronic form, in an automated manner, directly from an application supporting one organisation to an application supporting another. (Wrigley et al., 1994:219)

2. *Structured*

A distinguishing feature of EDI as opposed to many other communication technologies is that its messages are structured. The messages are structured in order to facilitate the transfer of data from the EDI message into the databases of the in-house information systems. An example of a

communication technology application with unstructured data interchange is video-conferencing, and E-mail.

3. *Standardised*

Another distinguishing feature of EDI is that EDI messages are standardised. The senders and receivers of the EDI messages have agreed upon a specific standard that determines the syntax of the EDI message. Commonly, but not necessarily, the participants borrow standards from standardisation bodies. Examples are the ANSI X.12 standard, and the EDIFACT standard provided by the United Nations.

4. *Organisational boundaries*

Some researchers include "inter-organisational" in their definition of EDI. However, the technology itself is ignorant of organisational boundaries. Although many EDI applications cross organisational boundaries, *intra*-organisational EDI is equally well imaginable. Intra-organisational EDI is sometimes also referred to as *native* EDI. Consider for example the exchange of EDI messages between geographically dispersed departments within large multinationals. Hence, including the adjective "inter-organisational" in the definition of EDI is unnecessarily restrictive.

5. *Purpose*

Some researchers explicitly refer to the purpose of the EDI system. For instance, EDI is used to exchange *business* documents between *transaction-related* organisations. In general however, the purpose of a technology should be avoided in its definition when it is not restricted to that purpose. For example, including *business* documents would exclude EDI messages exchanged by the public sector, such as between health care organisations. Hence, the purpose of EDI or EDI systems should be avoided in the definition.

6. *Infrastructure*

While some researchers argue that the interchange is "computer-to-computer", others argue that it is "application-to-application". The latter is more precise as "application" captures the software component of information systems only whereas "computer" captures the hardware component too. In

an inter-organisational EDI system, the applications with which EDI is exchanged are called "in-house applications" or "in-house information systems".

Reviewing these components, key elements of EDI are electronic interchange and the structure and the standardisation of the EDI messages. The exchange between "applications" is preferred over the exchange between "computers". Finally, the purpose of EDI and whether it crosses organisational boundaries or not are unnecessarily restrictive. Therefore, EDI is defined in this dissertation as:

EDI Definition
The structured and standardised interchange of data between computer applications over an electronic transmission medium.

The collection of applications that exchange EDI messages between each other constitute an information system that is referred to as the *EDI system*. If EDI crosses organisational boundaries, the collection of organisations that exchanges EDI messages is referred to as an *EDI partnership*.
The term *inter-organisational information systems (IOS)* is often used to point out the inter-organisational element of information systems (Kaufman, 1966; Barret & Konsynski, 1982). An inter-organisational information system can be defined as a system "that involves resources shared between two or more organisations" (Barret & Konsynski, 1982:94) or as an "automated information system shared by two or more companies." (Cash & Konsynski, 1985:134; see also Suomi, 1992).
A typical candidate for an inter-organisational EDI system is a purchase order from one organisation to one or more of its suppliers. The purchase order typically contains elements such as the addresses of the organisations, the products that are to be purchased and the expected delivery time. A purchase order with these elements is structured and consequently it can easily be translated into an EDI message. In this example, problems arise when the

organisations use different product codes for the same products. Such problems are solved by standardising the product codes.

Another EDI example is the exchange of product data, both preliminary and final, between engineering, design and manufacturing departments. This class of applications has become known under the term PDI (Product Data Interchange). PDI is subject to specific standards in order to be compatible with CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) applications.

1.2.2 EDI integration

An organisation implementing EDI faces a number of options to integrate EDI with the existing in-house applications. Swatman and Swatman (1991) developed a model that introduces four stages of EDI integration. These stages represent four different options to integrate EDI with the in-house information systems.

1. *Stand-alone PC*

   In this stage, the organisation uses stand-alone PCs to key in the outgoing EDI messages and to receive and print the incoming EDI messages. A printed EDI message receives the same status as an incoming paper-based document.

2. *EDI converter*

   In this stage, the organisation uses an EDI converter to transform incoming EDI messages into input files that its own internal system can interpret and vice versa. There are no fundamental differences between files input from incoming paper-based documents and files created by the EDI converter.

3. *Software integration*

   In this stage, the application possesses EDI conversion software itself and the intermediary step of creating in-house files has been eliminated. This commonly enables organisations to send and receive EDI messages in

(nearly) real-time, rather than to periodically update the application with the input file.

4. *Structural integration*
   This final stage "would result in EDI influencing the functional structure of the organisation and the structure of the supportive information systems within the organisation" (Swatman & Swatman, 1991:5)

The first three stages represent technical solutions towards the integration of EDI with the in-house applications. They are depicted in Figure 1-1.

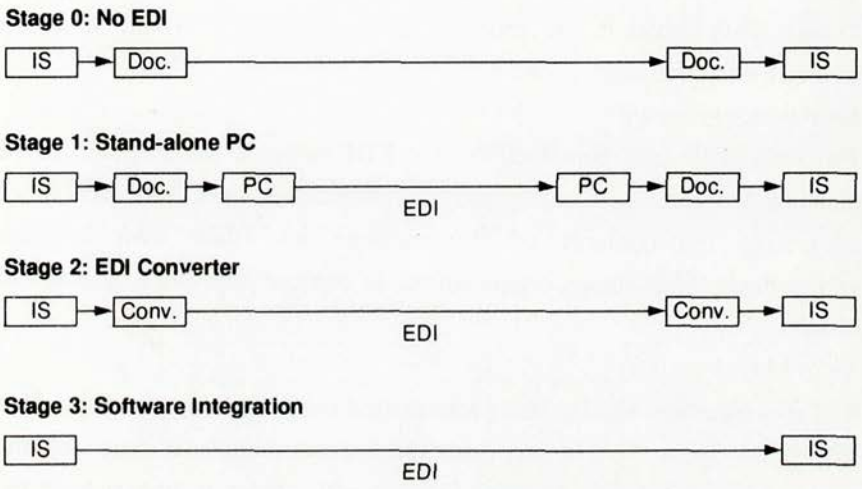


Figure 1-1 Stages of EDI integration
(adapted from Swatman & Swatman, 1991)

The fourth stage, "structural integration", does not refer to the mere replacement of the paper-based documents with EDI. It refers to the way organisations are able to benefit from the advantages that EDI offers through modification of the organisations' structures. It is useful to discuss these advantages of EDI first, before exploring this stage in more detail.

1.2.3 EDI advantages

The advantages of Electronic Data Interchange over paper-based document exchange fall within five categories (see also Hofman, 1989; Sheombar & Wagenaar, 1991; Sheombar, 1992; Scala & McGrath, 1993):

1. *Speed*
   An EDI message is faster than a traditional mail message. An EDI message can transport more data, in less time, to more recipients.
2. *Avoidance of ambiguity*
   Data in the EDI messages is structured and standardised to a specific format. This makes it less prone to ambiguity than it would be in for example a fax message.
3. *Ease of data capture*
   The structured data contained by the EDI message are intended to be machine-processable. Consequently, organisations have less trouble of integrating the contents of the message into their own in-house applications. This allows organisations to capture data once, and at the source.
4. *Reliability*
   EDI messages are usually being transported over third-party Value-Added Networks. These VANs are commonly quite reliable if only for the competitiveness of the industry. Consequently, there is less risk of the message being modified, or even lost.
5. *Cost*
   The exchange of EDI messages is comparatively cheap. Note that communication costs are considered here, in stead of initial investment costs.

1.3 Research problem

EDI has reached widespread use during the end of the eighties and the beginning of the nineties. According to research of Ediforum, an organisation that promotes the use of EDI in the Netherlands, the number of EDI users in the Netherlands increased from 4500 in 1991, to 10 000 in 1992, to 15 000 in 1995. The number of EDI messages they exchanged increased from 42 million to 65 million in 1993. The 1994 number of EDI messages was estimated to be 111 million (Ediforum, 1991; 1992; 1995).

The overwhelming use of EDI in practice was accompanied by an interest of researchers in the performance and organisational impact of EDI. A number of case studies has been described in the literature (see e.g. Rochester, 1989 for an early case study; and Van Tulder & Wagenaar, 1995 for recent cases). Also, classifications were developed to analyse the potential impact and benefits of communication technology.

An early appreciation of the potential opportunities of telecommunications is expressed in the work of Clemons & McFarlan (1986) and Hammer & Mangurian (1987). This work examines the possibilities of communication technology to contribute to a firm's competitive advantage. Clemons and McFarlan (1986) discuss the opportunities of telecommunications by examining the value chain (Porter, 1985). Hammer and Mangurian (1987) present a dedicated classification in order to organise and analyse opportunities for telecommunications.

In a discussion of the potential impacts of inter-organisational communication technology, Cash & Konsynski (1985) use the competitive strategy framework of Michael Porter (1980). A similar approach to illustrate the advantages of information technology in general for competitive strategy is given by Parsons (1983) and McFarlan (1984). Johnston & Vitale (1988) developed a dedicated classification for organisations to achieve competitive advantage through inter-organisational information systems. Worth noting here are also the well-known classifications of Venkatraman (1991, 1994), who maps the application of information technology (including

communication technology) and the degree of business transformation onto the range of potential benefits.

To illustrate these classifications with actual applications, many authors employ the examples of the American Airlines reservation system (for a description see especially Copeland & McKenney, 1988) and the American Hospital Supply order-entry system (for a description see especially Short & Venkatraman, 1992). The use of these same examples over and over again has led to accusations of weak empirical support, and introduced more extensive research to assess the impacts and benefits of EDI on the organisation.

Notable is the publication on the advantages of EDI provided by Benjamin et al. (1990). Benjamin et al. describe and analyse three US EDI cases. Using the case studies they demonstrate that EDI has been employed mainly for efficiency reasons. They note that the organisations are in low stages of EDI integration and that more "mature" systems may be offering more substantial benefits. Two major conditions for EDI success are derived: 1) the existence of industry standards and 2) the firm's ability to manage necessary changes in organisational structure and work processes. With respect to the latter condition, Benjamin et al. conclude that:

> *"Ultimately, the critical factor in determining which firms derive the greatest benefits from EDI will be the ability to manage major changes in work design and organisational structure."* (Benjamin et al., 1990:37).

Venkatraman & Zaheer (1990) assessed the quantifiable benefits of an inter-organisational EDI system between an insurance company and its insurance agents. They could find no support for an improvement in effectiveness and only weak support for an improvement in efficiency. In their analysis, they conclude:

> *"We believe that theoretical models should focus on the following issues: (a) the* structure *of electronic integration (including conditions and characteristics of business relationships [...]) and (b) the* process *of electronic integration (including the roles,*

> *responsibilities, and control of business activities [...]).*" (Venkatraman & Zaheer, 1990:391)

Swatman & Swatman (1992), in discussing their fourth stage of EDI integration (described previously), conclude that:

> "... *while EDI* per se *is not a competitive weapon (except in the very short term), there is immense scope for competitive advantage to be gained from the way in which EDI is integrated into the organisation's structure.*" (Swatman & Swatman, 1992:17)

The argument that the advantages of EDI are well exploited when combined with an organisational redesign is also supported by Bjorn-Andersen & Krcmar (1995). They cross-analyse 14 European EDI cases and conclude that:

> *"The common statement that a successful EDI project requires a complete redesign of traditional business functions [...] is supported by the experiences from our study. Only when new work organisation accompanied EDI and traditional business processes were re-engineered, did we see significant performance advantages."* (Bjorn-Andersen & Krcmar, 1995:323)

At least two important observations can be made with respect to these conclusions. The first is that, among other things, organisational performance appears to be substantially influenced by the relationship between the use of EDI and a potential redesign of the organisation. Hence, this relationship seems relevant and important to further investigate.

The second observation is that the relationship between EDI use and organisational redesign is relatively unexplored. All authors above conclude with the statement that the relationship is important for organisational performance. Few however, if any, give directions as to what the relationship should look like. Given the apparent relevancy of the relationship, there is clearly insufficient insight in the relationship between EDI use and organisational design.

The above observations lead to the main research question of this dissertation:

Research question
What is, or can be, the relationship between EDI use and organisational redesign in an EDI partnership?

In order to answer this research question, the dissertation addresses the following research objectives:

Research objectives
1. To determine the organisational design parameters that are, or can be, influenced by the use of EDI;
2. To develop a preliminary conceptual model that expresses the relationships between these organisational design parameters and EDI use;
3. To extend the model to EDI partnerships and adjust the model if necessary.

1.4 Research method

A research area that is largely unexplored inherently requires a theory building approach (see e.g. Yin, 1989). Opposed to the theory building approach is the theory testing approach. In a theory testing approach, an accepted part of the theoretical body of knowledge of the research area is extracted into hypotheses, and these are more or less rigorously tested. The theory building approach on the other hand aims at developing testable theory: concepts are identified, and relationships between the concepts are drawn. In research areas where this approach is appropriate, the extraction of testable hypotheses is often too premature, and the processes through which theory is developed are inherently less rigorous. Because the research area of this dissertation is largely unexplored, the theory building approach was chosen.
In order to build theory, a theoretical perspective was adopted and empirical data was gathered to confront the conceptual framework derived from literature from this perspective with practical applications. In the first section,

the theoretical perspective is described and justified. The method of gathering empirical data is described and justified in the following section. Finally, the causality of the relationship between IT use (and hence, EDI use) and organisational redesign is discussed.

1.4.1 Theoretical perspective

The first research objective is to determine the organisational design parameters that are, or can be, influenced by the use of EDI. The set of parameters in the framework needs to be selected from a larger subset of design parameters. Since the number of organisational design parameters is substantial, a one-by-one examination of each parameter is hardly practical. A more efficient approach is the examination of design parameters by clusters. Each cluster represents a sub-area in organisational design and constitutes a collection of design parameters that deal with specific parts of the organisation to be redesigned. A widely accepted clustering of design parameters is given by Mintzberg in his book "*The structuring of organisations*" (1979). Mintzberg's clustering is used in this dissertation to examine the areas of design parameters that are, or can be, redesigned with the use of EDI.

The second and third research objective concern the development of a conceptual model that expresses the relationships between organisational design parameters and EDI use in an EDI partnership. In constructing this model, a perspective on organisational design needs to be chosen. In the organisational design literature there are at least five leading perspectives (Stebbins et al., 1995). These are the ABCE/OA&A model (Mackenzie, 1986), the five-track and MAPS technology (Killman, 1977), the information processing approach, the sociotechnical systems school, and the perspective of self-design (Weick, 1979).

The first two perspectives "require the specific consulting services of their authors" (Stebbins et al., 1995:105), which is why they have not been used in this dissertation. The perspective of self-design is relatively new to this field and "general guidelines for choices among IT options are drawn from

sociotechnical systems principles and information processing guidelines (Galbraith)" (Stebbins et al., 1995:107). This leaves us with two remaining perspectives: the information processing approach and the sociotechnical systems approach.

A comparison of the information processing approach and the sociotechnical systems approach is given in Table 1.

Design approach	Information processing	Sociotechnical school
Essence of approach	Coherence or fit	Joint optimisation of social system and technical system
Authors	Galbraith (1977), Nadler & Tushman (1988)	Trist (1982), Pasmore (1988), Taylor & Felten (1993)
Time horizon	1967-present	1948-present
Important design concepts	Task uncertainty, strategic choices, information processing capacity	Systems theory, equifinality, multiskills, autonomous work groups, variance analysis
Design process	Strategic and operational design processes	Numerous action research-based processes
Principles to guide design effort	Extensive	Extensive

Table 1 Comparison of the information processing perspective and the sociotechnical school (cf. Stebbins et al., 1995:106)

Besides summarising the five perspectives to organisational design, Stebbins et al. have also analysed the perspectives on their treatment of information technology variables. With respect to the treatment of information technology in the sociotechnical systems approach the following is remarked:

> "*Information systems are designed to provide feedback, so that employees can detect and respond to variances. Where computer-*

> *controlled equipment is used, the object is to make technology as flexible as the end products to be produced. Information technology, then, is viewed as part of the new flexible technology within the work place.*" (Stebbins et al., 1995:107)

With respect to the treatment of information technology by the information processing approach they argue that:

> *"Information technology is viewed in two ways within operational design: (1) as a part of basic workflow and (2) as a managerial control process or mechanism to facilitate performance of work and control."* (Stebbins et al., 1995:107)

In choosing a perspective for this dissertation, the information processing perspective has been adopted. Key requirements for a well-designed sociotechnical system are *controllability*, *flexibility*, and *quality of working life* (Van der Zwaan, 1990:132). The market requires more flexibility, and the organisation has to respond by flexible production, a flexible work force, and flexible production control. If information technology (and consequently, EDI) is mentioned in the sociotechnical systems literature, its possibilities for improving flexibility, and controllability of the sociotechnical system is mentioned. For example,

> *"In designing a new production system or redesigning an existing system it is currently possible to make that system more flexible than before, as well as to integrate what has been separated previously. One of the means to do this is by using flexible product automation (FPA)."* (Van der Zwaan, 1990:132)

The sociotechnical systems perspective views information technology as contributing to flexible technology, and consequently, it pays more attention to the *technological* capabilities of IT. The technological capabilities however, are not entirely distinctive for information technology. The information processing perspective on the other hand stresses the use of information technology for its potential to improve the *information processing capacity* of the organisation. In doing so, it can aid in various types of work flows and achieve better coordination and control, also in non-

production environments. In other words, the information processing perspective views information technology as one of the core concepts because of its *informational* capabilities. Because the informational capabilities are distinctive for information technology, the information processing approach was adopted in this thesis.

1.4.2 Empirical data

The gathering of empirical material is part of the theory-building approach in this dissertation. The empirical data is not used to test the framework -- given the exploratory state of the research area rigorous testing of the framework using hypotheses is too premature. Rather, the purpose of the empirical material in this thesis is to examine whether the relationships that have been identified are supported in practice. This is done by deriving a number of propositions from the framework. This set of propositions conveys the basic chain of relationships and in doing so address the main research question of this dissertation.

The empirical data that is incorporated in this thesis stems from case study material. The use of cases in comparison with other methods of data gathering has been addressed by Yin (1989). He advocates the use of case studies over other methods of research when the concepts and relationships that matter are not immediately evident, and when these relationships cannot be investigated in an isolated manner. In these situations, only case studies guarantee sufficient depth for the extraction of theory. These situations clearly resemble the research area of this dissertation.

The case study can be used to accomplish at least three aims (Eisenhardt, 1989). They can be illustrative, i.e. used to illuminate a theory. A second use of case studies is to test theory that has been developed. Finally, case studies can be used to build theory. Given the theory-building approach that is applied in this dissertation, the third aim is pursued. The case study material is used to build theory: it is complementary to the use of the theoretical perspectives. The case studies are used to evaluate whether the main concepts that have been identified in theory are supported in practice.

Specifically, this dissertation considers two cases, each representing a typical organisational redesign with EDI. The first redesign is a common one in industrial settings: a case in the redesign of logistical control. The second redesign is a common one in transport: a case in tracking-and-tracing of international cargo transport. The first case was part of the VEDI programme, a stimulation programme set up by the Dutch Ministry of Economic Affairs to stimulate EDI in various industry sectors. Each case has been publicly documented. The case used for this dissertation is documented in Van der Vlist (eds), 1992, on page 287-297 and concerns an EDI partnership consisting of two organisations.

The use of data from this case study can be characterised as secondary analysis. This implies that in using the empirical data the researcher is exposed to a number of dangers. To avoid these dangers, five criteria of the case study should commonly be met (see e.g. Hakin, 1982; Stewart, 1984). These criteria are 1. a relatively neutral purpose, 2. known data sources, 3. adequate time frame, 4. known gathering methods, and 5. consistency with current body of knowledge. These will subsequently be discussed in somewhat more detail.

Secondary material may be subject to strong scepticism when the purpose of the study is to gather data in order to strongly favour one particular statement. This frequently implies that both the selection and interpretation of data may be severely biased by the researchers. It is therefore important that the purpose of the study is comparatively neutral. The purpose of the VEDI programme was to stimulate EDI use. This could imply that the documentation on the use of EDI may be strongly biased towards overly stretched optimism. However, case study descriptions as well as synthesised documentation on the VEDI programme have consistently warned against too much optimism and reflect a dislike for unrealistic expectations with respect to EDI (see e.g. Van der Net & De Bruin, 1992).

A second requirement is the relative objectivity with which the case is written. Secondary material looses credibility when it is not precisely clear where the data came from, what type of data was actually collected, whom it was

extracted from, etc. Data form the VEDI programme in the form of both detailed case study descriptions and interpretative publications are publicly available.

The period in which the data is gathered may be very influential in the final results. The VEDI studies have been carried out relatively recently (1989-1992). There is no indication that the results have been specifically influenced by that period nor that new developments contradict the results documented in these descriptions. A fourth requirement is that the methods used to derive empirical data should be readily available. The VEDI programme coordinators have documented the way they selected the exemplary cases. Their selection criteria were aimed at getting cases from the most representative sectors in the national industry. As a final requirement, reliability of the material should be checked when the secondary research shows some clear inconsistencies with other research. There are no indications that this case study is remarkably different from other case studies.

The second case concerns an EDI partnership with seven organisations. It was conducted by the author using data sources at the organisation that developed the EDI system for the EDI partnership. The sources for this case material have been threefold. In the first place, documentation concerning the EDI project available at the EDI service provider was studied. The documentary sources included specifications of the EDI system, and detailed specifications of the old and new situation both with structured analysis techniques. Also, access to the company's E-mail system was granted. Through this system activities, events, disturbances, and actions concerning the EDI partnership were made accessible to each employee of the EDI service provider. In the second place, interviews with representatives of the EDI service provider in the case were held. The employees interviewed developed the EDI functionality, and visited the EDI partners frequently to install the system and assist in newly implemented procedures. In the third place, the EDI application was tried and examined. It was not possible to approach the organisations in the EDI partnership themselves.

The case describes phase one of a larger project. The first phase took place from July 1992 until June 1993. For the description and interpretation of the case study, the author was allowed to stay three months at the EDI service provider. The author stayed at the EDI service provider from March 1993 until June 1993. During that time, the project was entering a new phase, in which contracts between the EDI service provider and the EDI partnership had to be renewed.

The case study has been described in more detail by the author in an internal report. This report has been confirmed by the EDI service provider. Because this report has been marked confidential, the names of the organisations in the case are not included in the description of the case study in this dissertation.

1.4.3 Causal agency

The causality of the relationship between organisational design and information technology use has been subject to some discussion. Markus & Robey (1988) have analysed the causal agency of the theoretical models found in the literature on information technology and organisational change. They distinguish between three types, or perspectives. The first type of causality is called the *technological imperative*. In the light of this type, technology is viewed as an exogenous force which determines the behaviour of individuals and organisations. The essence of the technological imperative is characterised by the word "impact". In modelling the relationship between IT use and organisational redesign, the technological imperative would require IT use to cause a redesign of the organisation.

The second type is the *organisational imperative*. Using this perspective, the shape of technology is primarily determined by the organisation: the uncertainties of its environment, the complexities of the tasks, etc. The technology is considered to be the dependent variable. In modelling the relationship between IT use and organisational redesign, the organisational imperative would require a redesign of the organisation to cause the use and development of IT.

The third approach, the *emergent* perspective, is a combination of the first and the second. In this approach the variables both influence each other. The specific uses of information technology and the redesign of the organisation are mutually related, and either one of them does not cause the other in a deterministic way. Influences can be distinguished between the variables, while a unidirectional causal agency cannot. There is now awareness and acceptance that the emergent perspective is the most valid way to describe the relationship between information technology and organisational structure (Swanson, 1987; Raymond et al., 1993).

The relationship between information technology and the design of the organisation is similar to the relationship between the formation of strategy and the design of the organisation. Mintzberg (1990) discusses the patterns of this interrelationship and concludes that the emergent perspective applies to this process as well. He illuminates the relationship with the analogy of a person walking:

> *"...structure follows strategy as the left foot follows the right in walking. [...] None takes precedence; each always precedes the other, and follows it, except when they move together, as the organisation jumps to a new position."* (Mintzberg, 1990:69)

Van den Bosch (1993) points out that this pattern is not only valid for structure and strategy, but also for the relationship between the environment and strategy. This relationship is neither determined solely by the environment ('environmental determinism") nor solely by strategy ("strategic choice").

Concluding, the emergent perspective seems to be valid for many relationships that concern strategy, structure, and environment. These relationships also include the relationships between the use of information technology and organisational design. It is for this reason that causal agency from the emergent perspective is assumed throughout this dissertation.

1.5 Dissertation outline

The dissertation is structured in two parts, a theoretical part and an empirical part. Theoretical exploration is documented in chapter two, three and four. Empirical data is documented in chapter five and six. Chapter seven summarises the conclusions and provides recommendations. The following table gives an overview of the purposes, approaches and output of each chapter.

Ch	Title	Purpose	Approach	Output
1	Introduction	Provide introduction to the thesis		Research problem, research method
2	IT use and organisational redesign	Address first research objective, identification of useful parameters	Mintzberg's set of design parameters, prior research on IT use and organisational redesign	Design parameters influenced by EDI use
3	EDI use and organisational redesign	Address second research objective, development of preliminary framework	Information processing perspective to organisational design	Preliminary conceptual framework relating design parameters, EDI use, and organisational performance
4	Organisational redesign in EDI partnerships	Address third research objective, apply fr. work to EDI partnerships	Information processing perspective to design of inter-organisational relationships	Conceptual framework, modified for EDI partnerships, key propositions from the framework
5	EDI enabled redesign of logistical control	Confront framework with practice	Case study description of two-party EDI partnership and analysis of key propositions	Application of framework to two-party EDI partnership
6	EDI enabled redesign in transport	Confront framework with practice	Case study description of seven-party EDI partnership and analysis of key propositions	Application of framework to seven-party EDI partnership
7	Conclusions	Provide conclusions of the thesis		Conclusions, recommendations for further research

2. IT use and organisational redesign

2.1 Introduction

In this chapter the first research objective of this dissertation is addressed: the examination of the organisational design parameters that are, or can be, influenced by the use of EDI. Organisational design parameters can be grouped into a number of clusters, each covering a part of the organisation. The chapter reviews these clusters, their relationship with information technology, and discusses the clusters on relevance to EDI use.

In doing so, a three-step approach will be followed. The first step is to outline a number of clusters in the design of organisations. The configuration by Mintzberg (1979) is used. The second step is to examine the relationships between the parameters in these clusters and the use of information technology. What relationships between IT use and organisational design have been identified in the literature? In order to address this question, relevant prior research to information technology and organisational design is discussed.

The third and final step is to discuss the relationship between EDI use and these clusters. What organisational design areas are relevant in examining the relationship between EDI use and organisational design? Eventually, this chapter will set forward the design parameters that are likely to be relevant to EDI use.

This chapter is organised as follows. Mintzberg's configuration of clusters in organisational design will be given in section 2.2. Prior research on information technology and organisational design will be discussed in section 2.3. Section 2.4 contains a discussion on the relationships between EDI use and organisational design. Section 2.5 contains a summary.

2.2 Organisational design clusters

> *"Every organised human activity [...] gives rise to two fundamental and opposing requirements: the* division of labour *into various tasks to be performed and the* coordination *of these tasks to accomplish the activity. The structure of an organisation can be simply defined as the sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them."* (Mintzberg, 1979:2)

From Mintzberg's perspective, organisational design essentially comprises 1) the division of work, and 2) the achievement of coordination. He proceeds in his 1979 book "*The structuring of organisations*" by further dividing organisational design into four clusters, or "*groups*": 1) the design of positions, 2) the design of a superstructure, 3) the design of lateral linkages, and 4) the design of a decision making system. In each group the collection of design parameters deals with a specific part of the organisation. In this section, the clusters will subsequently be discussed.

The first cluster is the design of positions. The design of positions is concerned with the division and coordination of *tasks* (or *jobs*). The definition of a task is usually left implicit in organisational design. In this dissertation, a task is a set of *activities*. The definition of a task is recursive in the sense that an activity could in turn be a task. Through the introduction of this recursion

it is allowed to compose and decompose tasks until the granularity of the tasks fits the required level of detail. This feature is analogous to *levelled* diagrams in information systems analysis (see DeMarco, 1978, chapter 7; and Yourdon, 1989, chapter 9).

The way labour is divided into tasks and grouped into jobs is the first design parameter in this first cluster, and it is called "job specialisation". For example, people could perform the tasks repetitively or they could perform different tasks towards the completion of the final product. In the first situation, homogeneous tasks are grouped into jobs, whereas in the second situation, heterogeneous tasks are grouped into jobs. The second design parameter is called "behaviour formalisation". This parameter refers to the degree to which tasks and jobs are formalised. The third and final design parameter in this cluster is "training and indoctrination". This parameter refers to the extent to which individuals are trained for their jobs.

The second cluster in organisational design is the design of the superstructure. In Mintzberg's terminology, tasks and jobs are grouped into *units*. Other names for units are *subunits* and *departments*. The structure of the units is called a superstructure. There are two important design parameters involved in Mintzberg's design of superstructure: unit grouping and unit size. Unit grouping is concerned with the homogeneity of the tasks to be grouped into the unit. Unit size is concerned with the size of the departments.

The design of the superstructure also imposes new demands for designing coordination: not only coordination between tasks needs to be achieved but also coordination between the various units that have been composed. Mintzberg groups these control mechanisms in a third cluster: the design of lateral linkages. The two parameters in the design of lateral linkages are the design of planning and control systems and the creation of liaison devices. The first parameter refers to the degree to which budgets are used for planning and controlling units. The second parameter refers to the degree to which the horizontal communication between units becomes manifest. For instance, the degree to which there is institutionalised communication between a marketing and an R&D department.

The fourth and final research area is concerned with the design of the decision making system. The decision making system expresses the allocation of decision authority in the organisation: which units have control over which other units, etc. Mintzberg (1979) gives the following definitions of centralisation and decentralisation:

> *"When all the power for decision making rests at a single point in the organisation - ultimately in the hands of a single individual - we shall call the structure centralised; to the extent that the power is dispersed among many individuals, we shall call the structure decentralised"* (Mintzberg, 1979:181).

Mintzberg defines centralisation and decentralisation in terms of formal power exclusively (p. 181). Two design parameters are in this group: vertical decentralisation and horizontal decentralisation. Vertical decentralisation refers to the delegation of power in the line organisation, whereas horizontal decentralisation refers to the delegation of power in the staff of the organisation. Decentralisation can be *selective*, implying that some decisions are more centralised than others, or *parallel*, implying that most decisions are delegated to the same level.

A summary of these design parameters is given in Table 2. Each design cluster represents design parameters that either: 1. divide and structure labour, or 2. structure coordination between the divided labour, or a combination of both.

Design cluster	Division	Coordination
Design of positions	Tasks, jobs	Tasks, jobs
Design of superstructure	Units	
Design of lateral linkages		Units
Design of decision making system		Jobs and units

Table 2 Division and coordination in four design clusters (cf. Mintzberg, 1979)

2.3 IT use and organisational redesign

In this section, the relationships between IT use and organisational design that have been identified in the literature will be examined. First, some opinions on the stage of this research area are given. Second, an overview is provided of some prior research on IT use and organisational design. This overview is not intended to be exhaustive, but rather to identify major directions in finding the relationship between EDI use and organisational design.

2.3.1 Stage of research

Swanson (1987) has reviewed the research on information technology use in organisation theory. He uses three categories for his review, based on three different units of analysis: the determinants and effects of IT use by an individual *user*, the determinants and effects of IT use by an *organisation*, and the determinants and effects of IT by the *market*. His conclusion is that "existing theory is in general both underdeveloped and badly fragmented" (p. 198). With respect to organisational use of information technology, he concludes that "theory has as yet provided little predictive or explanatory power, and the general picture is one of substantial confusion and contradiction."

Five years later, Kambil (1992) comes to a similar conclusion in examining the effects of "electronic integration" on the design of "information technology mediated exchange relationships". Electronic integration is defined as "those strategies that apply information technology to transform business processes and relations; the business network or the business scope." (p. 6). Kambil examines and reviews theories of electronic integration, i.e. "those that provide *explanations* of the relationships and underlying principles that characterise particular aspects of the electronic integration phenomena" (p. 17, emphasis in original). Kambil arrives at a number of conclusions.

A first observation is that many theories are too "grand", that is, "grand theories provide us with relatively few specific propositions that are sufficiently precise to yield testable hypotheses." (p. 18). Related to this problem is the fact that there is a lack of consensus on key constructs: "while

multiple paradigms may be used to create useful and different images of the phenomena, it also gives rise to a lack of consensus on key constructs or a consistent language to characterise or explain the phenomena." (p. 18)

Kambil also argues that individual theories only limitly and partially explain electronic integration. "Few studies have attempted to integrate across different theories to create a rich explanation, or reconcile the assumptions underlying different theories that pertain to the phenomena." (p. 18) Theory construction is also hampered by the fact that issues of "level" have not been explicitly addressed: "The construction of a multi-level theory of electronic integration is hindered by the lack of consensus on key constructs that are relevant across levels, as well as the lack of a consistent language in the research literature to describe and explain the effects of electronic integration." (p. 19) Finally, he argues that theories are not generative, i.e. they should be: Capable of articulating new forms of electronic integration relations and specifying the principles by which forms are chosen. Existing theories of electronic integration and organisation fail to do this." (p. 19) Although one wonders which discipline *does* posses a theory that meets Kambil's requirements, these harsh conclusions reflect the research on information technology use and organisational design being in an exploratory stage.

Baroudi & Lucas also hold the opinion that the relationship between information technology and organisational redesign has not been satisfactorily addressed yet. Lucas and Baroudi have edited a special issue on information technology and organisational design of the *Journal of Management Information Systems* in the spring of 1994. In their preface to the special edition they write:

> *"For the first thirty years in which organisations deployed information technology (IT), it had limited impact on the design of organisations. In fact, most researchers asked what is the impact of technology on existing structures and attempted to document this, rather than exploring what new structures might be made possible by this new technology.*

> *[...] The kind of technology available to organisations today makes it possible for us to use IT in much more creative and useful ways. Rather than ask what the impact of technology has been after implementing a system, we can, and should, ask how one can use technology to design new kinds of organisations."* (Baroudi & Lucas, 1994:6)

In a subsequent article Lucas & Baroudi attempt to address the problem by introducing a set of information technology variables which can be used in designing organisations (Lucas & Baroudi, 1994). These variables are: virtual components, electronic linking, technological levelling, product automation, electronic work flows, electronic communications, technological matrixing, and electronic customer/supplier relationships. These variables have a relatively low *granularity*. For example, "electronic communications" implies electronic mail, electronic bulletin boards, and fax (p. 15). Also, the variables show a relatively low degree of *orthogonality*. For example, "electronic linking" is set next to "electronic communications", and also implies electronic mail, electronic conferencing. video conferencing, and fax. Both low granularity and orthogonality are symptoms of a research area that is still mainly in an exploratory stage.

Summarising, it can be said that the research area of IT use and organisational redesign has not yet achieved a generally accepted theoretical body. No theoretical framework has yet achieved general acceptance. This lack of theoretical grounding warrants a closer examination of the relationship between IT use and organisational redesign. In the next section, an overview is provided of some prior research. The main objective here is to arrive at some starting points through what variables IT use and organisational design are linked.

2.3.2 Prior research

In order to study the relationship between information technology and organisational design, Pfeffer and Leblebici (1977) surveyed the chief executives of 38 organisations. They found significant correlations between various determinants of organisational structure and information technology.

The results of their study need to be interpreted with caution however, as the information system architecture of the 70's is substantially different from today's. For example, in their analysis they assume that "information technology is expensive" (p. 246) and that there is only one department where "the computer" is located (p. 250).

Pfeffer and Leblebici conclude that "the effect of the computer on organisational structure appears to be still open to question" (p. 258). The explanation given by Pfeffer and Leblebici for the existing relationship between information technology and organisational design is that information technology contributes to the *control* and *coordination* of the organisation. Facilitating the control and coordination of the organisation may managers lead to restructure the coordination mechanisms.

An example of this is given by Allen & Hauptman (1987). Allen and Hauptman analyse the effects of communication technology on the structure of research and development (R&D) organisations. They start their analysis by assuming that R&D organisations can group their tasks in either of two ways: into a *project* organisation or into a *functional* organisation. A functional organisation is one where the individuals are clustered in *similar* technical specialities. A project organisation is one where the individuals are grouped together from *different* technical specialities who are working on a set of related problems.

According to Allen and Hauptman, there are three variables that determine whether a functional organisation is preferred over a project organisation or vice versa: rate of change of knowledge, task duration, and task interdependence. The faster knowledge in a technical specialty is progressing, the more preferable a functional structure is as opposed to a project team. This is because in a functional structure new knowledge is more effectively transferred among peers. Also determinative is the duration of the task, i.e. the time that a person has to spend to solve a specific problem. If this time is relatively long and the person operates in a project team, it is likely that the individual will lose contact with his/her peers, and miss important developments in his/her technical specialty. Finally, the interdependence among the specialities is important: the higher the interdependence, the more

the individuals need to remain in contact and the better a project team would be.

The above analysis is graphically summarised in Figure 2-1a. The three dimensions are set out so as to form a three-dimensional "organisational structure space". Each point in this space represents a set of values for task interdependence, rate of technological change, and task duration. The grey plane in this picture distinguishes the subspace where a functional organisation would be appropriate from the subspace where a project team would be appropriate.

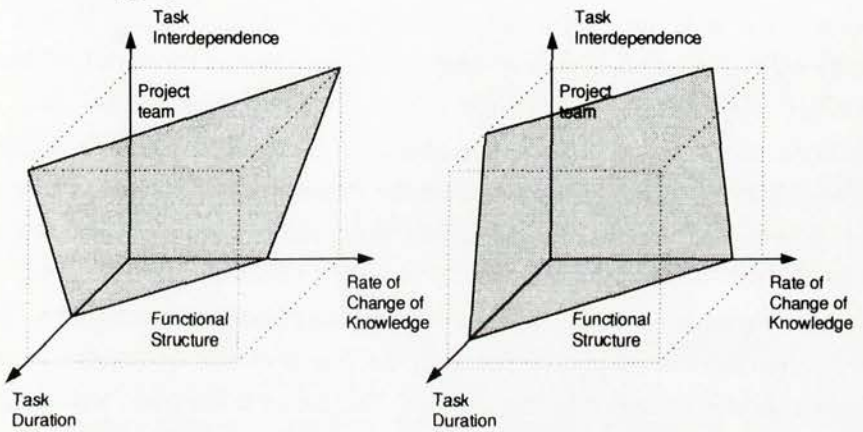


Figure 2-1 Grouping specialities in an R&D organisation
(cf. Allen & Hauptman, 1987:583)

Based on this framework, Allen and Hauptman discuss the effects of communication technology on the structure of the R&D organisation. First, advanced communication technologies may improve the coordination between technical professionals to maintain up-to-date technological know-how. Allen & Hauptman mention science and technology retrieval systems and bulletin boards. In a subsequent article (Allen & Hauptman, 1990), the authors rename this technology to "database for access of scientific and technological literature" (p. 287). Additional, more recent examples can be found on the world-wide web. These communication technologies improve the knowledge transfer for individual professionals. All other things held equal, easier transfer of new knowledge will *decrease* the need for a functional structure in

case task duration is long or rate of change of knowledge is fast. Through the use of these communication technologies, a project team organisation will be feasible for tasks that last longer, and for areas in which technology is more rapidly changing.

A second effect of communication technologies is that it can improve the coordination between the members of a project team. Allen & Hauptman mention sophisticated forms of electronic mail in which forums are organised by topic. More recent examples of these applications include the newsgroups in netnews. These improvements of coordination by information technology decrease the need for the actual instalment of a project team. Within a functional organisation, a project team could be formed electronically. Thus, all other things equal, through the use of communication technologies, a functional organisation will be feasible for tasks that require a higher interdependence. These three effects on the determinants mentioned cause a shift in grouping of technical specialities along the plane that is depicted in Figure 2-1b.

Another example of the improvement of coordination mechanisms by information technology can be found in the fourth cluster of organisational design that was identified in this chapter. The use of information technology to improve centralisation and decentralisation of decision authorities has been reviewed by George and King (1991). They have identified four different theories. The first theory is that the use of information technology will lead to a *centralisation* of decision authority structure. Several empirical studies support this theory, though sometimes with relatively weak results (George & King, 1991:65). The second theory is the opposite of the first: IT use will lead to *decentralisation* of decision authority in the organisation. This theory too has gained empirical support. Given the existence of empirical support for two conflicting theories, a third theory was bound to develop: the theory that there is no relationship between IT use and centralisation or decentralisation. Other factors than IT determine whether decision authority is shifted downwards or upwards in the organisation. Finally, there is a fourth theory, one that turns the cause-effect relationship around. This theory argues that IT

use *reflects*, rather than *shapes* the centralisation / decentralisation policy in the organisation.

George & King attempt to consolidate all four theories by arguing that *managerial action* is determinative for the relationship between IT use and centralisation / decentralisation. This is in line with the third and fourth theory, but not with the first and second. In the first and second theory, structure is determined by information technology, rather than by managers. However, after a closer examination of the work by the proponents of these theories, George and King argue that the first two theories have usually not been articulated in such a deterministic sense as their opponents would have liked them to be.

The managerial action imperative has some limitations as well though. Problems are 1) the assumption that managers are in full control of the entire organisation and 2) the assumption that organisations are structured by managers only and not as a process of adaptation to environmental forces. As both problems are substantial, George & King propose a view that recognises that "...there *can be* a powerful relationship between decision authority structure and information technology, but whether there *will be* depends to a great extent on the particular organisation's context, history, current power structure, management intent, and environment" (p.70).

The possible effects of information technology on changes in organisational design have also been analysed by Huber (1990b). An earlier version of this work (Huber, 1990a) appeared in Fulk & Steinfield (1990). Huber argues that new theory is needed because in recent years information technology has become more sophisticated, and has become more widely used. Examples include the increased use of communication technologies and the increased complexity of decision-aiding technologies. In order to set his theory apart from previous work, Huber terms these technologies *advanced* information technologies. Huber argues that the use of advanced information technologies leads to an increased *information accessibility*. The accessibility of information, in turn, leads to changes in organisational design. Huber develops the theoretical framework that is depicted in Figure 2-2.

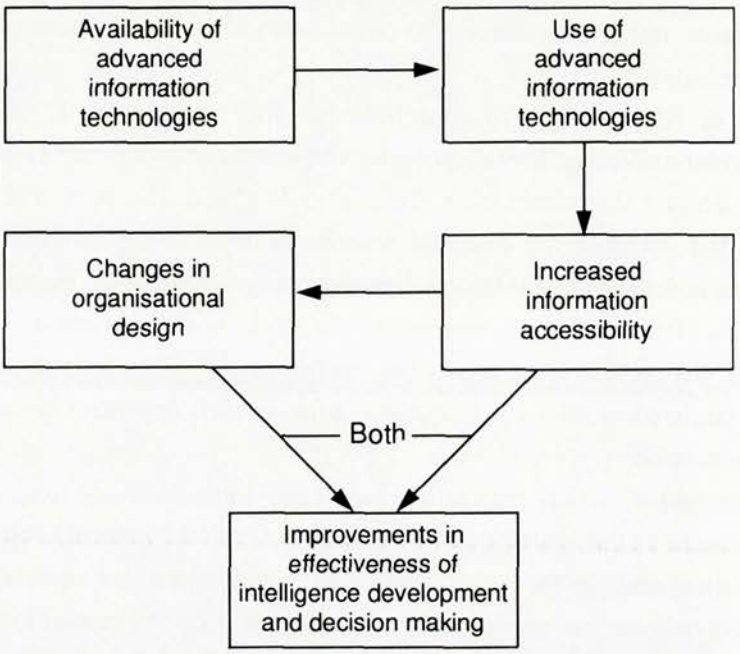


Figure 2-2 Information technology and organisational design (cf. Huber, 1990b:66)

Huber argues that the increased information accessibility brought about by the use of information technology leads to changes in organisational design. Both in turn may lead to improvements in effectiveness. For example, the increased information accessibility in the organisation leads to an increased possibility of decisions being made anywhere in the organisation, at all levels in the hierarchy. This effect might cause centralised organisation to decentralise some of their decisions and decentralised organisation to centralise some of their decisions.

Summarising, an important lesson from this literature is that information technology has the potential to improve *coordination.* Through the increased access of information, organisations are able to change and improve their coordination and control mechanisms. For example, an R&D organisation can build a project team within a functional structure, because the coordination of the units can be improved. As another example, an organisation can decentralise or centralise some of their decisions because information

technology allows it to control and coordinate these decisions more effectively. Here, information technology has an effect on the design of the decision making structure. Concluding this discussion, information technology use potentially influences and changes the coordination mechanisms in organisational design.

Besides the influence on coordination mechanisms that information technology may have, information technology will also have an effect on *formalisation* of organisational processes. Huber (1984; 1986) for example, argues that:

> *"...post-industrial C^2 [computing and communication -- JH] technologies will cause decision processes to be more formalised. This conclusion follows from two lines of reasoning. One is that advanced communication services will increase the accessibility of any source of information, formal or informal. Since the attractiveness of informal information sources is largely a function of their ready accessibility [...] the proportion of information that is formally acquired and processed will increase. [...]*
>
> *The second line of reasoning focuses on routinisation. Today's computers have aided in the routinisation of many decisions, such as inventory re-ordering. It would seem reasonable to believe that, in view of their increased capabilities, computers in the post-industrial society will aid in the routinisation of still more decisions. For both these reasons, then, we expect that in post-industrial organisations decision processes will be more formalised*" (Huber, 1984:937)

Huber argues that communication technologies may convey both formal and informal information. EDI, being a structured communication technology, belongs to the group that conveys formal communication. Following the arguments of Huber, it can be predicted that the use of EDI causes increased formalisation. Since, this prediction is based upon a technological imperative perspective (see chapter 1), and in this dissertation the emergent perspective is preferred, the conclusion is softened to the fact that formal communication technologies influence formalisation.

2.3.3 Scope of organisational design

In the previous section it was illustrated that the use of information technology potentially influences at least the coordination mechanisms of the organisation, and the formalisation of the organisation. Thus, when focusing on EDI use, coordination and formalisation of the organisation need to be taken into account in this dissertation.

However, the demarcation to one specific application of information technology has repercussions for the *scope* of the influence on coordination and formalisation. EDI is only one of many applications of information technology and consequently it influences coordination and formalisation in more modest ways than the use of information technology in general. The more ambitious the design of the organisation becomes, the larger the scope and variety of applications of information technology needs to be in order to have an influence on those designs.

The scope of organisational redesign is expressed by the level of analysis used to express the redesign. Referring to the Mintzberg's four organisational design clusters, it can be argued that each cluster deals with a larger, more ambitious part of the organisation than the cluster that it succeeds. The design of positions is concerned with tasks and jobs only, and thus concerns *task-related,* and *job-related* organisational design. The design of a superstructure and the design of lateral linkages are concerned with units, i.e. collections of tasks and jobs, and is therefore concerned with *unit-related* organisational redesign. Finally, the design of the decision making system permeates many levels of organisational design, but is mainly concerned with the authority distribution over units.

In order to limit the scope of the design, this dissertation considers only the task-related formalisation and coordination of the organisation, and not so much the redesign of formalisation and coordination between jobs and units. While EDI use is able to influence formalisation and coordination of jobs and units as well, it is generally more difficult to be able to isolate the use of EDI from other applications of information technology on these levels of redesign.

In the previous section for example, Allen & Hauptman showed that the application of information technology influences the grouping of units. These

applications however, were databases for access of scientific and technological literature, and sophisticated forms of electronic mail. Neither of these can be considered EDI, although the use of EDI can be a part of these applications. This illustrates that for instance in designing new coordination mechanisms between units, it is difficult to isolate EDI from the other technologies. Other applications of information technology, those that store and process information rather than convey it are needed as well. Thus, should the use of EDI be examined *in isolation of* other information technologies, the scope of the influence on formalisation and coordination is essentially limited. This is why only formalisation and coordination at the organisational task level are adopted in this dissertation.

2.4 Summary

In this second chapter, the first research objective of this dissertation was addressed: the identification of organisational design parameters that may be influenced by EDI use. Based on Mintzberg's work on the organisational design, four organisational design clusters were outlined in this chapter: 1) the design of positions, 2) the design of a superstructure, 3) the design of lateral linkages, and 4) the design of the decision making system. In each organisational design cluster, distinct parts of the organisation are object of study.

In the second part of this chapter, prior research to the relationships between IT use and these organisational design parameters was reviewed. First of all, this led to the observation that the relationships between these variables are not at all clear, and that research shows different, and sometimes conflicting results. This observation further supports the theory building approach chosen in this dissertation.

Nevertheless, from this prior research it can be deduced that information technology potentially influences at least the coordination mechanisms used in the organisation and the degree of formalisation within the organisation. In a discussion on the relevance of these relationships for EDI use and

organisational redesign, the research was limited to task-related organisational design.

In the next chapter a model is developed in which EDI use and the application of these organisational design parameters will be linked.

3. EDI use and organisational redesign

3.1 Introduction

In this chapter the second research objective will be addressed: the development of a preliminary framework that relates EDI use to organisational design parameters. The framework is preliminary because the inter-organisational aspects of design in an EDI partnership are not discussed in this chapter. This chapter assumes that EDI is *native*, i.e. used within organisations to avoid these aspects for the moment. In the next chapter, the preliminary framework will be applied to EDI partnerships, and modifications and adjustments will be discussed.

The previous chapter has illustrated that organisational design parameters can be partitioned in a number of clusters. It was argued that EDI use is at least related to formalisation and coordination at the task level of design. In developing the model for EDI use and organisational redesign, these design parameters are used, and consequently, a large number of design parameters will be left out of the model. The lack of full exposition of these parameters

makes it necessary to apply the *ceteris paribus* condition to the model: thus, all other design parameters are assumed to be held constant.

The chapter is organised as follows. First, the information processing perspective will be described in section 3.2. This perspective distinguishes between variables that create information processing requirements and design parameters that create information processing capacity. These concepts will be reviewed in section 3.3 and 3.4 respectively. The use of EDI as a design parameter is introduced in section 3.4. The preliminary framework is presented and discussed in section 3.5. Finally, a summary is given in section 3.6.

3.2 The information processing perspective

Early organisational design literature has been heavily influenced by "The principles of scientific management", written in 1911 by Frederick Taylor. A frequently cited principle of scientific management is that managers should find the "one best way" of performing a job. The one best way should be formalised and imposed upon all workers. A consequence of this principle is that the structure of the organisation is characterised by a large amount of rules and procedures, and a strict hierarchy in which authority is formally laid down. This type of structure has become known as a *mechanistic* configuration of organisational design.

Based on empirical research, Burns & Stalker (1961) have been among the first to recognise that besides the mechanistic design, a second type of structure proved viable, and sometimes more effective. This type was characterised by a *lack* of rules and procedures, and a lack of formal hierarchy. To differentiate this structure from the mechanistic design, the term *organic* design was introduced. Eleven characteristics of an organic design are outlined in Burns & Stalker, 1961, pp. 119-120. Organic configurations are characterised by informal settings of design parameters, mechanistic configurations are characterised by formal settings of design parameters.

Burns & Stalker viewed the mechanistic structure and the organic structure as two extremes on a continuum. The recognition that both structures could be

effective introduced a *contingency* approach to organisational design. This approach is based upon two premises (Galbraith, 1973:2):

1. There is no one best way to organise;
2. Any way of organising is not equally effective.

In a contingency approach, the question is under what conditions a mechanistic or an organic configuration would be appropriate. Treating the type of configuration as a dependent variable, researchers have identified various independent variables. Notable studies have been the ones by Mohr and Pennings, who studied the effect of tasks and environment respectively.

Mohr (1971) tested the relationship between organisational structure and the complexity of the *tasks* of the organisation. To identify the type of organisational structure, Mohr looked at the style of supervision. An *authoritative* style of supervision reflected a mechanistic configuration, whereas a *democratic*, or a *participative* style indicated an organic one. Mohr gathered data from 144 work groups in 13 local health departments, ranging from groups of custodians and dog catchers to groups of dentists and physicians. He did not find support for the hypothesis that style of supervision was dependent on the complexity of the tasks. In an interpretation of these results, Mohr stated that both structure and complexity do not relate in simple and clear directions, simply because "neither is a unidimensional or even a relatively homogeneous concept." (1971:454). He recognised that task complexity within the groups was of insufficient variety: all tasks were complex to a moderate or high degree. Finally, he pointed at *task interdependence* as an additional task variable that would possibly account for the differences in configuration.

Pennings (1975) investigated 40 widely dispersed branch offices of a large United States brokerage organisation to see whether characteristics of the *environment* had an effect on the type of organisational structure. He found that almost all environmental variables that he identified showed no significant correlations with structure. In an interpretation of this work, Pennings recognised that he had only looked at fairly homogeneous organisations, and noted that the offices did not have a great deal of task interdependency. He suggested that task complexity and task interdependence

could well be determinative for the type of structure, rather than the environment.

One observation from this work is that both task complexity, as well as task interdependency, as well as the environment seem to matter to the type of organisational structure. A second observation however, is that the degree to which each variable has an impact on the type of configuration seems to differ substantially in specific situations. To incorporate this insight into theory, the *information processing* approach to organisational design has been developed. The information processing perspective focuses on the *uncertainty* generated by the tasks and the environment. Tasks and environment resemble different sources of uncertainty and organisations are configured so as to deal with this uncertainty. Galbraith (1973, 1977), a principal proponent of the information processing perspective to organisational design, argues that organisations have to be conceptualised as *information processing networks*: organisations principally need to process information, in order to cope with uncertainty.

Tushman & Nadler (1978; see also Nadler & Tushman, 1988) put forward the information processing paradigm as an integrative concept for organisational design. In doing so, they adopt the ideas of Galbraith on organisations as information processing networks. The tasks and the environment of the organisation constitute the uncertainty facing the organisation. These uncertainty variables create *information processing requirements*. To meet the information processing requirements, the organisation needs *information processing capacity*.

A core principle underlying the information processing perspective to organisational design is that an organisation should *match* its information processing capacity with its information processing requirements in order to be effective. An organisation with *more* information processing capacity than required is ineffective because it spends more valuable resources (time, effort, etc.) than needed. On the other hand, an organisation with *less* information processing capacity than required is ineffective too as it will be less able to cope with the information processing requirements and spend more valuable resources to fix it. Hence, the organisational design challenge is to match the

information processing capabilities with the information processing requirements. This principle is at the core of the information processing perspective on organisational design, and can be depicted by a pair of scales as in Figure 3-1.

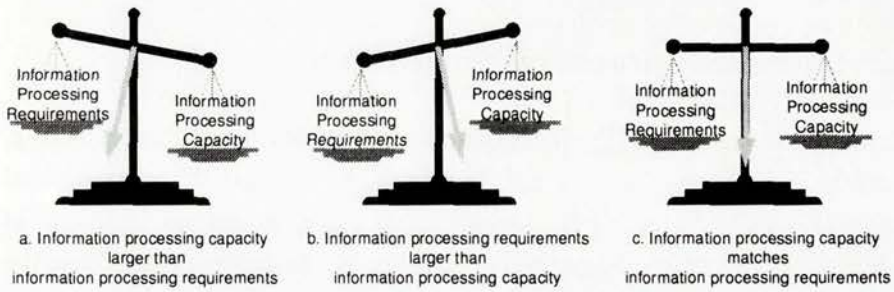


Figure 3-1 Matching information processing capacity with information processing requirements

The relationship between information processing capacity and information processing requirements is known as a *fit* relationship. In a conceptual framework in which variables are grouped and linked, the fit relationship is generally depicted as in Figure 3-2.

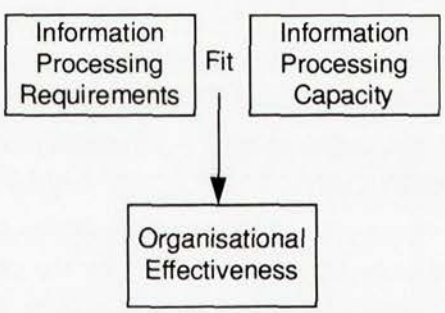


Figure 3-2 Modelling the fit-relationship
(cf. Tushman & Nadler, 1978:622; Nadler & Tushman, 1988:61)

The next sections will expand this conceptual framework to develop a model that relates EDI use and organisational design. In the following section, the

information processing requirements will be examined in more detail. In the subsequent section, the information processing capacity in the framework will be treated. Here also the way the use of EDI can be included in the model will be discussed. Section 3.5 will present the final framework and discuss its potentials and limitations.

3.3 Information processing requirements

Tushman & Nadler (1978) refer to information processing as "the gathering, interpreting, and synthesis of information in the context of organisational decision making" (p. 614). Organisations face a certain amount of information processing *requirements*. Nadler & Tushman (1988) describe information processing requirements as the "need to move information quickly to those who need it" (p. 58) and as the "need to exchange information in order to coordinate efforts and to make necessary adjustments to changes" (p. 59). These more informal descriptions introduce a number of dimensions relevant to information processing, such as speed (time in which information is processed) and effort (energy put in information processing). Following Tushman & Nadler's definition of information processing, information processing requirements are defined in this dissertation as the need to gather, interpret, and synthesize information in the context of organisational decision making.

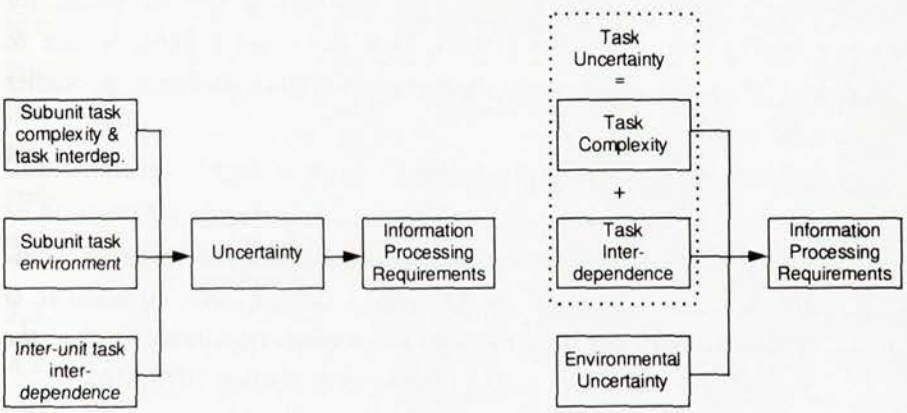
According to the information processing perspective to organisational design, the information processing requirements are determined by various sources of *uncertainty* facing the organisation. A frequently cited definition of uncertainty is the one by Galbraith (1973), who defines uncertainty as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organisation" (p. 5). Nadler & Tushman adapt Galbraith's definition to "a lack of information *about what will occur*" (1988:58, italics added).

Tushman & Nadler's original model for the information processing requirements of the organisation is depicted in Figure 3-3a. In this model, the information processing requirements are determined by uncertainty, which in

turn is based on tasks characteristics, environmental characteristics and subunit interdependence.

Both Tushman & Nadler as well as Daft & Lengel (1986) refer to "departmental interdependence" as a source of uncertainty. In the original model, Tushman and Nadler distinguish between task interdependence between subunits (*inter*-subunit interdependence) and task interdependence within subunits (*intra*-subunit interdependence). In the previous chapter, the research was limited to task-related organisational design. Therefore, only task interdependence will be discussed.

Uncertainty, then, can be partitioned into task uncertainty and environmental uncertainty. Task uncertainty in turn, can be partitioned into task complexity and task interdependence. By excluding the variables that refer to the design of subunits, and by adapting the model to point at task uncertainty and environmental uncertainty, the resulting model can be depicted as in Figure 3-3b. Task complexity, task interdependence, and environmental uncertainty will now subsequently be discussed.



a. Orginal model (Tushman & Nadler, 1978:617) b. Adapted model (preliminary)

Figure 3-3 Information processing requirements

3.3.1 Task complexity

Task complexity can be defined as the degree to which it is possible to predict the outcome of a task in advance (e.g. Nadler & Tushman, 1988:57). In the literature sometimes more specific variables are used to operationalise task complexity. A common operationalisation is the use of "task analysability" and "task variety" (e.g. Bensaou & Venkatraman, 1994). Task analysability refers to the degree to which an objective, computational procedure is used to resolve problems. Task variety is the frequency of unexpected and novel events that occur in the conversion (i.e. the decision) process.

There is little disagreement on the relationship between task complexity and the amount of information processing requirements in the literature. The higher the complexity of the tasks, the less it is possible to predict the outcome of the tasks in advance. The higher the unpredictability of the tasks, the more information processing requirements the organisation is faced with. The less possible it is to predict the outcome in advance, the more the organisation has to exchange information in order to make necessary adjustments to unanticipated events. This relationship can be found for instance in Tushman & Nadler (1978), Daft & Lengel (1986), Nadler & Tushman (1988), and Bensaou & Venkatraman (1994). Tushman & Nadler for example note:

> "*Where the nature of the subunit's work is highly certain, small amounts of information are sufficient [...] Little new information or information processing are required during task performance. Thus, the need for continual monitoring, feedback, and adjustment is minimal, and the information processing requirements for the subunit are relatively small.*" (Tushman & Nadler, 1978:616)

It should be noted here that complex and routine tasks can be defined at different levels. For example, at the highest level the task of a purchase department is complex. Part of this task at lower levels can be routine, for example the writing of a purchase document once the purchase decision has been made. Thus, task complexity is dependent on the level in the hierarchy of tasks that is considered.

The hierarchy of tasks is more or less analogous to the seven-layer ISO OSI reference model (see e.g. Tanenbaum, 1989). This reference model has been introduced to reduce the design complexity of modern computer networks. Using this model, networks are organised as a series of layers, each layer building upon its predecessor. At the lowest levels, hosts communicate by sending raw bits over a communication channel. At the highest levels, they communicate using complex file and terminal protocols. The lowest levels are comparable to tasks with low complexity, the highest levels to tasks with high complexity. Complex tasks build upon routine tasks as higher levels in the OSI model do on lower levels.

Ackoff & Emery's classification of systems (1972) is also instrumental in understanding the way routine tasks and complex tasks interrelate. They distinguish between at least seven types of systems. Focus on those systems that can adapt to the environment by changing structures, three types of systems can be identified: goal-seeking systems, multi-goal seeking systems, and purposeful systems. A goal-seeking system can respond in structurally different ways to structurally different events in one environment. An example is an electronic maze-solving rat. A multi-goal seeking system seeks different goals in at least two different environments. A purposeful system is one that can change goals as well as the structure by which to pursue them. Most familiar examples of purposeful systems are human beings. Each system embodies, but is also more complex than its predecessor, like complex tasks embody routine tasks.

3.3.2 Task interdependence

A second source of task uncertainty is the interdependence between tasks. The literature on task interdependence is predominantly based upon the work of J. Thompson (1967).

Thompson has introduced three different types of interdependence. To clarify the different interdependencies, he adopts the system view on organisations. In this view, organisations are open systems in which the elements are tasks or organisational units. Between the elements within the system, Thompson identifies three types of interdependence (p. 54-55):

1. *Pooled interdependence*
   Pooled interdependence implies that organisational units can perform tasks independent of each other. They do not need to interact with other units in any direct way. Yet they are dependent on each other in the sense that they share (and consequently compete for) the same resources. A diversified firm may illustrate pooled interdependence. Two different branches within a diversified firm may not interact at all, yet each division is be dependent on the other in the sense that they need to share (and compete for) the same corporate resources. For instance, should one branch suffer loss, the other may have to pay for that loss too.
2. *Sequential interdependence*
   Sequential interdependence implies that a task is dependent on the completion of another task. The output of one task is input for the other. An example of a technology supporting sequential interdependence of tasks is a conveyor belt in a manufacturing plant.
3. *Reciprocal interdependence*
   Reciprocal interdependence indicates that tasks are reciprocally dependent on each other. The outputs of each task become inputs for the other. As an example, Thompson offers the operations and maintenance units of an airline company (p. 55). The operations unit needs a serviceable airplane from the maintenance unit, and the maintenance unit cannot start until the operations unit "offers" the airplane needing maintenance.

Mintzberg (1979) has pictured the three types of interdependence as in Figure 3-4.

Thompson explains that organisations with sequential interdependence also contain pooled interdependence, and organisations with reciprocal interdependence contain both pooled as well as sequential interdependence. Organisations with sequentially interdependent tasks do share the same resources, if only because they need to exchange the product. Reciprocally interdependent tasks can be split in two sequentially interdependent ones.

Thompson also argues that each type of interdependence has coordination costs, pooled interdependence the least, reciprocal interdependence the most.

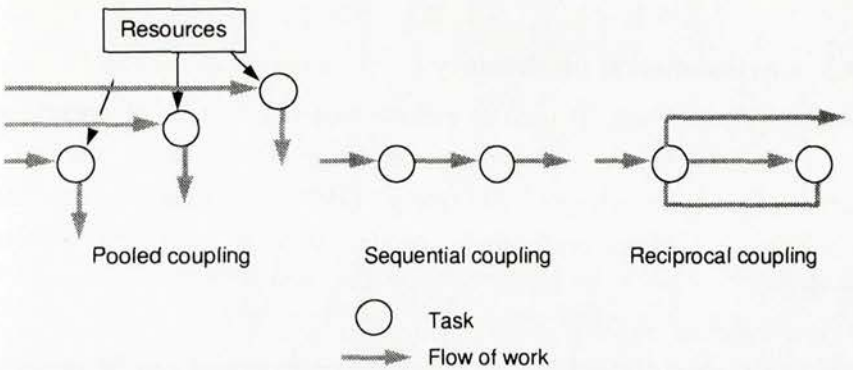


Figure 3-4 Pooled, sequential, and reciprocal coupling of work (Mintzberg, 1979:23, after Thompson, 1967)

From an information processing perspective, pooled interdependence induces the least uncertainty, and reciprocal interdependence the most (Tushman & Nadler, 1978). This is because the degree of interdependence determines the predictability of successful task completion. A task that is only pooled interdependent with another task does not have to rely on another task in order to be completed. Because it does not have to rely on another task, it is also more predictable: less control over the task is outside the scope of the task. Similarly, sequential and reciprocal tasks *do* have to rely on other tasks to proceed. In these situations, the factors that determine the successful completion of the task are significantly, and sometimes even largely outside the control of the task. Therefore, the task becomes more difficult to predict as the interdependence between tasks increases. In the words of Tushman & Nadler:

> *"Task complexity and intra-unit task interdependence are each sources of uncertainty [...] For example, routine tasks or tasks with a minimal amount of intra-unit dependence can be pre-planned, and their information processing requirements are minimal. Complex*

> *tasks, tasks that are not well understood, or tasks which involve reciprocal interdependence, cannot be preplanned and are associated with greater uncertainty."* (Tushman & Nadler, 1978:615)

3.3.3 Environmental uncertainty

The term "environment" is used to indicate external sources of uncertainty. The uncertainty of the environment can be expressed by a number of determinants. For example, Mintzberg (1979) introduces two main dimensions of environment: environmental stability and environmental complexity.

1. *Environmental stability*
   Stability refers to the degree to which the environment can be predicted. On the one extreme of the continuum are stable environments, on the other extreme are dynamic environments. It should be emphasised that "dynamic" is not the same as "rapidly changing". Rapidly changing demand patterns can still be called stable as long as they are predictable.
2. *Environmental complexity*
   Environmental complexity refers to the degree to which the environment can be comprehended by members in the organisational units. In case too many changing variables occur in the environment, and too many relationships occur between them, the decision makers can no longer grasp the environment, and consequently uncertainty increases.

Mintzberg also mentions two other dimensions: market diversity and environmental hostility. Market diversity refers to the amount of different markets that the organisation serves. Hostility refers to the degree to which competing organisations act in the environment. As Mintzberg himself points out, hostility can be subsumed into stability (a hostile environment is also dynamic) and market diversity can be subsumed into complexity (a diverse environment is also complex).

Environmental uncertainty can also be expressed by environmental *turbulence*, as defined by Ansoff (1988, 1990). Ansoff partitions the level of environmental turbulence in four dimensions (1990:31). The first two

dimensions concern the *changeability* of environmental challenges: these are complexity of the firm's environment, and the relative novelty of the successive challenges which the firm encounters in the environment. The last two dimensions concern the *predictability* of the environment: these are rapidity of change, and the visibility of the future.

All these variables point to certain aspects of environmental uncertainty, that can be defined as the degree to which it is possible to predict the environment in advance. Environmental uncertainty refers to the likelihood that the markets will change unexpectedly. Using similar arguments concerning the relationship between task uncertainty and information processing requirements, it can be concluded that environmental uncertainty positively influences the information processing requirements.

A summary of the determinants of information processing requirements is depicted in Figure 3-5.

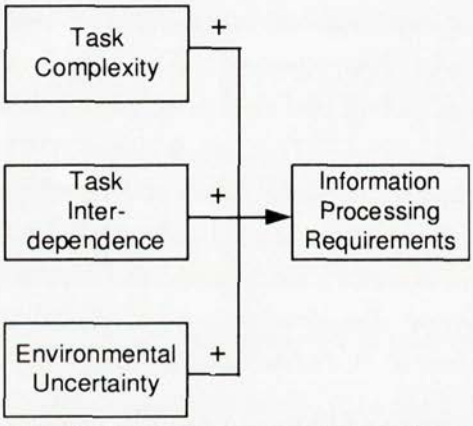


Figure 3-5 Information processing requirements
(+ = ceteris paribus a positive influence)

3.4 Information processing capacity

According to the information processing perspective, the organisational design challenge is to develop a configuration with an information processing capacity that matches the information processing requirements. The

organisational structure is comprised of a number of parameters, each of which can be set to increase or decrease the information processing capacity.

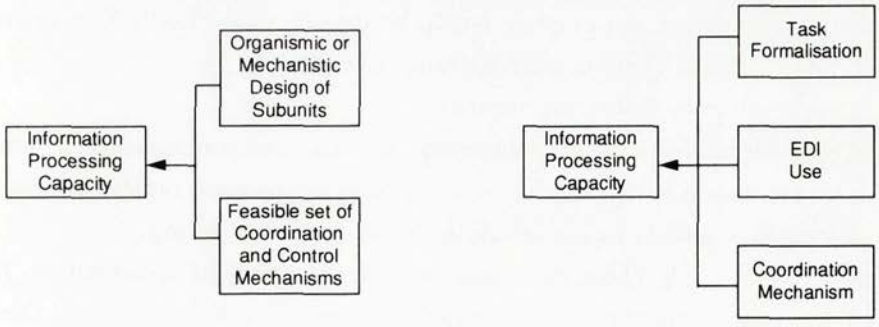
It is interesting to note that a formal definition of information processing capacity could not be found in the literature, although the term is heavily used. Analogously to the definition of information processing requirements adopted in the previous section, it can be conceptualised as the capacity to gather, interpret, and synthesize information in order to deal with uncertainty in the context of organisational decision making.

Tushman & Nadler (1978) argue that a first element in structuring organisations is the structuring of subunits. A second element in the designing of the organisational structure is the design of a feasible set of coordination and control mechanisms. Analogous to organic and mechanistic configurations, Tushman & Nadler distinguish between *organismic* designs and *mechanistic* designs:

> *"These structural terms will be a shorthand way of referring to a larger set of structural variables which frequently covary including: formalisation, centralisation, leadership style, degree of participation, lateral and vertical communication, and distribution of power and control."* (Tushman & Nadler, 1978:617)

In the previous chapter, the formalisation and coordination of tasks were identified as potentially influenced by EDI. These will be discussed in the next sections, as well as their relationship to mechanistic and organic configurations. Among the feasible set of coordination and control mechanisms, Tushman & Nadler included the usage of "formal information systems (e.g. MIS)" (p. 618). Since this dissertation focuses on EDI use specifically, "EDI use" is added as a separate variable influencing information processing capacity.

Figure 3-6 presents the adapted model.



a. Orginal model (Tushman & Nadler, 1978:617) b. Adapted model (preliminary)

Figure 3-6 Information processing capacity

In the next three sections, task formalisation, the coordination mechanisms, and EDI use, as well as their relationship with mechanistic and organic configurations, will subsequently be discussed.

3.4.1 Coordination mechanisms

One important element in the design of organisational structures is the design of coordination mechanisms. Thompson's work *Organisations in action* (1967) provides a theory on how organisations will group their tasks and how tasks will be coordinated. Thompson, after March & Simon (1958), identifies three types of coordination (1967:56):

1. *Standardisation*

   Standardisation indicates coordination by a predefined set of rules. For example, the output of an element in the system can be restricted to A, B, or C. Another element in the system may act either X, Y, or Z according to the predefined set of rules (*if* A *then* X, *if* B *then* Y and *if* C *then* Z). Thompson notes that the situations to which the set of rules applies have to be "relatively stable, repetitive, and few enough to permit matching of situations with appropriate rules" (Thompson, 1967:56)

2. *Coordination by plan*

   Coordination by plan indicates that organisational units use predefined schedules, rather than sets of rules to coordinate their actions. Schedules, or plans, are less rigid than predefined rules and allow for more dynamic

changes in action. An example would be the schedule of unit X to deliver products to unit Y within a certain range of time.

3. *Coordination by mutual adjustment*
   Coordination by mutual adjustment implies that organisational units coordinate their behaviour *during* the actions themselves, rather than using a predefined set of rules or schedules *before* they start acting.

Galbraith (1973, 1977) too examines the different types of coordination. He does not consider coordination by mutual adjustment explicitly as in his view, mutual adjustment is always present as a coordination mechanism. Other coordination mechanisms are only applied in case mutual adjustment is no longer sufficient to coordinate the tasks. Galbraith argues that in that situation essentially four types of coordination mechanisms can be used. These are:

1. *Hierarchy of authority*
   Galbraith argues that hierarchy is among the first mechanisms to be introduced to facilitate the coordination between organisational units. When a hierarchy is introduced, representatives of the organisational units sit together to coordinate the activities, rather than the entire units themselves.
2. *Rules, programs, procedures*
   This coordination mechanism is similar to Thompson's coordination by standardisation, and signifies the specification of the necessary actions in advance of task execution in the form of rules and programs.
3. *Goal setting*
   With this coordination mechanism, organisations set goals or targets for each task. The units themselves then take the decisions and subsume the resources that they think wise. This coordination mechanism is similar to Thompson's coordination by plan.
4. *Narrowing the span of control*
   Galbraith adds this strategy in 1977 as a "next step in coping with task uncertainty" (p. 48). In fact, it signifies an adjustment of the first coordination mechanism, the hierarchy of authority. By reducing the span of control (the number of employees subject to authorisation of a single person), more managers are needed to authorise the same amount of

employees. Middle management is introduced to cope with interdependencies at higher levels. According to Galbraith, "the effect is to increase the number of people who do not do the work" and "the amount of manager's salaries increases" (p. 49).

Mintzberg (1979) combines and synthesises the research on coordination mechanisms and identifies five basic types. These are:

1. *Mutual adjustment*

   Mutual adjustment is the coordination mechanism whereby individuals or organisational units group together to coordinate their work during the execution of a task. This coordination mechanism is similar to Thompson's coordination by mutual adjustment.

2. *Direct supervision*

   Direct supervision is the coordination mechanism whereby "one individual takes responsibility for the work of others, issuing instructions to them and monitoring their actions" (Mintzberg, 1979:4). Direct supervision is similar to Galbraith's coordination by hierarchy.

3. *Standardisation*

   The last three types of coordination involve adjustment before task execution through predefined planning. Mintzberg identifies three types of standardisation.

   A. *Standardisation of work processes*

      The first one is the one where work processes are standardised. It is predefined *how* organisational units accomplish a certain task.

   B. *Standardisation of outputs*

      The second type of standardisation is standardisation of outputs. Here coordination is achieved by specifying to organisational units *what* to achieve. Mintzberg gives the example of a taxi driver, who is told where to deliver a passenger and not which roads to take. This type of standardisation is similar to Galbraith's goal setting.

C. *Standardisation of skills*

The last type of standardisation is the one where skills of the employees are standardised, most notably through education. Coordination is achieved because each organisational unit knows what to expect from another organisational units based on their skills.

The relationships between the coordination mechanisms of Thompson, Galbraith and Mintzberg is depicted in the following table.

Thompson (1967)	Galbraith (1973)	Mintzberg (1979)
Mutual adjustment	-	Mutual adjustment
-	Hierarchy of authority	Direct supervision
Coordination by plan	Goal setting	Standardisation of outputs
Standardisation	Rules, programs, procedures	Standardisation of processes
-	-	Standardisation of skills

The coordination mechanism "direct supervision" implies that a *hierarchy of authority* is installed to coordinate the work. This is strongly related to the concepts of decentralisation and centralisation. Direct supervision indicates that the control over the task is handed over to a supervisor. Since the design of the decision making system is outside the scope of this dissertation, this coordination mechanism will not be treated.

Excluding direct supervision, or the introduction of hierarchy as a coordination mechanism, the remaining coordination mechanisms can be transformed into the variable *"standardisation of coordination"* representing the degree to which coordination is standardised. Settings of the variable "standardisation of coordination" represent a combination of planned, prespecified behaviour and ad hoc decision making. "Mutual adjustment" is the coordination mechanism with the least standardisation. "Standardisation of skills", "standardisation of outputs", and "standardisation of work

processes" are coordination mechanisms with relatively higher degrees of standardisation.

Under what conditions is which coordination mechanism suitable? Thompson asserts that types of coordination increase in complexity as well as in cost. He admits that it is difficult to measure those costs, but speaks in terms of time and effort to achieve a well-coordinated performance. Thompson links the modes of coordination to the three types of interdependence, and asserts that each coordination mechanism is appropriate for a particular type of task interdependence. For reciprocal interdependence, coordination by mutual adjustment is required, for sequential interdependence, coordination by plan would suffice, and for a pooled interdependence, standardisation would be enough. Thus, as the interdependence increases, the level of mutual adjustment increases. In information processing terms, as the level of information processing requirements increase, the level of mutual adjustment increases. This indicates that standardisation of coordination is suitable in situations with low information processing requirements, and mutual adjustment is suitable in situations with high information processing requirements.

Similarly, Galbraith suggests that coordination by rules and procedures is used to free communication channels from repetitive and recurring exceptions. He argues that rules and programs do not suffice any more as the environment and the tasks can not be anticipated upon in a reasonably cost-effective manner.

Mintzberg (1979) argues that:

> *"As organisational work becomes more complicated, the favoured means of coordination seems to shift [...] from mutual adjustment to direct supervision to standardisation, preferably of work processes, otherwise of outputs, or else of skills, finally reverting back to mutual adjustment"* (Mintzberg, 1979:7)

He depicts the application of the coordination mechanisms as in Figure 3-7.

Focusing on environmental uncertainty only, Mintzberg arrives at the conclusion that the more uncertain the environment is, the less coordination by standardisation will be possible and the more organisations will revert to other

means of coordination such as mutual adjustment. Only mutual adjustment is a coordination mode that functions in environments that are highly unpredictable.

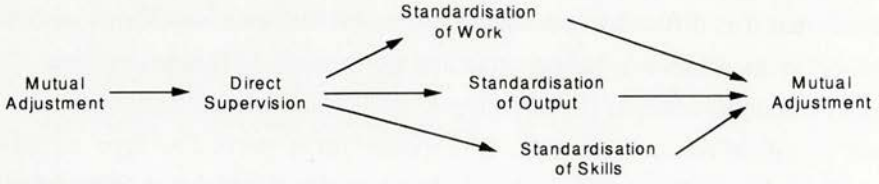


Figure 3-7 The coordination mechanisms: a rough continuum of complexity (Mintzberg, 1979:7)

Environmental uncertainty is, among other things, determined by environmental stability and environmental complexity (Mintzberg, 1979:286). With respect to the use of the coordination mechanisms in stable, simple environments, and dynamic, complex environments, he argues:

> *"Simple, stable environments give rise to centralised, bureaucratic structures, the classic organisational type that relies on standardisation of work processes (and the design parameter of formalisation of behaviour) for coordination. [..] When the dynamic environment is complex, the organisation must decentralise to managers and specialists who can comprehend the issues, yet allow them to interact flexibly in an organic structure so that they can respond to unpredictable changes. Mutual adjustment emerges as the prime coordinating mechanism, its use encouraged by the liaison devices."* (Mintzberg, 1979:286).

One observation from the theories above is that standardisation of coordination is only limitly possible in situations characterised by high information processing requirements. Should it be difficult to understand how tasks interact with each other, the more difficult the prespecification of the interaction will be, ultimately to the extent that it is simply not possible. Example tasks that have high information processing requirements are the tasks of a surgery team (high complexity, and high interdependence), and the

tasks of emergency units (high environmental uncertainty). While these tasks are at least standardised to some extent (the surgery team for example uses standardisation of skills), they also have to rely heavily on mutual adjustment to achieve the necessary coordination. Hence, it can be asserted that increased standardisation of coordination decreases the information processing capacity of the organisation. This assumption is illustrated in Figure 3-8.

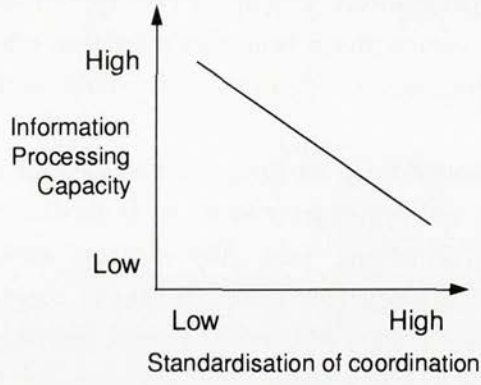


Figure 3-8 The influence of standardisation of coordination on information processing capacity

In this figure, low standardisation of coordination is similar to Mintzberg's coordination mechanism "mutual adjustment". High standardisation of coordination is similar to Mintzberg's "standardisation of work processes".

3.4.2 Task formalisation

According to Mintzberg (1979), who uses formalisation and *bureaucratisation* simultaneously, there are three types of formalisation (p. 81):

1. *Formalisation by job*

   In this case, the organisation specifies in a formal way how the job should be performed. In an insurance company for example, insurance prices for simple insurances (such as travel) can be written down in several rules. These rules describe how the job of underwriting a travel insurance should be performed.

2. *Formalisation by work flow*
   Here, not the job is formalised, but the work itself. Mintzberg gives the example of orchestra musicians, whose part in the organisation is *not* formalised by *how* they perform their music, but rather by *what* to perform, as written down in the music scores.
3. *Formalisation by rules*
   This type of formalisation is a "garbage can" type of sorts, indicating any rule specifying organisational behaviour other than job or workflow. An example of formalisation within this class would be the policy to wear uniforms etc.

Mintzberg explains that there are three main reasons for an organisation to formalise. A first and important reason, is *to facilitate coordination by standardisation*. Formalising jobs implies that work becomes more predictable and more predictable work is easier to coordinate. The second reason to introduce formality is *fairness*. Formal procedures guarantee that each client will be treated equally. This is the reason that governmental agencies are usually severely bureaucratised. The third reason is a *psychological* one and refers to the elegance of formality.

Task formalisation can be defined as the degree to which the task is prespecified. It should be emphasised that the variables task *complexity* and task *formalisation* cannot be equalled: task complexity refers to intrinsic characteristics of the task, formalisation refers to the *effort* of prespecifying these characteristics clearly. Formalisation is a design parameter for organisational design, whereas task complexity is a source of uncertainty.

Formalising work implies explicitly structuring of the tasks and the circumstances that influence it. Task formalisation is mutually related to the standardisation of coordination: in general, the more coordination is standardised, the more tasks are formalised and vice versa. The organisation studies recurring patterns and improves the prespecification of behaviour when these patterns occur. Rules on the way the jobs are performed and rules how they should be coordinated proliferate. The organisation becomes more formal, and more standardised.

The information processing capacity of task formalisation is similar to the information processing capacity of standardisation of coordination. Under very uncertain conditions, standardisation and formalisation are not possible: work can only be formalised when the circumstances are sufficiently certain to grasp in formal rules. Thus, formalisation of tasks is possible in situations where uncertainty, and consequently the information processing requirements are comparatively low. In settings characterised by high uncertainty, there is little possibility for any formalisation of tasks. In those cases, the organisation reverts to less formalisation.

Two assumptions can be derived from this section. First, task formalisation is mutually and positively related to standardisation of coordination. Second, like standardisation of coordination, the level of task formalisation negatively influences the information processing capacity of the organisation. This last assumption is summarised in Figure 3-9.

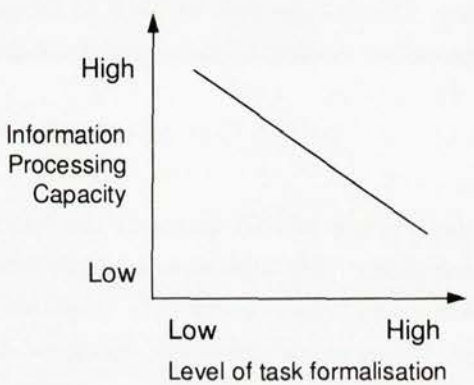


Figure 3-9 The influence of task formalisation on information processing capacity

High degrees of formalisation and standardisation are characteristics of mechanistic configurations. It follows that mechanistic configurations have less information processing capacity than organic configurations. This argument is also supported by Tushman & Nadler (1978) and Daft & Lengel (1986). Daft & Lengel provide an additional rationale for the argument that

organic configurations are better at information processing than mechanistic ones by pointing at an important component of uncertainty: equivocality:

> *"... is similar to uncertainty, but with a twist. Equivocality presumes a messy, unclear field. An information stimulus may have several interpretations. New data may be confusing, and may even increase uncertainty. New data may not resolve anything when equivocality is high. Managers will talk things over, and ultimately enact a solution. Managers reduce equivocality by defining or creating an answer rather than by learning the answer from the collection of additional data."* (Daft & Lengel, 1986:554, after Weick, 1979)

Following Daft & Lengel's explanation, high levels of information processing requirements may have a relatively high component of equivocality in task and environmental uncertainty. These high levels are best solved by organic configurations, because formal configurations are less suitable to process equivocal uncertainty. This is supported by Daft & Lengel, who argue that informal configurations are needed to manage equivocality (managers who talk things over).

3.4.3 EDI use

It can be argued that the use of EDI increases the information processing capacity of the organisation. This is because it allows more data to be more easily, more rapidly, and more accurrately captured by the internal information systems. Therefore, the amount of structured data made available to the organisational information systems, and consequently to the members of the organisation can be increased (see also Huber's model in the previous chapter). This in turn, increases the information processing capacity of the organisation.

This argument is also supported by Tushman & Nadler, who, with respect to the abilities of formal information and communication systems to improve information processing capacity, mention that:

> *"Formal information or communication systems are most amenable when information is quantifiable or formal in nature (e.g. scheduling, forecasting), while lateral relations are most*

> *appropriate for information which is less quantifiable (e.g. informal communication). Thus, there are two complimentary approaches to achieve substantial inter-unit information processing capacity; one is more mechanistic in nature, the other more organismic".* (Tushman & Nadler, 1978:618,619)

Taking into account that the use of formal information and communication technology is "more mechanistic" in nature, it can be argued that EDI use is mutually and positively related to the concepts of task formalisation and standardisation of coordination. EDI is, by definition, a *structured* technology that contains *standardised* data. The fact that an organisation is able to use EDI, indicates that it is possible to structure the information from the tasks that produce it, and that it is possible to structure the information for the tasks that receive it. Furthermore, the fact that an organisation is able to use EDI indicates that it is able to standardise the information exchange between the tasks. These indications do not *necessarily* imply that the organisation has formalised its tasks, and has standardised the coordination. However, since EDI is a formal technology, it is likely to be used in configurations with formal tasks and formal coordination.

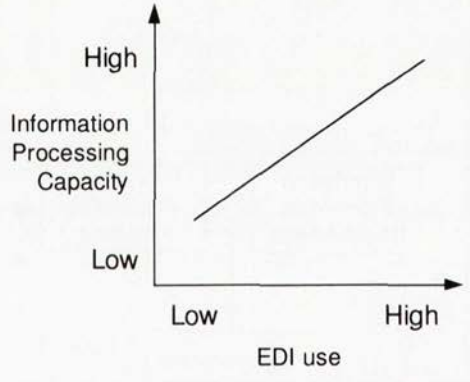


Figure 3-10 The influence of EDI on information processing capacity, (c.p. task formalisation and standardisation of coordination)

In summary, at least two conclusions can be drawn. First, EDI use positively influences the information processing capacity of the organisation. This is depicted in Figure 3-10. Second, EDI use is mutually and positively related to standardisation of coordination and task formalisation. It thus belongs to a *formal* configuration of the organisation.

3.5 A preliminary framework

The perspective chosen in this dissertation is the *information processing approach* to organisational design (cf. Galbraith, 1973; 1977; Tushman & Nadler, 1978). The information processing approach considers *information processing requirements* and *information processing capacity* to be integrating concepts for organisational design. The approach views organisations in terms of information processing systems that are designed to process information, in order to deal with the uncertainty they are confronted with. The design challenge is to balance the degree of information processing requirements with the degree of information processing capacity. The preliminary framework is depicted in Figure 3-11.

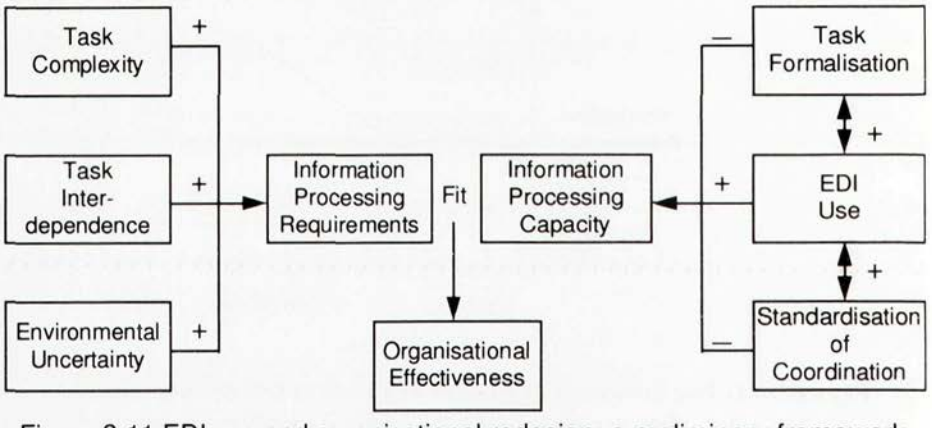


Figure 3-11 EDI use and organisational redesign: a preliminary framework

A novel and important contribution of this model is the introduction of the combined effect of EDI use on the information processing capacity of the organisation. The inclusion of the links between EDI use and formalisation and standardisation cause EDI use to have an indirect negative effect on the information processing capacity of the organisation. This indirect effect arises when the use of EDI is combined with an increased standardisation and an increased formalisation of the tasks. Both the direct effect and the indirect effect produce the combined effect of EDI use on the information processing capacity of the organisation.

The combined effect can be positive when the indirect negative effect does not exceed the direct positive effect. In other words, if EDI use is not combined with a substantial increase in formalisation of the tasks and standardisation of the coordination, the indirect effect is less likely to overshadow the direct effect. In that case, the information processing capacity is increased by the use of EDI. However, if the use of EDI requires the organisation to further standardise the coordination of tasks that was previously a mutual adjustment, the indirect effect may well be larger than the direct effect and consequently, the information processing capacity will be lower.

This contribution is due to the explicit focus on EDI use. EDI is an information technology that by its nature has a structuring and standardising component. This is why its relationship with formalisation and standardisation of rules and procedures is stronger than other information technologies. The use of IT *in general* has little impetus on standardisation and formalisation because many applications of information technology such as for example electronic mail and video-conferencing do support informal communication and the retrieval of informal information. The use of EDI specifically does have strong connotations with rules and procedures, reason why a combined effect can be expressed in the model.

One implication of this argument is that EDI use is less possible (and consequently less useful) in situations with high information processing requirements. If it is used under those circumstances, it can be predicted that it will decrease the information processing capacity of the organisation: the indirect negative effect will overshadow the direct positive effect. This

prediction is supported for example by Daft (1989). Daft points at the comparatively high information processing requirements of managerial tasks, and warns against possible inflexibility of information systems:

> *"Managerial activities are unstructured and constantly changing. Information, to be valuable, must change too. Computer information systems often fail to support management because they are not flexible enough to keep pace. Technology induces standardisation and requires procedures to govern data handling into and out of computers. Once in place, formal information systems have a life of their own and do not easily adapt to the changing needs of users"* (Daft, 1989:337)

The fact that the formal nature of EDI has potentially negative influences on the information processing capacity of the organisation is also supported by Van der Vlist (1988). He mentions for example:

> *"A telematics network is located at the interface between organisations and formalises the way of cooperation. This will imply a restriction of trading freedom and will already because of that be perceived as a threat." (Van der Vlist, 1988:17)*

Besides this contribution of the model, the model is also subject to limitations, specifically concerning the identification of relationships from the model in practice. In doing so, some important difficulties may arise. One difficulty is that the *ceteris paribus* condition that the model assumes is vulnerable when imposed upon organisations in practice. This condition is critical on the right side of the model, where only three of many variables appear. The previous sections have demonstrated that other design parameters, that have not been discussed here, can be identified on the right side. A witnessed change in information processing capacity may not be caused by any of the present variables appearing on the right side, because other design parameters, that are assumed to be held constant in the model, are not held constant in practice. This makes the model vulnerable.

Other difficulties are inherent to the contingency principles that underlie the model. Notably these difficulties have been addressed by Schoonhoven (1981). She discusses the use of contingency theory in organisational research

by taking the information processing model of Galbraith (1973) as object and illustration for her criticism. Her basic argument is that it is hard to draw straightforward propositions from this model, as many fundamental concepts of the theory remain 'hidden' in the language of the contingency researchers. She asserts that

> *"contingency theory is not a theory at all, in the conventional sense of theory as a well-developed set of interrelated propositions. It is more an orienting strategy or metatheory, suggesting ways in which a phenomenon ought to be conceptualised or an approach to the phenomenon ought to be explained."* (Schoonhoven, 1981:350)

Her criticisms are both directed to the vagueness of variables, as well as to the nebulous structure of the propositions relating those variables. The major concept in the theory that causes particular trouble is the concept of fit, and its relationship to the concept of organisational effectiveness.

The concept of fit is an ambiguous and controversial concept. For example, at least *six* interpretations, or *perspectives* on the concept of fit can be identified (Venkatraman, 1989): fit as moderation, fit as mediation, fit as matching, fit as *gestalts*, fit as profile deviation and fit as covariation. Venkatraman discusses the concept of fit in the light of strategy, context and performance. Fit as *moderation* implies that a context variable acts as a moderator between strategy and performance. Fit as *mediation* implies that contingency variables both affect strategy as well as performance. Here, strategy affects performance as well. Fit as *matching* implies that context should match strategy, without specific reference to performance. Fit as *gestalts* implies that *sets* of context variables (e.g. "environment") are matched with *sets* of strategic variables (e.g. "organic structure"). Fit as *profile deviation* implies that strategy should match a specified profile to perform well. Finally, fit as *covariation* implies that strategy variables and contextual variables should be internally consistent. Venkatraman points out that each perspective has repercussions for the way data should be statistically analysed.

Influential in information system research have also been the criticisms by Weill and Olson (1989) on contingency theory. They use a model of contingency theory that is displayed in Figure 3-12.

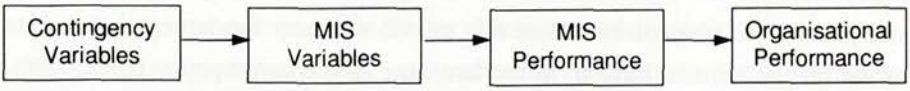


Figure 3-12 Contingency theory in MIS research (Weill & Olson, 1989:63)

Weill & Olson give the following explanation to the model:

> *"The contingency approach suggests that a number of variables influence the performance of information systems; the better the 'fit' between these variables and the design and use of the MIS, the better the MIS performance. Furthermore, there is an assumed 'fit' between MIS performance and organisational performance; in many studies (...) this 'fit' is assumed rather than demonstrated."* (Weill & Olson, 1989:63)

However, this view on the contingency approach is limited because it suggests a linear relationship between contingency variables, MIS variables and organisational performance. A richer contingency approach would suggest that a *fit* between contingency variables and MIS variables would determine organisational performance. Such a fit relationship is absent in the "contingency model" by Weill and Olson. Although Weill & Olson criticise theory for being naive in its deterministic assumptions, the contingency approach apparently assumes less deterministic assumptions than Weill & Olson do like to believe.

Related to the problem of conceptualising fit is the problem of conceptualising organisational effectiveness. It is ill-defined and subject to much discussion. Many times it even remains implicit in the model. For example, in Nadler & Tushman's adapted version of their 1978 model (1988:61), the variable organisational effectiveness has been omitted.

One of the primary reasons why "organisational performance is rarely operationalised" (Weill & Olson, 1989:65) is that, in their view,

> *"performance is a value-laden construct, highly dependent on the position from which it is viewed. In addition, performance is multi-*

> *faceted and has often been simplistically operationalised by one perceptual measure."* (Weill & Olson, 1989:76)

In a similar fashion, Daft (1989) notes:

> *"Overall effectiveness is difficult to measure in organisations. There has been no simple solution. Organisations are large, diverse, and fragmented. They perform many activities simultaneously. They pursue multiple goals. They generate many outcomes, some intended, some unintended"* (Daft, 1989:98).

Thus, organisational performance is a "complex, multidimensional concept that has no single measure" (Daft, 1989:105). Also, the firm ceteris paribus conditions imply that changes in overall organisational performance are difficult to measure and relate to the concepts in the framework.

One solution to circumvent these measurement problems is to witness indicators that indicate a *mismatch* between information processing requirements and information processing capacity. These indicators are both qualitative and quantitative in nature. Tushman & Nadler (1978) suggest that, in general, organic configurations have *more* information processing capacity compared to mechanistic configurations:

> *"While organic structures are able to deal effectively with greater amounts of uncertainty than more mechanistic structures, there are costs associated with this increased information processing capacity. Organismic structures consume more time, effort, energy, and are less amenable to managerial control. Thus, the benefits of increased information processing capacity must be weighed against the costs of less control and potentially increased response time"* (Tushman & Nadler, 1978:618).

Applying the indicators time, effort, energy, and managerial control, mismatches between information processing capacity and information processing requirements are located in this dissertation as follows:

1. Information processing capacity lower than information processing requirements

   This situation can be characterised as an *information processing capacity shortage*. In order to deal with the information processing requirements 1)

too much *time* is needed to process information for unanticipated events, 2) more *energy* is required to process this information, and 3) the number of resources is insufficient. Since a shortage does represent an unbalanced situation, a shift towards more organic configurations to gain organisational effectiveness can be derived and predicted.

2. Information processing requirements lower than information processing capacity

   This situation can be characterised as an *information processing capacity surplus*. In order to deal with the information processing requirements, the organisation has designed a structure that has more information processing capacity than is actually needed, or desirable. Capacity surplus is indicated by 1) there is too much time being spent in the processing of information, 2) there is too much energy being used to process information, 3) too much slack resources are allocated to process information, and 4) managerial *control* is less than adequate. Since a surplus also represents an unbalanced situation, a shift towards more mechanistic configurations to gain organisational effectiveness can be derived and predicted.

3.6 Summary

In this third chapter, the second research objective of this dissertation was addressed: the development of a conceptual framework that relates EDI use to concepts of organisational design. In order to meet this objective, first the information processing approach to organisational design was examined. The information processing approach conceptualises organisations as information processing networks and argues that organisational performance is dependent on match, or "fit" between the information processing requirements that the organisation faces and the information processing capacity of the organisation.

In section 3.3 the information processing requirements that are identified in the literature have been explored. It was argued that these requirements are determined by task uncertainty and environmental uncertainty. Task

uncertainty is commonly decomposed into task complexity and task interdependence. In section 3.4 the design parameters creating information processing capacity of the organisation was further examined. This analysis has led to three assumptions. Firstly, EDI use belongs to a *formal* configuration of the organisation, and is thus positively and mutually related to formalisation of tasks and standardisation of coordination. Secondly, EDI use positively influences information processing capacity. A third assumption on the other hand is that EDI use, by its indirect influence on task formalisation and standardisation of coordination is able to decrease information processing capacity as well. This holds in particular for situations with high information processing requirements.

In section 3.5 the preliminary framework is presented in Figure 3-11. In this section some difficulties in measuring the concept of fit and the concept of organisational performance were discussed, relating not only to unambiguous measurement, but also to the problem of upholding the ceteris paribus conditions. Four indicators were proposed to locate information processing capacity shortage or surplus.

In the next chapter, the third research objective will be addressed: the applicability of the model to EDI partnerships.

4. Organisational redesign in EDI partnerships

4.1 Introduction

In the previous chapter a conceptual model has been developed in which the degree of EDI use was related to organisational design parameters and organisational effectiveness. In this chapter, the third research objective is addressed: to determine the applicability of the model in EDI partnerships and adjust the model if necessary. Additional output of this chapter is a number of propositions conveying the basic line of argument from the final framework.

In order to examine the applicability of the framework in an EDI partnership, it is confronted with another research framework. In this framework, the information processing perspective has been applied to organisational redesign in *inter-organisational relationships*. It is similar to the framework developed in the previous chapter, but has a number of adaptations and extensions. These will be discussed in this chapter.

The next step in this chapter is to examine the adaptations and extensions with respect to EDI partnerships. Certainly not all inter-organisational relationships use EDI, which is why a number of adaptations and extensions

may not need to be included. The framework is positioned against the preliminary framework developed in the previous chapter, and a modified framework is presented.

This chapter is organised as follows. Section 4.2 discusses a research framework that applies the information processing perspective to organisational redesign in inter-organisational relationships. In section 4.3 and section 4.4 the extensions and adaptations of this framework are further discussed. Section 4.5 discusses the suitability of these extensions for EDI partnerships and positions the resulting framework with the framework from the previous chapter. Section 4.6 presents a modified framework and presents a set of propositions. Finally, section 4.7 provides a summary of the findings in this chapter.

4.2 Design of inter-organisational relationships

Bensaou & Venkatraman (1993; 1994) have examined the design of inter-organisational relationships. Applying the information processing perspective to the design of inter-organisational relationships, they arrive at a theoretical framework which is represented in Figure 4-1.

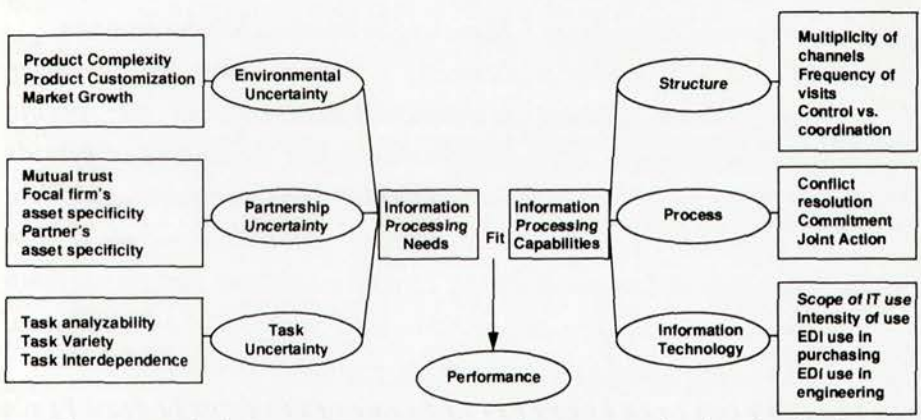


Figure 4-1 An information processing view to organisational redesign in inter-organisational relationships
(Bensaou & Venkatraman, 1993:11)

Figure 4-1 shows, amongst other things, the information processing perspective being applied to the design of inter-organisational relationships. It should be noted that the framework deals with inter-organisational relationships in general, not just with EDI partnerships. The variables "EDI use in purchasing" and "EDI use in engineering" can also take the value of "not present". In the subsequent sections, this framework, as well as the differences between this framework and the one presented in the previous chapter, will be examined in more detail.

4.3 Information processing requirements

A first observation is that inter-organisational relationships are subject to one additional source of uncertainty to the ones described in the previous chapter. Bensaou & Venkatraman have split uncertainty in three groups: task uncertainty, environmental uncertainty and *partnership* uncertainty. Task uncertainty is conceptualised as task variety, task analysability (both constituting task complexity) and task interdependence.

New are different operationalisations of the environment, and, as observed, partnership uncertainty. Bensaou & Venkatraman argue that partnership uncertainty arises "due to one firm's perceived uncertainty about its specific partner's behaviour in the future." According to Bensaou & Venkatraman:

> *"This type has been traditionally subsumed under the two other types, namely: general environmental uncertainty or the specific task uncertainty. (...) However, we recognise the emerge of hybrids (Williamson, 1991), networks (Jarillo, 1988) or partnership-like arrangements both inside (Henderson, 1990) and outside a firm (Johnston & Lawrence, 1988). Hence, we believe that partnership uncertainty should be distinguished from the broader environmental uncertainty and the narrow task uncertainty."* (1993:8)

Three variables represent a source of partnership uncertainty: the focal firm's asset specificity, the asset specificity of its trading partner and the level of mutual trust within the relationship. Mutual trust "is another factor which has been argued to contribute to the reduction of uncertainty about the

opportunistic behaviour by the other partner" (Bensaou & Venkatraman, 1993:9). Both trust and asset specificity are factors representing uncertainty between organisations and not within organisations.

Environmental uncertainty, the focal firm's asset specificity, partner's asset specificity, and mutual trust will subsequently be discussed in the next sections.

4.3.1 Environment

Bensaou & Venkatraman argue that the environmental uncertainty is determined by *capacity, complexity* and *dynamism*. Environmental capacity is defined as "the extent to which the environment can or does support growth" (Bensaou & Venkatraman, 1993:7). Aldrich (1979) has developed the concept of environmental capacity and defines it as "the relative level of resources available to an organisation within its environment." (1979:63). When the environment has rich capacity, a relatively high level of resources is available for the organisation, and consequently, the environment does support growth. When the environment has lean capacity, a relatively low level of resources is available for the organisation. Consequently, market growth is less likely.

Environmental complexity is defined by Bensaou & Venkatraman as "the heterogeneity and range of an organisation's activities" (p. 7). This refers to the degree to which the organisation serves many different markets. Should the organisation serve different markets, its environment is said to be heterogeneous. Should it serve similar markets, its environment is said to be homogeneous.

Finally, environmental dynamism is described as the degree to which the characteristics of the product that an organisation exchanges with its environment changes over time.

In general, the more complex, dynamic, and lean the environment is, the more uncertain it is, and the more information processing requirements it will impose upon the organisations in the inter-organisational relationship.

4.3.2 Asset specificity

Asset specificity refers to "durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated" (Williamson, 1985:55). Williamson (1985:95) identifies four types of asset specificity: site specificity, physical asset specificity, human asset specificity, and dedicated assets. These will be discussed below:

1. *Site specificity*

   Site specificity refers to the degree to which assets are specific because of their immobility. A site-specific asset has large set up and relocation costs. Examples include coal-mines and grain elevators.

2. *Physical asset specificity*

   Physical asset specificity refers to the degree to which the asset is specific because of physical attributes. Examples include very specialised tools or specialised dies.

3. *Human asset specificity*

   Human asset specificity refers to specialised knowledge needed to carry out a transaction.

4. *Dedicated assets*

   "Investments in dedicated assets involve expanding existing plant on behalf of a particular buyer" (1985:96)

Malone et al. (1987) identify another type of asset specificity: "time specificity":

> *"An asset is time specific if its value is highly dependent on its reaching the user within a specified, relatively limited period of time. For example, a perishable product that will spoil unless it arrives at its destination and is used (or sold) within a short time after its production is time specific."* (Malone et al., 1987:486)

Williamson (1991) argues that asset specificity introduces *bilateral dependency*. In the classical market, asset specificity is zero and the identity of the trading partners does not matter. When asset specificity is introduced, partners become bilaterally dependent and consequently they do begin to take

interest in the identity of their partners (see also Williamson, 1985, especially pages 52-56). This is why it can generally be argued that the more asset-specific the investment is to carry out a transaction, the more the activities and "whereabouts" of the partners are known, and the less information processing requirements from the partners this generates.

4.3.3 Trust

Trust is another factor that determines partnership uncertainty. Like asset specificity, the concept can be related to transaction cost economics. An important assumption within transaction cost theory is the presence of opportunism. Opportunism is defined as self-interest seeking with guile (Williamson, 1975). The presence of opportunism in a market causes the transaction to be carried out non-optimally. One solution to the opportunism potential is by developing a relationship in which opportunism is attenuated by trust.

In synthesing research on trust from a wide range of disciplines, Hosmer (1995) arrives at five conclusions about trust. First, trust is generally expressed as an optimistic expectation about the outcome of an event or the behaviour of a person. Second, trust generally occurs under conditions of vulnerability to the interests of the individual and dependence upon the behaviour of other people. Third, trust is generally associated with willing, not forced, cooperation. Fourth, it is generally difficult to enforce. Five, trust is generally accompanied by an assumption of an acknowledged or accepted duty to protect the rights and interests of others.

Trust implies goal congruence between the organisations, some commonality of purpose (Ouchi, 1980). Goal congruence reduces opportunistic tendencies. Thorelli (1986) defines trust as the "assumption or reliance on the part of A that if either A or B encounters a problem in the fulfilment of his implicit or explicit transactional obligations, B may be counted on to do what A would do if B's resources were at A's disposal." (p. 38)

Koenig & Van Wijk (1994) argue that trust is an

> *"informal mode of control governing mutually identified actors. It reduces uncertainty regarding mutual behaviour through a process*

> *of self-control. The trusting party develops mostly implicit anticipations regarding the trusted party's behaviour. Aware of the anticipations regarding its general conduct, the trusted party becomes "trust-worthy" if it feels the obligation to fulfil these anticipations. The combination of anticipation and obligation yields an effective informal mode of coordination. In addition, the existence of trust in a relationship gives the cooperation a flexibility not available in formal transactions: initiatives are possible outside the agenda."* (Koenig & Van Wijk, 1994:2).

Zaheer & Venkatraman (1995) distinguish between three types of trust. The first type is *characteristic-based* trust. This type is formed within a group on the basis of factors such as ethnicity. One party develops trust in another party because of the characteristics of that other party. The second type is *process-based* trust. This type of trust results from past and expected future exchanges. The third type is *institutional-based* trust. This type of trust results from embedded social practices in economic exchanges between institutions. In a subsequent survey, Zaheer & Venkatraman have operationalised trust into the following indicators (p. 382):

a. ... a high level of mutual trust
b. ... well known for fair dealing
c. ... stands by its word

Based upon this research, it can be argued that the development of trust decreases partnership uncertainty. It reduces uncertainty of the partner by developing expectations towards its future behaviour. Consequently the information processing requirements of the partnership are ceteris paribus reduced by increased trust.

4.4 Information processing capacity

Bensaou & Venkatraman argue that in order to attenuate the uncertainty of an inter-organisational relationship, organisations design their relationships in three respects. These are 1. *structure*, 2. *process* and 3. *information technology*.

Structure refers "to a hierarchy of structural mechanisms that fit along a continuum with respect to their relative capacity for reducing uncertainty" (1993:9-10). The structure of the relationship is characterised by multiplicity of communication channels, frequency of visits, and control vs. coordination, which refers to formalisation of the interaction in the relationship (1993:17). Multiplicity of communication channels, frequency of visits, and formalisation of interaction represent parameters that determine whether the structural configuration is mechanistic or organic. The amount of communication channels and the frequency of visits imply organic design. The formalisation of the interaction implies mechanistic design. Bensaou & Venkatraman argue that the more communication channels there are, the more frequent the visits are, and the less formalisation of interaction, the greater the information processing capacity. In other words, the less mechanistic the configuration of the organisational design, the higher the information processing capacity. This is consistent with the arguments from the previous chapter.

A new element in designing inter-organisational relationships is the *process* of the inter-organisational relationship. With respect to the process of the inter-organisational relationship, Bensaou & Venkatraman note:

> *"These represent socio-political processes underlying the relationship, and they range along a cooperative-conflictual continuum, and directly affect the extent to which information is freely exchanged between the dyad members because or in spite of the nature of the structural mechanisms (Stern & Reve, 1980). For instance, under the same dyad structure coordination capabilities will tend to decrease in a negative, conflictual, and non-cooperative context."* (Bensaou & Venkatraman, 1993:10)

A common element of "partnership uncertainty" and "process" is that they both refer to the *cooperation* between the organisations in the inter-organisational relationship. The variables in the process group are ways to *manifest* cooperation. The variables in the "partnership uncertainty" group are variables that *threaten* cooperation. From an information processing perspective point of view, the ways to manifest cooperation each have a

relative capacity to reduce uncertainty. The variables that threaten cooperation represent a source of uncertainty.

The third group of parameters adding to information processing capacity is "information technology mechanisms." These mechanisms "represent the use of information technology for facilitating inter-organisational coordination, especially the nature and scope of the electronic linkages between the two members" (p. 10). Variables in this construct are "scope of IT use", "intensity of use", "EDI use in purchasing" and "EDI use in engineering". The broader the scope of IT use, the higher the intensity, and the more EDI is used, the larger the amount of information processing capacity.

4.5 Discussion

In this discussion, the framework developed by Bensaou & Venkatraman is positioned to the framework developed in the previous chapter. First, some implications of the change in the level of analysis will be discussed. Second, the degree of partnership uncertainty and non-conflictual process mechanisms in EDI partnerships specifically are discussed.

4.5.1 Level of analysis

Bensaou & Venkatraman's framework indicates that the design of an inter-organisational relationship is similar to the design within the organisation, but that at least the level of analysis is extended. The extended level of analysis is depicted in Figure 4-2.

One notable consequence of the shift in level of analysis is that no longer the tasks within the organisation are object of analysis, but the tasks at the boundaries of the organisations with which the inter-organisational relationship is formed. These tasks at the boundaries of the organisation are called "boundary spanning" tasks (Aldrich & Hecker, 1977). According to Aldrich & Herker,

> *"Two classes of functions are performed by boundary roles: information processing and external representation. Information from external sources comes into an organisation through boundary*

> *roles, and boundary roles link organisational structure to environmental variables, whether by buffering, moderating, or influencing the environment. Any given role can serve either or both functions."* (Aldrich & Herker, 1977:218)

Examples of boundary spanning tasks include the tasks at purchase departments (inter-organisational relationship with suppliers), marketing and sales (inter-organisational relationships with customers), and maintenance departments (also inter-organisational relationships with customers). Applying an information processing perspective to organisational design, primary attention is paid to the information processing functions of boundary tasks.

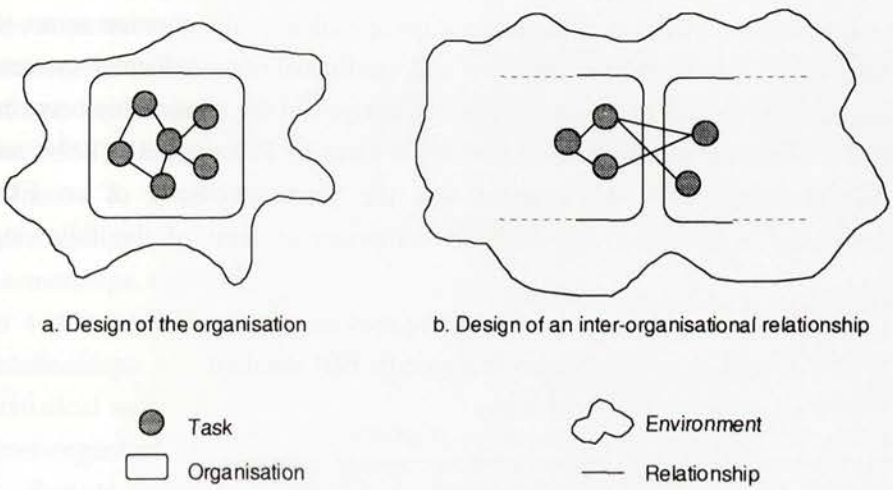


Figure 4-2 Extended level of analysis

One implication of shifting the level of analysis, is the required reconceptualisation of the environment. In intra-organisational design, the boundary spanning tasks of the trading partner's organisation are part of the environment. In organisational design in inter-organisational relationships this is no longer the case: their impact on information processing requirements has shifted from environmental uncertainty to task uncertainty.

Following the extensions in level of analysis by Bensaou & Venkatraman, in an EDI partnership task uncertainty not only stems from the tasks in the focal organisation, but also from the boundary spanning tasks of the trading partners. Boundary spanning tasks in an EDI partnership can be considered those tasks that put the input data from an incoming EDI message to use, and those that produce the output data that is sent by an outgoing EDI message.
An additional and important implication of the extended level of analysis is that the "information processing capacity" and the "information processing requirements", as well as "organisational effectiveness" are not applicable to one organisation only, but to the entire EDI partnership.

4.5.2 Partnership uncertainty

In applying the model to EDI partnerships specifically, the question arises to what extent partnership uncertainty and conflictual/non-conflictual process mechanisms vary in EDI partnerships. An analysis of the relationship between EDI investments and the asset specificity is given by Ribbers et al. (1994; see also Ekering, 1992). They argue that the asset specificity of an EDI investment is comparatively high. It comprises at least of the following aspects:

1) The information systems with which to send and receive EDI systems
2) The development or adoption of a specific EDI standard
3) The adjustment of product codes
4) VAN selection
5) Adjustment of procedures
6) Adjustment of (logistical) plans.

Because of this high asset specificity, Ribbers et al. argue that the implementation of EDI is usually restricted to a few organisations working closely together. Setting restrictions on the use of EDI indicates that the system is "closed". The alternative to various closed EDI systems is one *open* EDI system. Ribbers et al. remark:

> "*In an open EDI system, each organisation is in principle able to communicate with every other organisation, because a world-wide EDI standard is used that is recognised and accepted by all EDI*

> *partners. In this case there will only be the need for one EDI system. An open EDI system does not exist at the moment and indeed the question is whether there ever will (or could) be."* (Ribbers et al., 1994:67)

It should be noted that more and more components of EDI investments become less asset-specific. One example of decreased asset specificity of EDI investments is the use of the Internet as the basic infrastructure (aspect 1). As the world-wide web infrastructure further disseminates in the business community, more intensive use of the Internet for structured and formal communication can be expected. This relieves organisations from setting up specific information systems with which to send and receive EDI messages.

Another example of decreased asset specificity of EDI investments is the development of standards (aspect 2). Besides standardisation of EDI messages, trade scenario's are also more and more standardised. One example of standardising and modelling EDI trade scenario's in trade relationships is provided by Bons et al. (1995) and Lee & Bons (1995).

Bensaou & Venkatraman have, among other things, tested the degree of partnership uncertainty and conflictual/non-conflictual mechanisms in EDI partnerships. Operationalizing the variables into 41 indicators, representatives in 447 buyer-supplier relationships of 14 carmakers were surveyed. These relationships are both EDI partnerships and non-EDI partnerships. Using statistical analysis on these survey data, they developed five configurations in inter-organisational relationships. These five configurations are:

1. *Remote relationship.* This configuration represents a relationship with little information processing requirements: it shows very little task uncertainty, little environmental uncertainty and absent mutual trust. It has little information processing capacity, with limited and formalised structure, and non-existent use of information technology.
2. *Electronic control.* This configuration represents a relationship with little information processing requirements as well, but EDI is used in purchasing activities ("IT-mediated purchasing"). Bensaou & Venkatraman mention about this configuration:

> *"...the socio-political context characteristic of electronic control or IT-mediated control relationships consists of a highly supportive set of processes and actions. Tension between the two firms is typically dealt with by in a collaborative, and constructive problem-solving mode."* (Bensaou & Venkatraman, 1994:21)

3. *Electronic interdependence.* This configuration represents more intensive use of EDI in purchasing, engineering, quality and production control etc. It has high information processing capacity and high information processing requirements due to high task uncertainty and high task interdependence. But:

   > *"Partnership uncertainty, however, is lower since both parties have major assets tied up to the relationship and are unlikely to behave opportunistically."* (1994:22)

4. *Structural relationship.* This configuration represents a relationship operating in a climate that is "particularly confrontational. Not only disagreements are frequent, but also their resolution is adversial. In addition, the assembler does not play a strong commitment to the relationship" (p. 25). Furthermore, the "lack of mutual trust and strong sense of interdependence [...] further contribute to greater partnership uncertainty". This configuration, characterised by high partnership uncertainty and conflictual process mechanisms shows little use and scope of information technology, even in purchasing.
5. *Mutual adjustment.* This last configuration has both high levels of information processing requirements but low levels of information processing capacity. There is high task uncertainty, but "data indicates no significant use of information technology". Bensaou & Venkatraman conclude that this configuration represents a "poor fit" and explain this by the fact that this relationship is often relied upon by car assemblers for products for which suppliers have a monopoly.

At least two interesting observations can be made with respect to this empirical work. First is the "poor fit" of the "mutual adjustment" configuration. Using the extended explanations of the effect on EDI use on the information processing capacity, it can be explained why data shows no

significant use of information technology. This is because in situations with high information processing requirements, organic configurations arise. The use of EDI on the other hand, is favoured by mechanistic configurations. The introduction of EDI would have strong influences on formalisation and standardisation, which in turn would lower the information processing capacity. Since the organisation operates under high levels of information processing requirements, shifts towards more mechanistic configurations would represent mismatches, and consequently poor organisational effectiveness.

The second observation is that the empirical research supports that partnership uncertainty is low and process mechanisms are non-conflictual in EDI partnerships. The EDI configurations ("electronic control") and ("electronic interdependence") show limited to non-existent partnership uncertainty as well as the presence of non-conflictual process mechanisms.

4.6 Modified framework and propositions

In this chapter, the preliminary, *intra*-organisational framework developed in the previous chapter is extended to EDI partnerships. Again the perspective chosen has been the information processing approach to organisational design. Applying a research framework depicting organisational design in inter-organisational relationships (Bensaou & Venkatraman, 1993), three modifications of the framework have been made. First, the level of analysis of the framework is extended to the EDI partnership. Second, the boundary spanning tasks of the organisations in the EDI partnership are considered to be no longer part of the environment. Rather, they create task uncertainty by the complexity or their interdependence, they can be formalised, and their coordination can be standardised. Third, partnership uncertainty has been included in the model.

The modified framework is depicted in Figure 4-3.

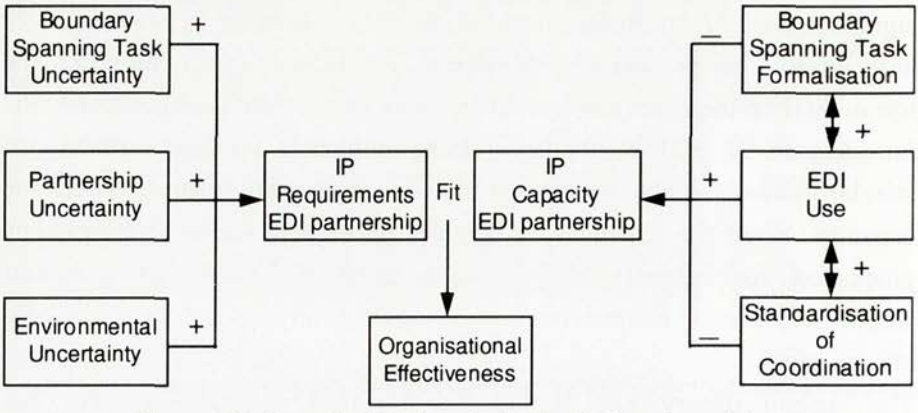


Figure 4-3 Organisational redesign in EDI partnerships

From this framework, at least four propositions can be drawn. These propositions are written down below.

Proposition 1

EDI use positively influences and is positively influenced by formalisation of tasks and standardisation of coordination in EDI partnerships.

This first proposition conveys that the use of EDI belongs to formal configurations of organisational design, and that it is consequently related to the formalisation of the tasks, as well as to the standardisation of the coordination of these tasks. This proposition is important because the fact that EDI belongs to formal configurations has a number of implications. One of these is the combined influence of EDI on the information processing capacity of the EDI partnership.

Proposition 2

EDI use positively influences the information processing capacity of the EDI partnership, but negatively influences the information processing capacity of the EDI partnership through increases in task formalisation and standardisation of coordination.

This second proposition conveys that EDI use has both a direct positive influence, as well as an indirect negative effect on the information processing capacity of the EDI partnership. This proposition is important because the positive and negative influence on information processing capacity of EDI use is one of the main contributions of the model, and needs further investigation.

Proposition 3

Partnership uncertainty is limited in EDI partnerships in the presence of asset specificity and mutual trust.

This third proposition conveys that partnership uncertainty in EDI partnerships is limited. At least two explanations have been identified in literature: high degrees of trust and high levels of asset specificity. Since these variables are relatively new in the model, it is important to verify whether these concepts can be identified in practice and whether they contribute to limited partnership uncertainty.

Proposition 4

Under conditions of organisational effectiveness, information processing capacity of the EDI partnership matches the information processing requirements of the EDI partnership.

The fourth and final proposition conveys the core of the information processing perspective to organisational design: that information processing capacity matches information processing requirements in order for the organisation to be effective. This proposition is important because it expresses that information processing capacity is not increased or decreased *per se*: rather this is a response to changes in the information processing requirements.

In the next two chapters, these four propositions will be applied to two cases: one concerning the redesign of logistical control, the other one in transport. The first case is a two-party EDI partnership, the second case a seven-party EDI partnership.

4.7 Summary

In this fourth chapter, the third research objective of this dissertation was addressed: to determine the applicability of the model in EDI partnerships and adjust the model if necessary. In order to meet this objective, first a research framework was provided in which the information processing approach was applied to organisational design in inter-organisational relationships. This framework, among other things, adds partnership uncertainty as an additional source of information processing requirements and conflictual/non-conflictual process mechanisms as additional design parameters.

The framework was positioned against the preliminary framework developed in the previous chapter. After discussing modifications to the framework, three modifications were made to the model: first, the level of analysis of the framework was extended to EDI partnerships. Second, the boundary spanning tasks of the organisations in the EDI partnership are taking into account as well. This has repercussions for task formalisation, task complexity, and task interdependence, as well as environmental uncertainty, to which these tasks traditionally belonged. Third, partnership uncertainty was included.

In section 4.6 the modified framework is presented in Figure 4-3. Also in this section four propositions were derived, conveying the basic line of argument from the framework. In the next two chapters, these propositions will be applied to two cases.

5. EDI enabled redesign of logistical control

5.1 Introduction

In the previous chapters, a theoretical model has been developed in which the use of EDI is related to concepts of organisational design. Furthermore, this relationship was examined in inter-organisational relationships. Concluding these chapters, the major theoretical findings derived from the framework were expressed in four propositions.

While the previous chapters focused on theoretical contributions, the next two chapters will be focusing on the application of the theory to practical situations. Specifically, the propositions will be held against two cases. The primary purpose of this examination is to confront the propositions with empirical material, and see whether the relationships that have been identified can be found and located in practice.

In this chapter the framework will be applied to an EDI partnership in logistics. Specifically, a redesign of logistical control will be described between a truck assembling company and one of its suppliers. The supplier and the assembler have implemented EDI in their inter-organisational

relationship and with the aid of EDI, they changed the logistical control of the flow of goods.

The structure of this chapter is as follows. The main concepts of the logistical redesign discussed in the case are outlined in section 5.2. The actual case is described in section 5.3. An analysis of the redesign with respect to the propositions is carried out in section 5.4. A summary of the conclusions is outlined in section 5.5.

5.2 Context

Logistics is concerned with the distribution of goods through successive stages in a *supply chain*. A supply chain can be defined as a collection of organisations in which each organisation adds value to a product. In a manufacturing environment, organisations typically add value to the product either by producing a component, or by assembling a set of components. These supply chains can be "unrolled" in a diverging manner from the assembler of the final product to the organisations that produce components onwards. Examples of these supply chains include the production of cars, trucks, and the like. The case in this chapter is concerned with a truck assembler and one of its suppliers of components.

A common aim for any logistical "designer" is meeting customer demand by delivering products while minimising costs of transportation and costs of inventory (or safety stocks). In order to achieve this, a logistical designer can, among other things, vary the type of logistical control. Logistical control is concerned with the way the flow of goods are controlled through successive stages in the supply chain. Another typical design problem is the geographical location of inventory depots. The case in this chapter deals with a redesign of logistical control.

The next sections will discuss the type of EDI application that the case is about and describe the EDI partnership of the case.

5.2.1 EDI in logistical control

Literature (e.g. Schonberger, 1982; De Vaan, 1990, and Van der Vlist et al., 1992) stresses that there are two main types of logistical control systems to control the flow of goods through successive stages in a supply chain: push and pull. In a *push* type logistical system, organisations anticipate upon the demands of their customers and order the necessary material in advance so as to react upon changes in demand that could not be anticipated. This results in a number of safety stocks throughout the supply chain, as depicted in Figure 5-1a. This system has also been called *make to stock*, or *assemble to stock* (Van der Vlist, 1994b), depending on whether manufacturers add value to the product by creating components or by assembling them.

In the *pull* type logistical system, organisations assemble and/or make products at the time they are ordered by the end-customer. Orders from assemblers to suppliers are neither sent batchwise nor based upon a forecast. Rather they are based upon an actual order of the end customer, which is inherently of a smaller batch size. Pull systems can be implemented throughout an entire supply chain, as depicted in Figure 5-1b. Depending on the type of logistical process involved, these systems are also called *Assemble to Order*, *Make to order*, and *Engineer to Order*.

In many, if not most, cases a pull system is less costly than a push system. This is because pull systems reduce the need for safety stocks and ultimately try to eliminate them. Each safety stock induces inventory costs, which can be substantial and burden the individual cost price for the final product. Reducing the number and volume of these safety stocks to the minimum is therefore of paramount importance, reason why many organisations have been looking at pull logistical control systems.

Implementing a pull system is not always viable however, due to various production constraints, such as long production lead times and the economies involved in large batch sizes. Therefore, both *push* and *pull* systems may occur within a supply chain. The point at which the *push* system stops and the *pull* system begins is called the *client-order decoupling point (CODP)*. From the CODP onwards to the final customer, the activities of the manufacturer (e.g. engineering, making, and assembling) are directly coupled to the order of

the client. These mixed types of supply chain management are depicted in Figure 5-1c.

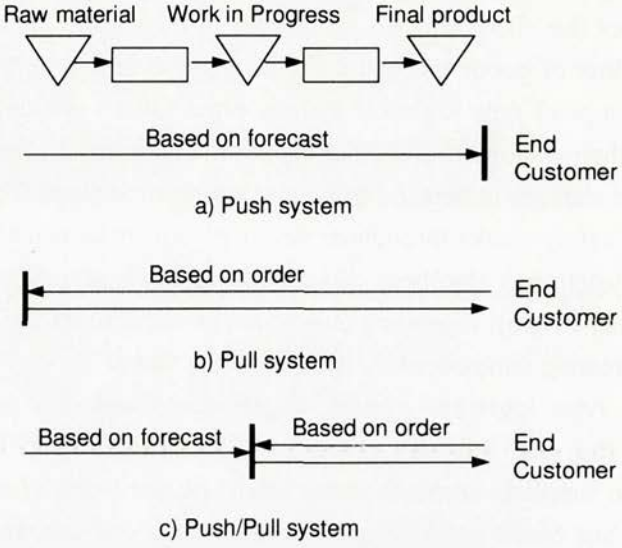


Figure 5-1 Push vs. Pull systems
(adapted from Kreuwels, 1994)

The common term for the logistical control redesign that aims to shift the logistical control in a supply chain from a push towards a pull-oriented system is *Just-In-Time* (JIT) management. A Just-In-Time redesign can be described as an attempt to move the order-decoupling point away from the final customer, thus shifting from a push towards a pull type of logistical system. A simple and effective description of Just-In-Time logistical design is given by Baily (1991):

> *"The basic idea is first to make sure that parts and materials arrive just when they are required for processing or assembly, thus eliminating the need for stock to be held in case they arrive late; and second to make sure that goods delivered are acceptable, eliminating the need for stock to be held in case goods are rejected."* (Baily, 1991:75)

A pull redesign is easier to implement with products that can be made or assembled by the supplier in relatively short time. This is because a long lead

time of a product inhibits the possibilities of arriving just-on-time at the assembly line. For example, if the lead production time of a particular component was four months, this component would have to be ordered four months before it is actually needed. A just-in-time planner would have to be able to reliably forecast demand four months ahead. In many environments, such a precise prediction of demand is not possible.

This problem has been addressed by introducing the concept of "Multi-Level Supply Control" (MLSC; see e.g. Hoppenbrouwers et al., 1994a, 1994b; Van der Vlist, 1994a, 1994b; Kreuwels, 1994). MLSC is a pull system in supply chains where demand is unpredictable and lead times of components are long. Basically, the instructions on the end-customer's order are sent in *parts* to the supplier. Each part is sent at a later stage and contains more specific information. Based on the generic data, suppliers start making the components, and continue to transfer the component into one that is more specific when they receive additional data. For instance, a supplier of fuel pumps may not need to know in the beginning what the *truck type* of the fuel pump is. This is because for the first and major part of the assembly of fuel pumps the truck type is irrelevant. Only the last week before final delivery, the product is tuned to a specific truck type. The implication of implementing a MLSC concept in this particular example is that a supplier can start to assemble fuel pumps as soon as is known how many trucks are ordered. Consequently this implies a significant reduction in lead time. For the truck manufacturer it implies a significant reduction in safety stock and consequently, in inventory costs.

The implementation of a pull logistical control system requires a more intensive information interchange between organisations than a push logistical control system. In a push-oriented system, assemblers place an order at the supplier as soon as their safety-stock arrives below a particular level. This order is usual in the form of a large batch. In a pull-oriented system, assemblers place an order at the supplier as soon as an order from their customers enters. This order is usual of a much smaller batch size: just as much of the components that are necessary for the final product. Given equal

demand in push and pull-oriented systems, the frequency of the orders also increases in the pull system.

The boards of EDIFACT and ODETTE (intended to develop EDI messages specific to the automobile industry) have developed a number of messages that can be used to implement a JIT logistical system. The messages DELFOR (general delivery schedule) and DELINS (ODETTE version) are messages with which the manufacturer notifies a supplier about the future needs for a specific component. For instance, an organisation may notify its supplier that on September the 15th a quantity of 306 will be required. The data from the message may vary in detail and certainty. Alternatively, a buyer may notify the supplier that within three months, a quantity of 900 will "probably" be required. Thus, these messages can both be used to send forecasts and specific orders.

The messages DELJIT (just in time delivery schedule) and SYNCRO (ODETTE version) are messages that notify a supplier about the future needs for a specific component in order of assembly. For instance, the message may notify a supplier that the manufacturer will assemble products A1, A2, and B1 in the coming three days. For product A1 and A2 the buyer needs a quantity of 90 components A each. For product B1 the buyer needs a quantity of 10 components A and a quantity of 20 components B. This message can be used in the more complex JIT settings, where components are delivered in order of final product assembly.

The Edifact message DESADV (despatch advice) is used by the supplier to notify the buyer that goods are ready to be shipped. In the ODETTE standard, this data may be conveyed in two messages: AVIEXP and FORDIS. In the AVIEXP message, the supplier takes care of the delivery, whereas in the FORDIS message, the buyer arranges the transport.

5.2.2 The EDI partnership

In general it can be said that the more complex the logistical control system between various organisations in a supply chain is, the more the inter-organisational relationships in this respect are based on long-term contracts. Thus, the contracts between the assemblers and the suppliers have a longer

duration (usually at least one or more years) in a pull than in a push system. For instance, the managing director of a truck company implementing a pull system has said: "In stead of more transaction-oriented relationships, relationships arise based upon long-lasting contracts. Not the price will be determinative, but the quality of service, constituting of the total purchase and logistical performance of the supplier." In another pull implementation (Van der Vlist, 1992:277) a car assembler decreased the number of suppliers and built a more extensive relationship with the remaining ones. One of these suppliers, a Dutch steel manufacturer, mentioned eight advantages of the new system, of which the increased contractual length of the relationship was listed first.

The case concerns an EDI project between a truck assembler and a tyre supplier. The redesign was set up between two plants. The supplier's plant constructs tyre-wheel-combinations (TWCs) for a number of customers, of which the truck assembler's plant is one. The major part of TWCs that the assembler requires for the assembly of trucks is supplied by this particular supplier. The duration of the contract between the truck assembler and the supplier is one year. Time span has remained one year in the pull situation (p. 293).

5.3 Case description

The description of this case is divided in three sections. The first section describes the old situation. The second deals with the objectives for the EDI project that was introduced and a description of the EDI system. The third section describes the new situation.

Old situation

The assembler and the supplier cooperate under an umbrella contract that rudimentary specifies the yearly consumption of TWCs by the assembler. Within the contract, the yearly number of TWCs is subdivided into monthly specifications. At the beginning of each month, the assembler provides the supplier with a more accurate forecast for that particular month. Among other

things, the supplier uses this information to manage the inventory of the TWC components.

Based upon the monthly forecast, each day the assembler faxes an order in which the necessary amount of TWCs for that day in the coming week is specified. This fax is manually entered into the supplier's in-house information system. The system checks the TWC numbers and checks whether the necessary components are present in the inventory. In case both checks are passed, the fax is processed as an order. In case either one of the checks fails, the supplier contacts the assembler by telephone. After the fax has been processed as an order, it is frequently changed by the assembler in the period before delivery: "The order scheme thus created was modified on the latest occasion quite regularly" (Van der Vlist et al. (eds), 1992:289).

Based upon the orders registered in the in-house information system, the supplier's planners schedule the load for the trucks that are to deliver the TWCs. These trucks drive on average twice a day from the supplier's plant to the assembler's plant to deliver the TWCs to a central depot. The planning is done manually and aims at batchwise-delivery, implying that as much of the same types of TWCs are delivered as possible at the same time. Among the elements that the planners take into account are truck capacity and batch size of the construction line. Once the planning is completed, the necessary freight documents are prepared.

Based upon the information in the truck schedules, the construction scheduling takes place. This constitutes of two activities: the generation of construction orders and the planning of the actual construction.

The tyres are delivered at a central depot. The supplier remains responsible for the TWCs until the assembler has signed the freight documents. Since the tyres are delivered in bulk, the assembler needs to arrange the TWCs in order of chassis assembly. In order for the assembly line not to stagnate, a safety stock of three to four days is held. Once the TWCs are arranged for the assembly line they are ready to be fit onto the chassis.

The tasks in the old situation are graphically depicted in Figure 5-2.

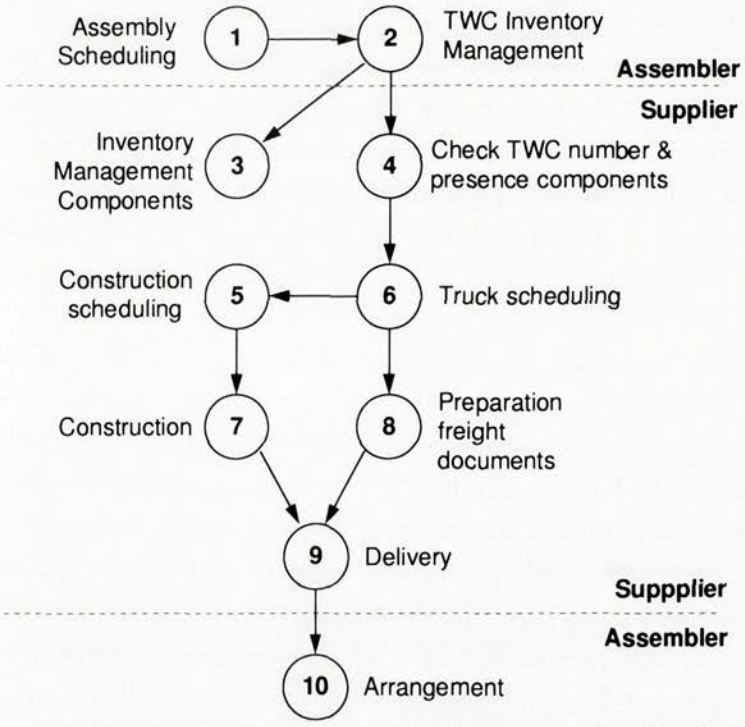


Figure 5-2 Old situation (based upon Van der Vlist et al., 1992:287-297)

Figure 5-2 depicts the tasks along with their dependencies. For example, task *9. Delivery* is linked with task *7. Construction* and *8. Preparation freight documents*. These linkages express that delivery can only be accomplished once the freight documents have been prepared and the TWCs have been constructed.

The assembler is contractually allowed to modify the orders when truck scheduling is in progress, or even when truck scheduling is finished. However, as soon as the freight documents are prepared, the order is called "fixed" and the truck assembler is no longer allowed to make changes. The time between delivery and the moment when the order becomes fixed was called "fixed-order time". In the old situation, fixed-order time was approximately 2.5 days.

The EDI system

Early 1990 the assembler expressed to the supplier the wish to deliver the TWCs in order of chassis assembly, rather than batchwise. This would 1) free the assembler from the activities to arrange the TWCs before chassis assembly could start and 2) ultimately reduce the TWC safety stock at the assembler to approximately half a day. Ideally, the TWCs were already barcoded with chassis number at the supplier so that once arrived at the assembler they could directly be transported to the appropriate chassis.

Based upon these motivations, the supplier and the assembler introduced a logistical redesign project, with the aim to enable the supplier to deliver TWCs in order of chassis assembly. Part of the project should be the introduction of EDI. Using daily EDI messages the assembler could inform the supplier of the chassis that are about to be assembled.

The resulting EDI system enables the exchange of EDI-messages that are similar in structure to ODETTE SYNCRO and EDIFACT DELJIT messages. The EDI message that the assembler daily sends to the supplier carries the number of TWCs needed for a particular period of time. Each TWC is coupled to a particular chassis that the assembler is planning to assemble. The quantity of TWCs needed is divided in three groups of data. Each group of data points at the required quantity for TWCs in a particular period of time. The first group contains the required quantity of TWCs in the coming two days (day N+1, and day N+2). Each TWC is coupled to a chassis and the chassis are sorted in order of assembly. This data has the status of "fixed-order", implying that the assembler is not contractually allowed to change the data.

The second group contains the required number of TWCs in the next eight days (from day N+3 until day N+11). In this group, the combination of TWCs with the chassis is fixed (p. 292), but the order in which the chassis will be assembled can still be changed by the assembler. The third and final group contains the required quantity for TWCs in the next fifteen days (from day N+11 until N+25). This group has the status of "forecast". TWCs and chassis are not yet combined, and the chassis are not sorted in order of assembly yet.

The EDI message is graphically depicted in Figure 5-3.

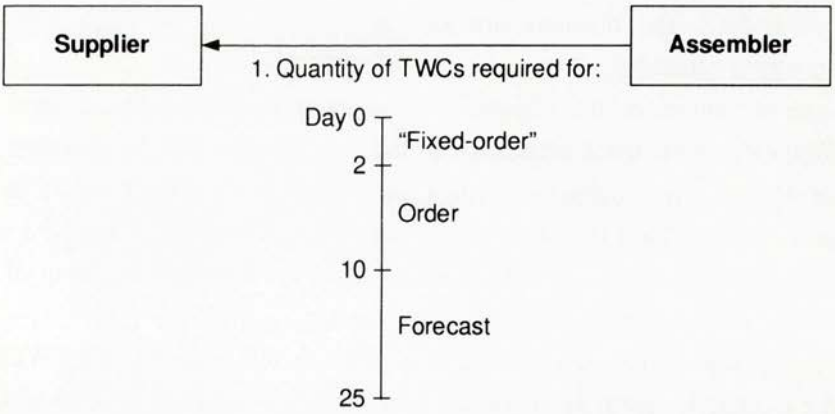


Figure 5-3 EDI message (Based upon Van der Vlist et al., 1992:293)

New situation

The assembler and the supplier still operate under the umbrella contract in which a forecast of the yearly consumption of TWCs by the assembler is specified. However, in stead of sending a more accurate forecast each month, the assembler daily sends the assembly scheduling, through the EDI message. In the new situation, the third group of data (number of TWCs needed for day N+11 until N+25) forms the basis for the inventory management of the TWC components at the supplier.

The data from the first and second group (number of TWCs needed for day N+1 until N+10) are directly entered into the supplier's in-house information system. The system checks the TWC numbers and checks to see whether the necessary components are present in the inventory. In case both checks are passed, the number of TWCs needed from day N+1 until N+10 are processed as orders.

Based upon the orders registered in the in-house information system, a new application starts scheduling the supplier's trucks for day N+2. The planning is more sophisticated than in the old situation because in the new situation the trucks have to deliver the TWCs in order of chassis assembly. Among the elements that are taken into account in the new situation are order of chassis assembly at the assembler, TWC sizes, pallet sizes and capacity of the trucks.

Once the application has finished the orders for day N+2 receive the status "fixed-order". The planners are still able to modify the truck schedule manually if necessary.

In the old situation, the construction orders were created based upon the information in the truck schedules. In the new situation this is no longer the case. Rather, the construction orders are created based upon the data in the second group of the EDI message (amount of TWCs needed for day N+3 until N+10), and the current inventory of TWCs at the supplier. Planning of the orders is still done manually.

Once the TWCs have been constructed, the supplier arranges the TWCs in order of chassis assembly. These are new activities that have been taken over from the assembler. Also, labels indicating the chassis number are put on the TWCs in order to facilitate direction to the assembly line. Once the TWCs are loaded, the supplier's trucks drive the TWCs to the assembler, where they are delivered "just-in-time" at the assembly line.

The tasks in the new situation are graphically depicted in Figure 5-4.

The redesign of the logistical control system has had the following results:

1. An important advantage for the assembler is the significantly reduced safety stock of TWCs on its premises. In the new situation, the assembler's TWC safety stock is reduced to half a day (p. 297).
2. The assembler's arrangement of the TWCs to fit the chassis assembly line is significantly facilitated since the arrangement of the TWCs have been taken over by the supplier (p. 297).

5.4 Discussion

In this section, the propositions that were derived in the theoretical chapters will be applied to the case. The first proposition deals with the influence of EDI use on task formalisation and standardisation of coordination. The second deals with the influence of EDI use on the information processing capacity of the EDI partnership. The third proposition concerns the limited partnership uncertainty in the partnership. The fourth proposition concerns

the fit between information processing capacity and information processing requirements in the inter-organisational relationship.

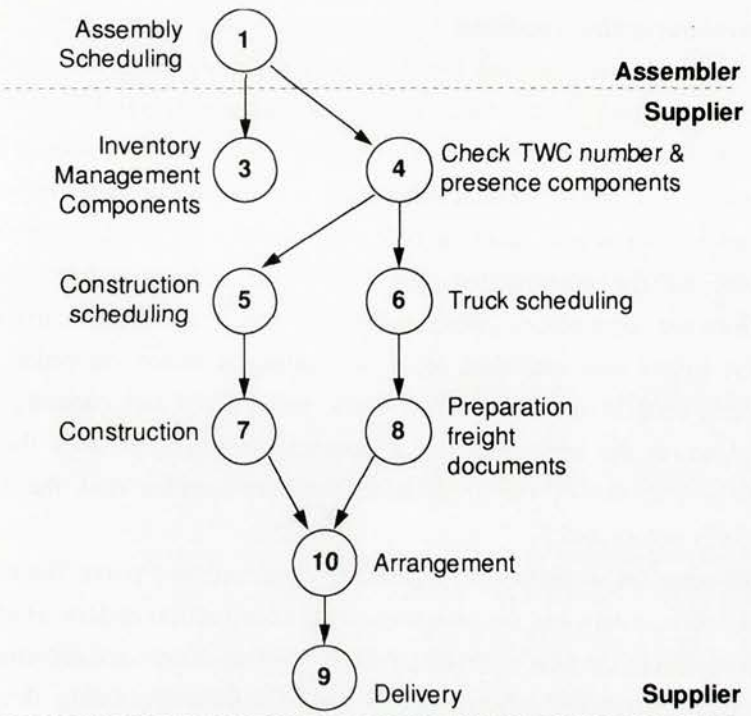


Figure 5-4 New situation (based upon Van der Vlist et al., 1992:287-297)

Proposition 1

EDI use positively influences and is positively influenced by formalisation of tasks and standardisation of coordination in EDI partnerships.

In the old situation, the assembler daily sent a fax with the number of TWCs needed for that particular day next week. In the new situation, this fax has been replaced with an EDI message. The EDI message is not conveying the same amount of data as the fax message, but contains additional, more detailed data: it contains a more detailed forecast from the assembler's

assembly scheduling activities and it contains the chassis numbers for the TWCs needed. This additional data is required by the supplier to schedule and arrange the TWCs according to order of chassis assembly. The supplier, who receives the data, uses the data in the EDI message in the applications for truck and construction scheduling.

On the supplier's side, at least two boundary spanning tasks are confronted with more detailed data: these are truck scheduling and construction scheduling. According to the first proposition, the use of EDI should favour formalisation of the tasks. Truck scheduling was carried out manually in the old situation, and was a function of order information, truck capacity and batch size of the construction line. The case indicates that relatively straightforward procedures were followed, but they were carried out manually. In the new situation, truck scheduling is based on order of the assembler's chassis assembly, TWC sizes, pallet sizes and capacity of the trucks. Also, in the new situation, a computer application does the truck scheduling. The use of the application software implies that the task is substantially automated.

In the old situation, construction scheduling contained two parts: the creation of construction orders and the planning of the construction orders. Both were done manually. In the new situation, the construction orders are automatically created based upon the information in the EDI message, using developed construction order generation software. Planners are still able to change the contents of the assembly orders. However, the use of the assembly order generation software implies that the scheduling is substantially automated in the new situation.

One observation from these changes is that both tasks show a similar pattern: in the old situation, the tasks are relatively simple and manual procedures were used to carry them out. In the new situation, procedures have been automated to support the tasks. Also, the nature of the tasks has been changed. The applications for both truck scheduling as well as construction scheduling now employ the more detailed data that is conveyed by the EDI messages. Thus, the detailed input is incorporated in the tasks, and the procedures to handle the more detailed input are formalised (and automated)

with it. This indicates that the proposition that the use of EDI positively influences and is positively influenced by task formalisation is supported.
In the old situation, the coordination between the assembler and the supplier was based upon yearly prognoses, more accurate monthly prognoses, and specific daily orders (call offs). This coordination was standardised in the contract to a significant degree. In the new situation, the coordination between the assembler and the supplier is also based upon chassis numbers, by which the supplier is able to deliver the TWCs in order of chassis assembly. The supplier arranges the TWCs in order of assembly and labels them accordingly. While the coordination has become more complex, the standardisation has also kept pace. The standardisation has been made possible by the new task formalisation: the truck scheduling and the construction scheduling are all structured and formalised to facilitate the standardisation of the coordination between the supplier and the assembler.
Conclusion from this discussion is that EDI has been used to convey more detailed data, and that tasks are formalised and that coordination is standardised in order to take more advantage of this detailed data. These observations from the case support the proposition that EDI use does favour the formalisation of tasks and the standardisation of coordination of both actors in the EDI partnership.

Proposition 2

EDI use positively influences the information processing capacity of the EDI partnership, but negatively influences the information processing capacity of the EDI partnership through increases in task formalisation and standardisation of coordination.

The case shows that the use of EDI in stead of the fax has increased the structured data accessibility with respect to assembly data at the supplier. This is due to at least two reasons. Firstly, the use of EDI has improved the speed with which the data is captured in the in-house applications of the suppliers. Both fax and EDI have roughly the same speed of transmission, but EDI improves the ease (or speed) with which the data can be captured into the

in-house applications significantly. Secondly, more detailed data has been captured in the in-house applications through EDI. This data also represents more information, as the data is obviously meaningful to the supplier. The increase in structured data accessibility indicates an increase in information processing capacity of the EDI partnership.

At this point it should be noted that the new situation is not simply a more mechanistic version of the old situation. Specifically, the new situation operates under a different type of logistical control, which has repercussions for the tasks that support and organise logistical control. Hence, it is difficult to argue that a task, for instance truck scheduling, has been more formalised in the new situation than in the previous situation. Rather, the task itself has changed to meet the required logistical redesign. Consequently, it is more appropriate to speak of *re-formalisation* than of *increased* formalisation. More generally, the mechanistic configuration under which the old logistical control took place was replaced by a modified, but still mechanistic configuration under which the new logistical control takes place.

It is for this reason that the case does not indicate a negative influence on information processing capacity due to increased task formalisation or increased standardisation of the procedures. There has been no increase in formalisation and standardisation, rather there has been a re-formalisation and re-standardisation of tasks to achieve the new design of logistical control.

One additional observation in this respect is the increase in fixed-order period. The fixed-order period is defined as the period in which the assembler is no longer allowed to make changes to the order. Consequently, fixed-order period is an indicator of the extent to which the supplier is *able* to make changes to an order. The fixed-order time is increased by half a day, from 2.5 days to 3 days (p. 295). This may imply an information processing capacity surplus: too much time and effort would be needed to process the information about the change. However, a more likely explanation is that production constraints are more pressing in the new situation. Arrangement of the TWCs in order of chassis assembly is an activity that takes up additional time in the delivery of the goods. It is thus likely that fixed-order time has increased by half a day not because of too much organic information processing capacity, but because

this additional time is needed to construct and arrange the goods in order of chassis assembly.

In conclusion, the case supports the proposition that the use of EDI positively influences the information processing capacity as it improves the accessibility of the data concerning the assembly line. On the other hand, no negative influence of an increase in task formalisation and standardisation of coordination on the information processing capacity of the EDI partnership can be identified. The new situation does not represent a more mechanistic version of the old situation, but rather a shift from one mechanistic configuration to another.

Proposition 3

Partnership uncertainty is limited in EDI partnerships in the presence of asset specificity and mutual trust.

This case is an example of an EDI investment that is combined with an adjustment of (logistical) plans. These plans are strongly dedicated to the partnership, consequently they show asset specificity to a significant extent (cf. Ribbers et al., 1994). The logistical plans are customised for the assembler and the supplier. There are no indications that the application of the changes in logistical plans in other settings is intended.

Amongst other things, the arrangement of the TWCs has been taken over by the supplier. Once the TWCs arrive at the assembly line, little time is left to replace a TWC if the quality does not meet acceptable standards. Consequently, the assembler needs to trust the supplier to a substantial degree. While a high degree of trust is not mentioned explicitly in the case, there are indications that the partnership operates under a substantial degree of trust. With respect to the three types of trust mentioned in chapter four, there are indications for process-based trust and institutional-based trust. Process-based trust is based on past exchanges: since the assembler and the supplier have a long-term relationship and operate under umbrella contracts, they have a long record of past operations. Institutional-based trust is based on formal mechanisms such as professionalism, and legal protection (see also

Hosmer, 1995:389). Since the assembler and the supplier employ legally enforceable umbrella contracts, this type of trust is also present.

A cousin of trust (cf. Thorelli, 1986) arises as an additional element of partnership uncertainty in this case: the presence of market power and dependency in the relationship. Clearly, the assembler has substantial power over the supplier. It is this power that causes, among other things, partnership uncertainty to be limited. The assembler is able to exert power, for example by imposing the arrangement of TWCs upon the suppliers. The case study description indicates that the degree of collaboration to develop the new concept was significant ("after the assembler had taken the initiative, both sides actively explored possibilities to renew the logistical concept", p. 297). The primary benefits however, as expressed by the reduction of safety stock, are clearly located at the assembler.

Thorelli (1986) defines power as "the ability to influence the decisions or actions of others" (p. 38). The term "influence" may be used to indicate that power is actually being exercised. In the context of this case, the assembler has exerted his power over the supplier by directly influencing the tasks concerning delivery of TWCs.

Concluding, the case supports the proposition that partnership uncertainty is limited at least through the substantial asset-specificity and to the level of trust. Also, the presence of power and dependency is an additional determinant for limited partnership uncertainty.

Proposition 4

Under conditions of organisational effectiveness, information processing capacity of the EDI partnership matches the information processing requirements of the EDI partnership.

In the previous sections, it was argued that EDI has increased the information processing capacity of the EDI partnership. More specifically, this increase was due to the increased accessibility of structured data concerning the scheduling of the assembly line. The final proposition argues that under

conditions of organisational effectiveness, the information processing requirements of the EDI partnership have to be increased.

In the conceptual framework, the information processing requirements are determined by task complexity, task interdependence, partnership uncertainty, and environmental uncertainty. At the previous proposition it was argued that partnership uncertainty is limited. Also with respect to environmental uncertainty, the case does not mention a change in environmental pressure to the EDI partnership. There are no indications that an increase in environmental uncertainty has increased the information processing requirements.

The case study description does however indicate changes in the tasks truck scheduling and construction scheduling. In the old situation, truck scheduling was based on truck capacity and batch size of the construction line. In the new situation, truck scheduling is based on order of the assembler's chassis assembly, TWC sizes, pallet sizes and capacity of the trucks. Consequently, the case study indicates that truck scheduling is more complex since the number of input variables has increased. However, its automation indicates that the extent to which it can predefined continues to be high.

Construction scheduling contains two parts: the creation of construction orders and the planning of the construction orders. Both were done manually in the old situation. In the new situation, the planning of the construction orders is still done manually (p. 294). However, the construction orders are automatically created based upon the information in the EDI message and no longer on the information in the truck schedules. The creation of the construction orders has become a different procedure in which need for TWCs, current inventory of TWCs, and TWC increase through construction orders are taken into account. This procedure is arguably more complex as the number of input variables has increased, although its automation indicates that it can still be predefined to a large extent.

With respect to task interdependence, a change in dependency *structure* of the tasks can be witnessed. Specifically, construction scheduling starts when the orders are checked on TWC number and the components are present. In the old situation, construction scheduling started when trucks were scheduled. It

is however difficult to relate shifts in dependency structure to the information processing requirements. This is because the variable task interdependence does not represent shifts in dependency structures, but shifts in types of interdependence given a certain dependency structure. In terms of interdependence types, the tasks remain sequentially interdependent: there was no indication of a change towards reciprocal interdependence.

Concluding, the increase is matched by an increase in the information processing requirements, more specifically by additional complexity of the tasks. The tasks were differently designed to deal with more data. The increase in information processing capacity that these changes required were matched by EDI use. EDI use was accompanied with a re-formalisation of the tasks and re-standardisation of the coordination.

One last observation with respect to this case is that in the redesign of logistical control, the reduction of safety stocks has been the ultimate target. In order to achieve this reduction, a change in logistical control was examined. This change in logistical control in turn, imposed increased information processing requirements on the EDI partnership. Then, the increased information processing requirements were matched by an increase in information processing capacity. The use of EDI was considered as a part of this effort at some point in the process. Viewing the development of the whole process, the development of the EDI system did not came first and the organisational redesign came later. Neither did the organisational redesign came first, and the development of the EDI system later. The case shows elements of both paths: both did influence each other during the process. This supports the notion set forward in chapter two that IT-enabled organisational change is neither determined by information technology alone, nor by organisational design requirements alone. Rather, both are taken account into the process of developing the redesign. In retrospect it is thus harder, if not impossible to identify the causal structure of relationships between the variables.

5.5 Summary

In this chapter, the conceptual framework was applied to a case that covers a redesign of logistical control. Also, different types of logistical control were discussed, as well as the reasons and conditions to shift from one type to another.

The propositions derived in the previous chapter were applied to the EDI partnership in the case. There are clear indications that EDI use positively influences and is positively influenced by task formalisation and standardisation of coordination. EDI use showed a positive influence on information processing capacity. At the side of the information processing requirements, increase in task complexity was witnessed to utilise the increased information. Both changes are in line with the fit proposition from the information processing perspective to organisational design.

Additionally, partnership uncertainty was limited at least because the investments showed a high degree of asset specificity and a high degree of mutual trust. The case suggests however at least one additional determinant for partnership uncertainty: the presence of power and dependency in the relationship.

6. EDI enabled redesign in transport

6.1 Introduction

In the previous chapter, the propositions derived in the theoretical chapters of this dissertation were tested using empirical data from a two-party EDI partnership. In this chapter the theoretical framework is applied to a case in the transportation sector. Specifically, the EDI application is concerned with the "tracking and tracing" of goods that are being transported. The EDI partnership in this chapter includes seven organisations: one manufacturer, four suppliers, and two forwarders. The suppliers and the forwarders supply the information to an EDI database, and the manufacturer retrieves the information.

The sources for this case material have been threefold. In the first place, documentation concerning the EDI project available at the EDI service provider was studied. In the second place, interviews with representatives of the EDI service provider in the case were held. In the third place, the EDI application was tried and examined. The case describes phase one of a larger project. The first phase took place from July 1992 until June 1993. The

author gathered material at the EDI service provider from March 1993 until June 1993. The method used to gather the case material has been outlined in more detail in chapter one.

This chapter is organised as follows. The context for the description of the case is described in section 6.2. Section 6.2 contains a general introduction on EDI in transport and on tracking and tracing applications in particular. The case is described in section 6.3. In section 6.4 the propositions will be applied to the case. Finally, section 6.5 provides a summary of the conclusions of this chapter.

6.2 Context

The procedures involved in the transportation of goods range from very simple to very complex. Complexity increases, among other things, as the transportation needs to cross more countries, and as the transport needs to switch transportation modes. Four modes are usually identified: road, rail, water (seas and rivers), and air. The case described in this chapter concerns the movement of components from the United Stated to Europe, by air (main transport) and by road (pre- and posttransport).

Complex transportations are characterised by the involvement of a wide variety of organisations, and an intensive document exchange. For instance, the export of goods through a port involves at least nine different types of organisations and over 18 formal documents. The document exchange to coordinate this transport has been the basis for the Port of Rotterdam simulation game (Wagenaar, 1990; 1992). Document exchanges can be expressed by using scenario's: sequences of documents between organisations. A scenario of document exchange in the port of Rotterdam has been documented in Sol et al. (1991). Similar scenario's are described by Wrigley (1992) and Wrigley et al. (1994).

There are at least three parties in any non-trivial transportation scenario: shippers, consignees, and carriers. Shippers and consignees agree to move cargo, and the carrier takes care of the physical transportation. Many other types of organisations are often included in the scenario as well, however. For

financial payment and insurance, banks and insurance companies are involved. For multi-country transport, customs and other government authorities are involved also.

In case of multi-modal transport, organisations taking care of mode transfer take part in the scenario. An example is the stevedore who transfers goods from water to road or rail and vice versa. Furthermore, many carriers are represented by agencies. An example are the liner agencies who represent liners in many different countries. Finally, the complexity of transport has given rise to organisations that specialise in transport arrangement and coordination: these are called freight forwarders. The case documented in this chapter involves two freight forwarders, one multinational manufacturer with two U.S. departments (the shippers), and four suppliers.

6.2.1 EDI in transport

The transportation industry is characterised by intensive exchange of formal documents. Also, much information on those documents is duplicated from one document to another. The complexity of document exchange has led to significant formalisation of the documents and standardisation using reference numbers.

The more documents are exchanged, the more the advantages of EDI over traditional document exchange become apparent. Given the amount of structured and standardised paperwork in transport, it is therefore not surprising that a variety of EDI applications has been adopted in the transportation sector. At least four different types of applications of EDI can be witnessed in the transportation industry (see e.g. Kerkhof, 1994:143; Van der Vlist et al. (eds), 1994).

A first application is the EDI exchange with customs. Many transportation companies use EDI to send a customs declaration and in order to receive a customs response (CUSDEC and CUSRES in the Edifact standard). The "Sagitta" package developed specifically for the interchange with Dutch customs has proven to be successful for this purpose (De Lange, 1993). A second application is the exchange of the transportation instruction through

EDI (IFTMIN in the Edifact standard). This message is commonly sent by the shipper to the carrier or to the forwarder (in case the carrier is represented) or by the forwarder to the carrier (in case the shipper is represented). A third EDI application concerns the exchange of financial documents such as invoices.

A fourth type of EDI application concerns the exchange of status messages from the carrier to shippers, forwarders, or consignees. An information system from which the status of goods in-transit can be derived is commonly called a *tracking and tracing* application. Tracking refers to the storage of status data, and tracing refers to the ability to examine the movement of the goods based upon this data. The input information for these tracking and tracing applications is usually conveyed by EDI messages. The format of these EDI messages can be IFTMAN format ("arrival notice"), or a similar one in which current time and place of cargo is mentioned.

The case described in this chapter concerns the fourth type of EDI application. Specifically, the suppliers and the forwarders provide the information on the transport of the goods, and the manufacturer receives and utilises it.

6.2.2 The EDI partnership

The case documented in this chapter involves seven organisations. The first organisation is a multinational manufacturer of electronic equipment. Two U.S. departments, the purchasing department and the consolidation centre, take care of the transportation of components to European plants. In those plants various types of electronic equipment are assembled.

The manufacturer aimed at tracking and tracing the logistical flow from the suppliers of components to the European plants. In the first phase of the EDI project, four U.S. suppliers of components are involved, that produce the majority of components for two European plants. Also involved are two international forwarders, to which the main transport to Europe is delegated. Each forwarder takes care of one European plant. The shipment of the

components from the U.S. to Europe takes place by airline. The forwarders delegate physical transportation by air to major air carriers.
Each type of component is assigned to one supplier: the suppliers do not compete. Contracts between the suppliers and the manufacturer are long term. The relationship between the manufacturer and the two forwarders is also dedicated. Each forwarder is assigned to the arrangement of transport to one European plant. The contracts between the forwarders and the manufacturer are also long term.

6.3 Case description

The description of this case is divided in three sections. The first section describes the old situation. This situation lasted until April 1992. The second deals with the objectives for the EDI project that was introduced and a description of the EDI system. The third section describes the new situation. This situation describes the first phase of a larger project. The first phase lasted from April 1992 until June 1993.

Old situation
The case starts at the materials management departments located in the European plants. Based upon an MRP algorithm the number of components needed for a specific time frame is determined. The MRP system collects the materials requirements data and decides whether the materials requested are in stock using data from the inventory system. If not, the materials need to be ordered from external suppliers. The MRP system decides which supplier needs to be approached based upon information from a supplier management system. The suppliers that are located in the U.S. are grouped into a purchase request for the U.S. purchasing department.
The U.S. purchasing department receives the purchase requests derived from the MRP system every weekday. On the basis of the information on the requests, they contact the U.S. suppliers. The order specifications are communicated to the supplier, who is asked to confirm whether the order can be fulfilled. Release dates and quantities are exchanged. As soon as the

purchasing department receives confirmation, the order data is keyed into an order management system, which generates formal purchase orders for suppliers and for file purposes.

A supplier of components typically determines the moulding plan to mould the components and prepares the necessary materials. Based upon this moulding plan, the machines are set accordingly and the components are produced. On the scheduled day of release, a truck picks up the order and drives it to the consolidation centre. The supplier has prepared the order for shipping by filling in the necessary freight documents (item list and bill of lading).

The consolidation centre is the US department responsible for receiving components from the suppliers, consolidating shipments, and releasing shipments to the appropriate forwarding companies. When the components arrive at the department's dock, packages are counted and the item list is reconciled with the packing list. This list has been derived from the order management system. The floor personnel attaches a bar code number to the order and moves it to the staging area for consolidation. The packing list, on which the bar code numbers are added, is input in the transport management system. This is an information system used to assemble consolidation lists, to book shipments and to generate a number of transport documents. The system matches bar code numbers with other information from the order and assembles a consolidation list. All orders are consolidated by destination. When the consolidation is "closed", a unique shipment number is assigned to each consolidated shipment.

When the shipment is identified, the system generates a booking request that is sent to the appropriate forwarder. After the booking confirmation, the system generates a shipment manifest that contains detailed information about the consolidated freight. When the consolidation is closed and the documents are ready, the freight is being transported to the airport, and released to the forwarder.

Usually, the forwarders consolidate the shipments from the manufacturer with other shipments before they are shipped to Europe. To each individual shipment, a House Airway Bill (HAWB) is assigned. The HAWB number is

given to the shippers with the booking confirmation. Each consolidated shipment is assigned a Master Airway Bill (MAWB) number. This number is "owned" by the air carriers, but forwarders can assign an MAWB number on their behalf. Consolidated shipments are, with the MAWB, released to the air carriers.

Air carriers use the MAWB to ship the goods to Europe. The individual HAWBs of each single customer is generally ignored. Air carriers disaggregate consolidated shipments into Unit Load Devices (ULD, i.e. air containers) according to a ULD plan and transport them to Europe. The ULD plan is a manifest that contains the mapping of different MAWBs (different forwarders) to different ULDs.

Once at the European airport, air carriers aggregate the shipments again and release them to the appropriate forwarders. Trucking companies are subcontracted to transfer the shipments to the European plants.

Figure 6-1 provides a graphical summary of the old situation.

The EDI system

The U.S. purchasing department is the department that supplies information about the goods flow to the European plants. After the purchase request is made, the European plants frequently contact the purchasing department in order to find out the status of the goods in transit. The manufacturer judged this to be too frequently, as the requests for information took the purchasing department too much work. The purchasing department had to find out what component was in what shipment and contact the consolidation centre or the appropriate forwarder each time a request was made.

In order to save resources at the purchasing department, the manufacturer engaged in a cooperation with an organisation that had developed an information system providing logistical services. The EDI service provider operates and maintains a logistical database management system (DBMS) that can be fed by EDI, and accessed through the use of a variety of applications. The logistical database is able to hold data about shipments in-transit at a line item level of detail.

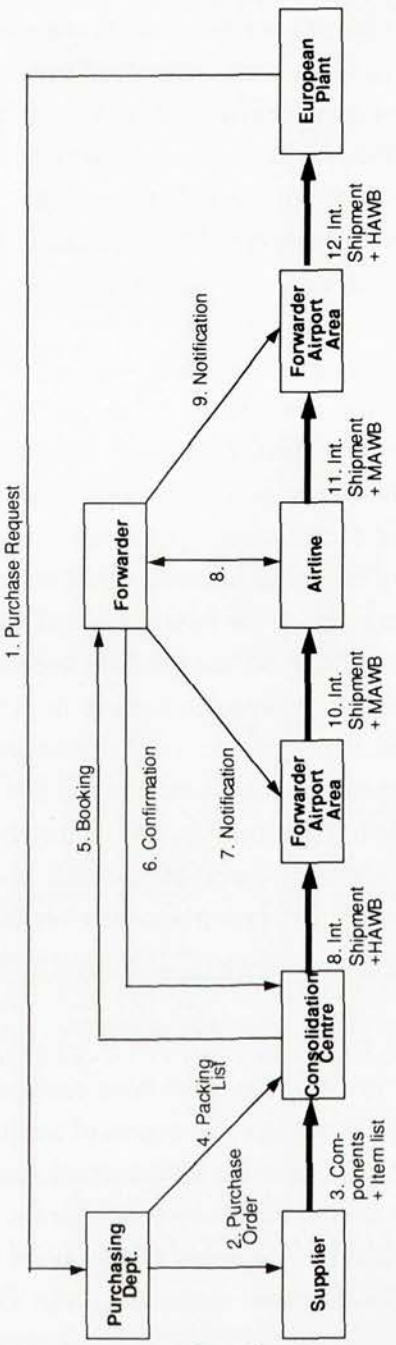


Figure 6-1 Old situation

The EDI service provider set out as a joint-venture between two major U.S. carriers, one airline carrier, and one sea and rail carrier. The joint-venture had started development of the system in 1989 and formally announced it in April 1992. On May 21, 1992, the European division was formed and settled in the Netherlands. At the time of research (March-June 1993), the European division had about 30 employees. The organisation is young and has an organic organisational design, as exemplified by flat hierarchical structures and coordination by mutual adjustment.

As a first phase of the project, the manufacturer and the EDI service provider decided that the logistical flow from four suppliers to two European plants should be tracked by the system. This phase lasted from April 1992 to June 1993. The four suppliers were selected by the manufacturer to participate on the basis of the volume of components purchased for use by the two European plants. The data about the goods in-transit could be entered by suppliers, by the consolidation centre, and by the forwarders, and could be retrieved by the purchase department. In doing so, the purchase department would be able to respond more adequately to information requests from the European plants.

In a subsequent phase of the project, the manufacturer and the EDI service provider intended to introduce more suppliers and goods flows towards more European plants in the EDI partnership, and ultimately make the information accessible to European plants as well. At the time of research (March 1993 until June 1993), the EDI partnership was only beginning to transfer to this phase. Therefore, only the first phase of the project is described in this case.

New situation

In the new situation, the suppliers have been equipped with an application operating on the database management system of the EDI database. They use this application to enter data into the EDI database regarding the components that they are about to ship to the consolidation centre. This shipment data is transferred to the transport management system of the manufacturer by EDI. The translation of the database structure of the EDI database into the

database structure of the transport management system is taken care of by the EDI software provider.

When the supplier's shipment information is available to the transport management system, the components are transformed into new, consolidated shipments together with other shipment data. This saves the consolidation centre from the effort of rekeying the information into the system. The shipment information is directly integrated with the other components data in the transportation management system.

Once the components are consolidated into international shipments, a booking is created, for which a booking document, as well as related freight documents are generated. The booking data, containing the new shipment and component data is transferred back from the transport management system to the EDI database, of course using EDI. The EDI database now contains data about the bookings, the shipments and the components within each shipment.

Once the shipments are booked, the forwarders take care of the delivery to the European plants. The shipments do pass four stages in which the status of the components is tracked. The forwarders use their internal databases and EDI translation software to track the components and to send the appropriate messages to the EDI database. The forwarders have experience with EDI and consider it to be a service to their customers.

These stages and their corresponding status messages are:

1. *Departed from origin*
   This status is entered when the shipment is handed over to the freight forwarder. The status message contains the HAWB number.
2. *Departed from origin airport*
   This status is entered when the shipment has been consolidated and is handed over to the air carrier. This status message contains the MAWB number and the air flight number.
3. *Arrived at destination airport*
   This status is entered when the shipment is handed over to the agent that represents the forwarder in Europe.

4. *Proof of delivery*

   The final status is entered when the shipment is handed over to the European plant.

When the status messages are interpreted and incorporated in the database, the EDI database is filled with data about components, shipments, bookings, and their status. This allows the purchase department to view the status of the components in-transit.

The use of the system is depicted in Figure 6-2.

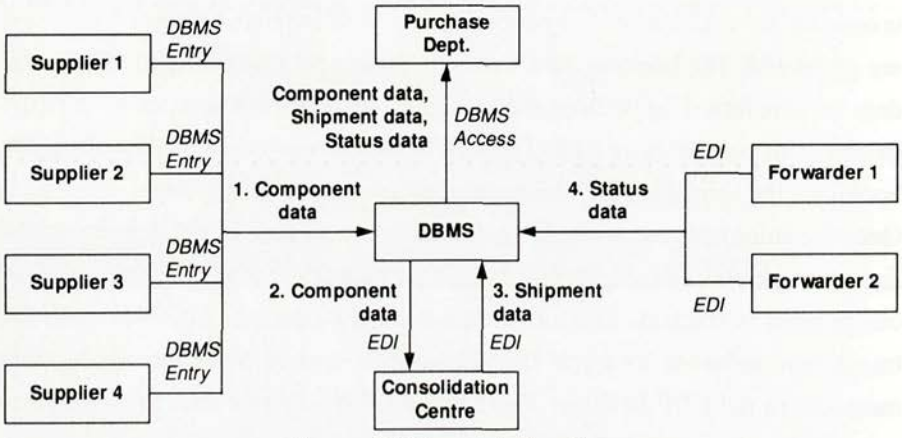


Figure 6-2 Current situation

In the first phase of the project, the introduction of the EDI system has had the following results:

1. The purchasing department has reduced the effort and time it is occupied with requests from the European plants about the shipments of the goods. It can be expected that in the next phase of the project, when the system is installed at the European plants, these requests will be reduced even more, ultimately to a minimum.
2. The need for rekeying information into the transport management system by the consolidation centre is eliminated. This elimination can be regarded as a welcome side effect of the process: since the transport management system uses the shipper's component data for consolidation scheduling,

booking, and document handling, it was necessary to exchange the data from the EDI database to the database of the transport management system.

6.4 Discussion

In this section, the propositions that were derived in chapter four will be applied to the case. The first proposition deals with the influence of EDI use on task formalisation and standardisation of coordination. The second deals with the influence of EDI use on the information processing capacity of the EDI partnership. The third proposition deals with the limited partnership uncertainty in an EDI partnership. The fourth proposition concerns the fit between information processing capacity and information processing requirements in the EDI partnership.

The case description reveals two EDI exchanges: the first between the suppliers and the manufacturer, the second between the forwarders and the manufacturer. In the first exchange, the consolidation centre receives component data from the suppliers for use in its transportation management system. In Figure 6.2, this is depicted with the arrow labelled "2. Component data". The other exchange is from the consolidation centre and the two forwarders to the EDI database, which in turn is accessed by the purchasing department. In Figure 6.2, this is depicted with the arrow labelled and "3. Shipment data", and "4. Status data". At each proposition the two EDI exchanges will subsequently be discussed.

Proposition 1

EDI use positively influences and is positively influenced by formalisation of tasks and standardisation of coordination in EDI partnerships.

The case description points out that at the side of the consolidation centre the orders from the four suppliers do no longer have to be entered into the transportation management application manually. The data in the EDI

message is converted into an input file that the transportation system is able to read. The intensive use of the transportation management system (it is used for consolidation schedules, booking, and preparation of freight documents) indicates that many of the tasks of the consolidation centre have been substantially automated. The case indicates that these tasks, as well as the functionality of the transportation management system has been left "intact". The use of EDI conveys the same formal data as had to be entered manually. This is required, or the data would not be as easily captured into the system.

In order to enter the component data into the EDI database, each of the four suppliers has been equipped with an application operating on the database management system. When shipments of the suppliers are ready, they are requested to enter the shipment data into the EDI database. There are no indications that this added responsibility had an influence on their tasks. The only change is that the data that they filled in on the freight documents is now also entered into the system.

It should be noted that the minimum of change both at the supplier as well as the consolidation centre is a deliberate design choice. The EDI exchange to the consolidation centre is required to take advantage of the transportation management system at the consolidation centre. This system transforms component data into shipment data. Because the suppliers and the consolidation centre do not use the data in the EDI database, they were to be "disturbed" as little as possible. Consequently, neither task formalisation nor standardisation of the coordination between the suppliers and the consolidation centre changed. The current degree of formalisation and standardisation at these parties was not a subject for discussion and was accepted as a fixed variable.

The second EDI exchange concerns the sending of EDI status messages from the consolidation centre and the two forwarders to the EDI database (accessed by the purchasing department). The EDI exchange from the consolidation centre towards the EDI database is required to make the shipment data accessible to the purchase department. The EDI exchange from the

forwarders makes status data about the shipments accessible to the purchase department.

The case study does not indicate a change of tasks at the side of the forwarders, except that they have to issue an EDI message to the EDI database. The forwarders have experience with EDI and consider it to be part of the customer service to the manufacturer.

The case study does indicate an increase in the formalisation of tasks at the purchase department. In the old situation, the information requests from the European plant were processed in an unstructured fashion. There were little "rules" or "procedures" to follow: the requests were handled on an ad hoc basis. Furthermore the coordination was characterised by low standardisation: mutual adjustment between the forwarders, the consolidation centre and the suppliers was necessary to find out the status of the goods.

In the new situation, the task of handling these requests has become more structured and standardised. The procedure is formalised and standardised through the provision of the data in advance by the forwarders. When an information request arrives at the purchase department, the EDI database is accessed and the information is given.

Conclusion from this discussion is that in the first exchange, the use of EDI was constrained by the current degree of formalisation and standardisation, and little to no effect on organisational design could be located. This can be largely attributed to the fact that the first EDI exchange is required for the second EDI exchange: it feeds the transportation management system with component data, so that the transportation management system can transform the component data into shipment data. This shipment data in turn, is send back to the EDI database.

The second EDI exchange reveals a positive influence of the use of EDI on task formalisation and standardisation of coordination. In the second exchange, the use of EDI in a previously unstructured environment was combined with task formalisation and increased standardisation of coordination between the forwarders and the purchase department.

Proposition 2

EDI use positively influences the information processing capacity of the EDI partnership, but negatively influences the information processing capacity of the EDI partnership through increases in task formalisation and standardisation of coordination.

In the case of the consolidation centre, the case shows that the use of EDI has had limited to non-existent impact on the information processing capacity of the consolidation centre. While there are increased benefits in speed of processing the information, they are certainly not substantial relative to the previous situation. Neither has the accessibility of the data had any improvement.

Since the influence of the use of EDI on the task formalisation and standardisation of coordination was also marginal, if not non-existent, the overall effect of the use of EDI on the information processing capacity of the partnership between the suppliers and the consolidation centre is marginal as well.

In the case of the purchasing department, the case supports that EDI use has a positive influence on information processing capacity of the purchasing department. The purchasing department is able to access more data from the transport of goods to the European plants in the new situation than in the old situation. In next phases of the project, for instance when the goods flow to all European plants is being monitored using EDI, the information accessibility of this EDI partnership is likely to increase even more.

The increases in standardisation of coordination and task formalisation on the other hand, represent a shift towards a more mechanistic configuration. It is thus expected to negatively influence the information processing capacity of the EDI partnership. The case indicates that the organisational redesign has decreased the information processing capacity in the sense that: a. the overall response time has been reduced, b. less energy is spend on the processing of the requests. There are no indications from the case that less resources have been allocated or that managerial control has been improved.

Concluding, in the first EDI exchange, the use of EDI influences the information processing capacity of the consolidation centre positively, but only marginally. In the second EDI exchange, the use of EDI positively influences the information processing capacity by increasing the accessibility of data from the suppliers and the forwarders. Substantial task formalisation and standardisation of coordination on the other hand resulted in an overall decrease of information processing capacity for this particular task. The shift to a more mechanistic configuration decreased the amount of time and energy necessary to process information and freed resources for other, more organic forms..

Proposition 3

Partnership uncertainty is limited in EDI partnerships in the presence of asset specificity and mutual trust.

This case is an example of an EDI investment that is combined with an adjustment of rules and procedures. These procedures are strongly dedicated to the partnership, consequently they show asset specificity to a substantial extent (cf. Ribbers et al., 1994). The procedures are customised for the participants in the partnership. The dedicated investments require the partners to know each other and their operations, reason why asset specificity decreases the information processing requirements with respect to partners.
Application of similar rules and procedures in other settings is not intended, at least not in the first phase. In subsequent phases, the EDI system will be used by other forwarders and suppliers as well. It can be expected that the application of the EDI system will be more generic. Under those circumstances, the investments will be less specific, but still customised to such an extent that it enforces participants to have knowledge of the partners for which the investments are meant. In those situations, decreased asset-specificity may lower partnership uncertainty only marginally.
In the EDI partnership from the previous chapter, the presence of a high degree of trust is not mentioned explicitly in the case. Also in this case, the

presence of mutual trust does not really seem to play a substantial role. With respect to the three types of trust mentioned in chapter four, the presence of process-based trust and institutional-based trust seems apparent. Process-based trust is based on past exchanges: since the manufacturers, the suppliers, and the forwarders have long-term relationships, they have a long record of past operations. Institutional-based trust is based on formal mechanisms such as professionalism, and legal protection. Since the manufacturer, the suppliers, and the forwarders employ legally enforceable contracts, this type of trust is also present.

The role of mutual trust not being substantial with respect to partnership uncertainty in this case, it can be assumed that market power of the manufacturer over the suppliers and the forwarders appears to be an additional determinant that lowers partnership uncertainty. It is well possible that the fact that the suppliers and forwarder are dependent on the manufacturer strongly influences the compliance of the participants.

Proposition 4

Under conditions of organisational effectiveness, information processing capacity of the EDI partnership matches the information processing requirements of the EDI partnership.

The case study shows that the information processing requirements of the consolidation centre have not substantially changed because of the project. This is illustrated by the fact the component data follows the same procedures as the component data from the item lists. A substantial change is also not expected according to the theory, for limited impact on information processing capacity was reported as well.

With respect to the purchasing department, the case study indicates that the information processing requirements have not changed with respect to partnership uncertainty or environmental uncertainty. The information requests from the European plants belong to the environmental uncertainty of the EDI partnership. The information processing requirements from the

environment have neither increased, nor decreased: the case study reports that at least in the first phase of the project, the number of requests was the same. The task uncertainty on the other hand has been substantially decreased. The complexity of the tasks of the purchasing department has been decreased: it is now much more possible to predefine the task in advance, which makes the tasks less complex. Furthermore, a change in task interdependency can be witnessed.

In the previous situation, a request had to be processed by the purchasing department, and the purchasing department in turn needed to contact one of the suppliers, the consolidation centre, or one of the forwarders. This indicates *reciprocal* interdependence between the suppliers of information and the recipient of the information: the purchasing department has to wait for the answer of the information sender, and the information senders have to "wait" for the request of the purchasing department.

In the new situation, while the purchasing department still requires the outputs of the information sender, the information senders no longer wait for a request. Rather they provide the information instantly as soon as it is available. This indicates a shift towards *sequential* interdependence.

Interestingly, Thompson's (1967) mappings of coordination mechanisms on types of interdependence are applicable in this case. The shift from reciprocal interdependence to sequential interdependence was matched by a shift from mutual adjustment to standardisation of coordination. In information processing terms, the decrease in information processing requirements induced by sequential interdependence matches a decrease in information processing capacity induced by standardisation.

It is useful to examine the consequences of the next phases of the EDI project in more detail, to see if some predictions can be drawn. In the next phases of the project more logistical flows will be monitored, which implies the inclusion of more suppliers and more forwarders. Also, the participants intended to grant the European plants access to the EDI database.

The access of the European plants to the EDI database implies among other things that their tasks cease to be part of the environment of the partnership,

and belong to the tasks included in the model. Also, the increased access to structured data would increase their information processing capacity. Since the next phase of the project entered as the time of the research drew to an end (June 1993), it was not possible to examine the effects on task formalisation and standardisation at the European plants in more detail.
However, one representative of the manufacturer presented the benefits of the new situation at a U.S. conference at a time when the EDI partnership was entering the second phase (June 1993). He mentioned the following benefits:

1. The shipment data entered by the suppliers and the forwarders, thus derived from various sources, is transformed into a single source of information
2. The use of a single database allows for relatively easy installation of new data providers
3. The need for rekeying information into the transport management system by the consolidation centre is eliminated
4. The consolidation centre is able to improve the load management through more efficient consolidation of components.
5. The European plants are able to improve the planning of the distribution of goods. Improvements are possible because in the new situation the opportunity exists to intercept and re-route the flow of components.

The fifth benefit seems to offer support to the prediction that European plants are able to face increased information processing requirements. The executive reports the ability to intercept and re-route the movement of goods. This indicates an increase in task interdependence between the task "distribution planning" of the European plant and the transportation of the forwarder. In the old situation, these tasks were sequentially dependent: distribution scheduling could start when the goods arrived in Europe. In the new situation, these tasks are reciprocally interdependent: distribution scheduling still depends on the transportation, but transportation is now also dependent on distribution scheduling.

In the old situation, the information processing requirements for intercepting and re-routing goods movement were too high. The European plant had no sufficient information processing capacity to handle these requirements because it had limited access to the required information. It had to contact the purchasing department, which in turn had to contact the consolidation centre or the appropriate forwarder. The forwarder had to look through the files to locate the status of the goods. Eventually, the status of a particular line item was returned to the purchase department, who returned this information to the European plant. The process took too much time and took up too many resources to turn this procedure into standard working rules. Thus, reciprocally interdependent transportation was hardly possible as it generated too much information processing requirements. However, with the increased information processing capacity of the European plant, such interception becomes viable as it takes less time and takes less resources to find out the exact status of the goods and redirect them when needed.

6.5 Summary

In this chapter the propositions were applied to an EDI case in international transport. After an introduction to the transportation industry and to EDI applications in transport, the case was described. After the case description, the propositions were applied and discussed.

Two EDI exchanges were identified in the EDI partnership. The first EDI exchange concerns the exchange between the suppliers' component data and the transportation management system. This exchange showed only a modest positive influence on information processing capacity of the partnership, and no change in information processing requirements. It was pointed out that the primary purpose of this EDI exchange was to assist the information accessibility for the purchase department, and had to leave the procedures at the consolidation centre intact.

The second EDI exchange concerns the sending of EDI messages from the forwarders and the consolidation centre to the EDI database. These EDI exchanges showed an increase in information processing capacity by

increasing the accessibility of structured data. Furthermore, a shift from an organic configuration to a mechanistic configuration could be witnessed, leading to an overall decrease of information processing capacity. This decrease in information processing capacity was matched by a decrease in task complexity and a shift in interdependence from reciprocal to sequential interdependence. Additionally, partnership uncertainty was limited in the EDI partnership. Again, power of the manufacturer and dependency of the suppliers and the forwarders were pointed out as a determinant of partnership uncertainty.

This chapter ended with a prediction regarding the next phases of the EDI project. Specifically, the ability to face increased information processing requirements of the European plants was proposed. The manufacturer presented the ability to re-route and intercept goods flows: this would indicate a shift from sequential to reciprocal interdependence in the relationship between the manufacturer and the forwarder: implying increased information processing requirements.

7. Conclusions

7.1 Introduction

The primary aim throughout this thesis has been to build a theory that relates EDI use to organisational design. First, the organisational design literature was studied in more detail onto their use of information technology variables. Next the use of EDI was related to a set of these parameters and linked to organisational performance using the information processing perspective to organisational design. This framework in turn was modified in order to be applicable to EDI partnerships. Finally, a set of propositions conveying the basic line of argument was held against two empirical cases to investigate whether support for the propositions could be found in practice.

In this final chapter the results of the study will be outlined. In the next section, the major conclusions and contributions of the dissertation will be presented. Following to these conclusions is a discussion on the implications of these findings for practice. Finally, a number of suggestions for further research is given.

7.2 Conclusions

Four major conclusions can be derived from the research work reported in this dissertation. The first conclusion presents a general finding on the relationship between EDI use and organisational design parameters. The second conclusion presents the combined effect of EDI use on the information processing capacity of the organisation. The third conclusion presents findings concerning the fit relationship in the information processing perspective. The fourth conclusion is on the applicability of these findings in EDI partnerships. They will subsequently be discussed.

Conclusion 1
EDI use favours and is favoured by a mechanistic configuration of organisational design.

In this dissertation a number of organisational design parameters has been reviewed, as well as the conditions under which they take a certain value. One important observation from this review is that design parameters can hardly be seen in isolation from each other: many design parameters show strong interdependence. The interdependence of the design parameters is one important enabler for the rise of *configurations*, i.e. types of organisational design that have strongly related values for the organisational design parameters (see e.g. Mintzberg, 1979).
In the organisational design literature configurations can be classified to the extent that they are more mechanistic or more organic (see e.g. Tushman & Nadler, 1978). The mechanistic configuration, is, among other things, characterised by substantial *prespecification* of organisational behaviour. For instance, task execution and coordination mechanisms are substantially prespecified: mechanistic configurations show high degrees of task formalisation, and high degrees of standardisation of coordination. The organic configuration, is, among other things, characterised by less prespecification of the organisational behaviour. Consequently, the organic

configuration shows lower degrees of task formalisation and lower degrees of standardisation of coordination.

In this dissertation it has been argued that the use of EDI is strongly related to mechanistic configurations of organisational design. One important argument for this relationship is that the use of EDI requires organisations to prespecify their exchange of data to a substantial degree. Since the prespecification of data exchange is encouraged, if not determined, by prespecification of tasks and coordination, it can be expected that the use of EDI favours, and is favoured by mechanistic configurations of organisational design. The two cases discussed in the dissertation also support this relationship.

This conclusion has a number of implications. First of all, it points at strong influences of EDI on the prespecification of behaviour in and between organisations. Thus, in those situations where prespecification is non-existent or not substantial, organisations can hardly benefit from the use of EDI unless they are willing to formalise and standardise the inter-organisational relationship. Whether this is possible or desirable is, at least to a certain extent, for the organisations to decide.

In chapter three it was argued that complex, higher level tasks embody routine, lower level tasks. For example, a purchasing department of a large company faces the complex task of purchasing, which embodies at least the routine task of administer purchase decisions. A second implication of the first conclusion is that EDI is particularly appropriate for the lower level tasks. For routine tasks, the information processing perspective suggests a mechanistic structure, and for complex tasks an organic structure is suggested.

A third implication of the conclusion is that it points at the value of international, national, and sector standardisation of EDI messages and trade scenario's. International standardisation is of substantial value to the use of EDI in and between organisations, because it can aid in prespecifying the required behaviour. Organisations that are not willing or able to benefit from the efforts of international standardisation will either a) hardly be able to benefit from EDI or b) have to develop standards on their own.

A fourth implication of the first conclusion is that it points at directions for the relationship of EDI use to organisational performance. Since the use of EDI strongly relates to mechanistic configurations of organisational design, it follows that the influence of EDI use on organisational performance is strongly related to the influence of mechanistic configurations on organisational performance. In this dissertation, this relationship has been investigated in more detail.

Conclusion 2
Besides a direct positive influence on the information processing capacity of the EDI partnership, EDI use also has an indirect negative influence through the positive influence on task formalisation and standardisation of coordination.

According to the information processing perspective to organisational design, mechanistic and organic configurations are designed to achieve a certain level of *information processing capacity*. Information processing capacity is defined as the capacity to gather, interpret, and synthesise information in order to deal with uncertainty in the context of organisational decision making.

Following Galbraith (1973; 1979) and Tushman & Nadler (1978) it was argued that mechanistic and organic configurations of organisational design have different influences on information processing capacity. Specifically, organic configurations have *more* information processing capacity than mechanistic configurations. The rationale for this argument is as follows. Mechanistic organisations are concentrated on a predefined set of future events. If uncertainty increases, the mechanistic organisation treats events that the bureaucracy cannot handle as exceptions. Eventually, uncertainty becomes significant to such an extent that future events are to be treated as exceptions more likely than not. Under those circumstances, the use of, and need for bureaucracy decreases. It is at this point that organic configurations enter. These organic configurations are better able to treat larger degrees of

uncertainty, and in the terminology of Tushman & Nadler, they consequently have a larger information processing capacity. Organic configurations are used in situations with high information processing requirements, and mechanistic configurations are used in situations with low requirements.

A simple example of the use of an organic vs. a mechanistic configuration occurs when exceptions need to be handled by routine tasks. Routine tasks are taken care of in a formal, standardised, i.e. mechanistic way. However, when something goes wrong, the organisation temporarily adopts an organic configuration. For instance, coordination by mutual adjustment is then needed to meet the increased information processing requirements.

One implication of the information processing perspective is that as the configuration becomes more mechanistic, in the terminology of Tushman & Nadler, it looses information processing capacity. By focusing upon a predefined set of future events, the organisation is no longer able to anticipate upon each and every uncertain event that will happen in the future. On the other hand, by focusing upon a predefined set of future events, the organisations are able to develop rules and procedures to handle those. Thus, while the organisation looses some of its information processing capacity, it also reaps benefits of greater effectiveness. These advantages become for instance manifest in lower response times, and resource parsimony.

In this dissertation we have examined the impact of EDI use on the information processing capacity of the organisation. The use of information technology in general contributes to this information processing capacity by improving the accessibility of data (see e.g. Huber, 1990a). The use of EDI in particular contributes to this information processing capacity by improving the accessibility of *structured* data. Not only is EDI able to speed up the exchange of structured data, it is also possible to convey more detailed data to more applications than conventional message exchange.

On the other hand, since EDI use is strongly related to mechanistic configurations of organisational design, it follows that EDI use has, besides a direct positive, also an indirect negative influence on information processing capacity. This is because by positively influencing task formalisation and

standardisation of coordination, the organisation also adopts a more mechanistic configuration. In adopting a more mechanistic configuration, it looses information processing capacity.

It should be emphasised that a decrease in information processing capacity is not at all necessarily negative for organisational effectiveness. On the contrary, if the organisation faces lower information processing requirements, the model argues a decrease in information processing capacity to be more effective. Typically, organic configurations show longer response times, require more energy and resources spent, and are less amenable to managerial control in situations with low information processing requirements than mechanistic configurations (Tushman & Nadler, 1978). In those situations, shifts to more mechanistic configurations imply greater effectiveness: decreases of response times, less energy and resources spent and more control over operations. Under conditions of organisational effectiveness, information processing capacity should match information processing requirements. Thus, under low information processing requirements, mechanistic configurations are appropriate, whereas under high information processing requirements, organic configurations are appropriate.

This conclusion conveys a novel and important contribution of this research to the current literature on the value of EDI for organisational design. It points at the fact that the influence of EDI use on information processing capacity is neither exclusively positive nor negative. The degree to which EDI use induces a shift towards more mechanistic configurations and the degree to which EDI improves structured data accessibility determine to a large degree what the net effect of EDI use on information processing capacity will be.

The conclusion also points at the reason why organisations that face high information processing requirements will find the use of EDI less practical. This is because high information processing requirements require an organic configuration. Since EDI use favours, and is favoured by mechanistic configurations, it can be expected that the positive influences of EDI will be outweighed by the negative influences on information processing capacity. An example of the dangers of increased task formalisation induced by EDI is

given by Konsynski (1992), as he discusses a number of major mistakes that managers can make in the decision to use EDI:

> *"Managers forget the importance of the informal and formal structure. Informal relationships are lost in the creation of formal relationships. If we create a formal relationship, what informal relationships that really made the system work in the past are no longer operative? As an example, one organisation that established an EDI linkage created a three or four day delay in their processing, because the informal channel in the past had alerted them to orders via phone calls. Now orders had to go through their formal procedures within the various organisations, and this actually introduced delays"* (Konsynski, 1992:97)

Using the model developed in this dissertation, it can be argued that in this example the organisation lost information processing capacity in adopting EDI. The adoption of EDI positively influenced the reliance on formal procedures. In this example, this increased reliance on bureaucracy was undesirable because the organisation also needed to rely on organic design as expressed by the coordination by mutual adjustment (phone calls) in order to handle orders.

This conclusion has also implications for the relationship between information processing capacity and the use of information technology in general. The use of information technology is not necessarily restricted to mechanistic configurations, as applications such as E-mail and video-conferencing show. The conclusion indicates that in order to assess the impact of the applications of IT on information processing capacity, a first assessment needs to be made on whether the application supports a mechanistic or an organic configuration. Through explicitly focusing on EDI in this dissertation, the effects on mechanistic organisation could be explicitly isolated.

It should be noted that the use of EDI to decrease the information processing capacity for routine, less interdependent tasks may free up resources to increase information processing capacity for complex, highly interdependent tasks. Thus, the resources saved may be used to shift towards more organic

configurations for other tasks and other environments that the organisation faces. This dissertation however has focused on the first order effects of EDI (e.g. saving resources) and not on the second order effects (e.g. spending saved resources).

Conclusion 3
Under conditions of organisational effectiveness, the effect of EDI use on information processing capacity matches the information processing requirements.

This conclusion is a version of the core concept of the information processing perspective to organisational design: that information processing capacity should match information processing requirements. If the effect of EDI use on information processing capacity is overall positive, the information processing requirements can be raised. For instance, in the case documented in chapter five, the increased accessibility of assembly line information allowed the supplier to increase the complexity of the tasks.

On the other hand, if the effect of EDI use on information processing capacity is overall negative, the information processing requirements must be lowered. For instance, in the case documented in chapter six, the decreased information processing capacity of the purchasing department was matched by a decrease in task complexity and a shift from reciprocal interdependence towards sequential interdependence.

One important implication of this conclusion is that, under conditions of increased information processing capacity, the use of EDI enables organisations to handle increased information processing requirements. This enables organisations for example to increase task complexity, increase task interdependence, or handle increased environmental uncertainty. Under conditions of decreased information processing capacity, the use of EDI may force the organisation to handle decreased information processing requirements. This may force organisations for example to decrease task

complexity, decrease task interdependence or handle decreased environmental uncertainty.

Conclusion 4
EDI partnership uncertainty is limited in the presence of asset specificity, trust, or the ability to exert power by one or more participants over the others in the partnership.

The information processing perspective to organisational design has originally been developed under the assumption of an organisational level of analysis. EDI however is commonly, although not necessarily, implemented between organisations. Different organisations implementing an EDI system are called an EDI partnership. In this dissertation the information processing perspective to organisational design was applied to EDI partnerships.
Among the major modifications that need to be made to the model is the inclusion of *partnership uncertainty*. In the preliminary theoretical model, partnership uncertainty has been argued to be influenced by the degree to which the investments are asset-specific, and the degree to which the parties in the partnership trust each other. In the cases discussed in this dissertation, an additional determinant of partnership uncertainty was located: power. Specifically, the ability to exert power by one or more participants over the partnership contributed to limited partnership uncertainty. In the case documented in chapter five, power was exerted by the assembler on the supplier. In the case documented in chapter six, power was exerted by the manufacturer on the suppliers and (although less) on the forwarders.

7.3 Implications for practice

Throughout this dissertation a primary accent was placed on theory building. Theories and perspectives on organisational design have been explored, and two cases were described to confront important relationships with current practice. Certainly, the preliminary theory that has been developed in this

chapter needs further research and additional confrontation with empirical material. Nevertheless, some important implications for practice can be pointed out. It is however, with necessary reservations that these implications should be read and understood.

The implications for practice have tentatively been formatted into "EDI success factors". Certainly, there are many other success factors to the development, implementation, and use of EDI (see e.g. Bjorn-Anderson & Krcmar, 1995). The EDI factors discussed here are the ones that can be derived from the work in this dissertation. These factors for EDI success are: 1) the presence of, or need for a formal configuration of organisational design, 2) an adequate match with information processing requirements, and 3) low partnership uncertainty.

1. *The presence of, or need for a mechanistic configuration of organisational design*

   The research indicates that EDI is more successful in inter-organisational relationships that are, or need to be, substantially formalised and standardised. Organisations willing to implement EDI should carefully consider whether behaviour and interaction in the inter-organisational relationship can, or need to be prespecified. If this is not the case, EDI will be a less suitable information technology, and EDI will probably fail to contribute to organisational effectiveness. The research indicates that there are many situations when prespecification of behaviour and interaction is not possible because the uncertainty is simply too high. Still implementing EDI under those circumstances will require mechanistic parameter settings in situations where organic structures are more effective.

2. *An adequate match with information processing requirements*

   The research indicates that EDI is more successful when its impact on information processing capacity is matched by a similar change in the information processing requirements. For instance, if the organisation operates in more uncertain environments, or deals with tasks that have higher complexity and interdependence, EDI may be used to substantially increase the information processing capacity of the organisation. Similarly,

if EDI is combined with shifts from organic to mechanistic configurations, this enables organisations to decrease task complexity and task interdependence. Under those circumstances that EDI creates information processing capacity surplus or shortage, implementing EDI does not contribute to organisational effectiveness.

3. *Low partnership uncertainty*

   The research indicates that EDI exchange benefits from limited partnership uncertainty in EDI partnerships. This limited uncertainty is either created by asset specificity, trust, power considerations, or both. Organisations willing to implement EDI should carefully consider whether there is sufficient power or trust in the relationship to ensure limited partnership uncertainty. Under those circumstances where partners do neither trust each other nor where power can be sufficiently exerted to comply, organisations face high partnership uncertainty. High partnership uncertain in turn, increases the information processing requirements, and consequently, a shift to mechanistic configurations as induced by EDI does not seem likely to contribute to organisational effectiveness.

7.4 Recommendations for further research

A number of aspects in this dissertation deserves more attention in future research. Furthermore, the model could benefit from a number of extensions. Both the possible extensions as well as the aspects of the model that need further attention are largely theoretical in nature, implying that current theory is still to premature to test in a more rigorous manner.

A first aspect of the model that needs more research is the concept of fit and organisational performance. In this dissertation, the problem of measuring changes in organisational performance was circumvented by locating indicators for information processing capacity shortage or information processing capacity surplus. Recent advancements in the measurement of organisational performance (e.g. Daft, 1989) such as stakeholder approaches could be used to advance measurement in this respect.

A second aspect of the model that needs more research is the concept of power and its relationship to partnership uncertainty. In the preliminary theoretical model, trust and asset specificity were considered determinative for partnership uncertainty. In the cases power and dependency considerations in the inter-organisational relationship also added to partnership uncertainty. The examination of power- and trust-related issues in the context of EDI is relatively new (see e.g. Webster, 1993; 1994). While this dissertation has focused on their contribution to partnership uncertainty, power and trust considerations permeate the EDI relationship and deserve more attention.

Possible extensions to the framework developed in this dissertation can be the further examination of the influence of other organisational design parameters on the information processing capacity of the organisation. In doing this, many parameters for which the *ceteris paribus* condition held can be incorporated in the model. This in turn will make the model more stable and less vulnerable to the ceteris paribus conditions in further examinations of support in practice.

One tentative parameter that is worth investigating is the centralisation and decentralisation of authorities in an organisation. Previous research has linked centralisation to formal configurations, and decentralisation to informal configurations (e.g. Mintzberg, 1979). This would indicate that EDI use favours and is favoured by centralisation of operations. Since the influence of information technology on centralisation and decentralisation is still subject to heated debate (e.g. George & King, 1991), this proposition clearly needs further research.

Depending on the different tasks and the different environments that an organisation faces, it is designed in organic and/or mechanistic ways. In this dissertation the focus has been on the "what" question, i.e. what types of organisational designs are appropriate under what circumstances. Clearly what is important as well is the "how" question, i.e. how do organisations manage to change from mechanistic to organic designs and vice versa. The organisation may employ single loop and double loop learning (see e.g. Argyris & Schon, 1978) to learn how to adapt to different degrees of

uncertainty in tasks and environments. For instance, employing double loop learning implies that the perspective of the organisation towards a certain problem is questioned. Using double loop learning, changes in tasks and environment may lead the organisation to question its organisational structure and shift towards another one. The actual process of shifting from one structure to another is a very important research area and a potential field for future research.

Another extension to the model is the use of other applications of information technology. It has been argued in this dissertation that researchers should first assess whether the information technology application contributes to a formal configuration or an informal configuration of organisational design. When this assessment has been made, further influences on the information processing capacity of the organisation can be predicted.

An example to illustrate the applicability of the model to other information technologies is the example of video-conferencing. The use of video-conferencing supports organic configurations of organisational design in favour of mechanistic ones. This is for example because it supports mutual adjustment of coordination. One implication of the relationship is that it enhances information processing capacity not only by increasing the accessibility of unstructured data, but also by its negative effect on task formalisation and standardisation of coordination. Under conditions of high information processing requirements, video-conferencing is more likely to be applied than EDI. The differences for the model are depicted in the Figure 7-1.

It should be emphasised that EDI and videoconferencing can be used in complementary ways, rather than that they should be interpreted as substitutions. Thus, under low information processing requirements, mechanistic configurations and use of EDI are appropriate, and under high information processing requirements, organic configurations and use of videoconferencing are appropriate.

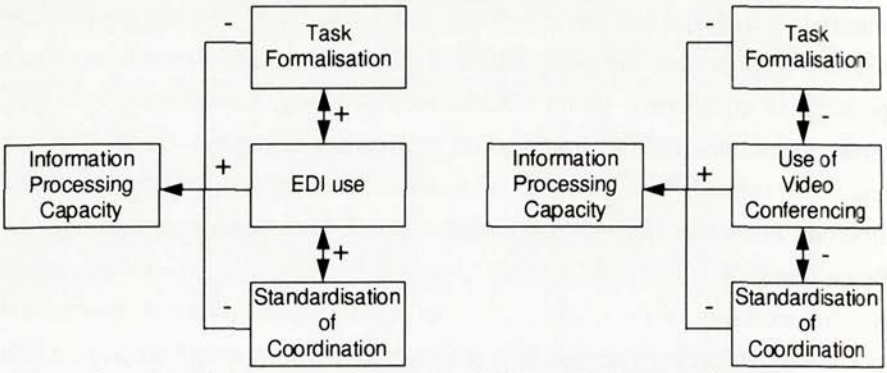


Figure 7-1 Influences of the use of EDI and video-conferencing on information processing capacity

It is interesting to note that if the "use of EDI" and the "use of videoconferencing" are overlapped, for example by naming it "use of IT", the effect on task formalisation, standardisation of coordination becomes inconclusive. This illustrates that IT use by itself is able to contribute both to mechanistic as well as organic configurations, and that distinct influences can only be identified when a particular application of information technology, such as EDI or videoconferencing, is investigated.

Another interesting path is a closer examination of the socio-technical systems approach to see whether the concepts identified are consistent with this approach, and whether additional, relevant concepts can be found. Parallel to these improvements and extensions of the current theory, further support for constructs and relationships in practice can be examined. At this stage of the research, case studies still seem to be the most valuable sources of input. When relationships identified in the theory reach more or less stable patterns and are less vulnerable to ceteris paribus conditions, a more rigorous approach towards testing theory can be pursued.

In this dissertation, the relationship between EDI use and organisational redesign in EDI partnerships has been investigated in more detail. An attempt was made to shed some more light on this interesting and relevant subject. Throughout the thesis, an accent has been laid upon theory building. It is in this area that the main contributions of this dissertation can be located. One contribution is the further application of information processing perspective towards organisational design in the field of IS. While this perspective seems especially relevant for investigating the relationship between IT use and organisational design, it has not gained widespread use in the IS literature. In this thesis we have adopted this approach and shown how IT variables are linked to organisational design variables: primarily by the ability of IT to allow better access to structured and unstructured data. A second contribution is the further exploration of organisational redesign in inter-organisational relationships. This dissertation has examined the nature of EDI partnerships in more detail, and argued that partnership uncertainty is low in the presence of asset specificity, trust, and power considerations. A third contribution of this work is the recognition of the combined effect of EDI use on the degree to which an organisation is able to handle uncertainty. As with practically all applications of information technology, this effect is positive in the sense that it improves information accessibility. On the other hand, the use of EDI is strongly connected with mechanistic as opposed to organic configurations. Shifts from organic to mechanistic configurations represent lower capacity to deal with uncertainty. Thus, by positively influencing mechanistic configurations, the effect on information processing capacity can be indirectly negative. This effect is novel and important, because it has implications for many researchers attempting to unfold the relationship between IT use and organisational redesign. It suggests that they should distinguish between information technologies for structured, and for unstructured data.

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SAMENVATTING

"Towards organisational redesign in EDI partnerships"

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In deze dissertatie staat de mogelijke invloed van *electronic data interchange* (EDI) op de organisatiestructuur van een samenwerkingsverband van meerdere organisaties centraal. EDI wordt gedefinieerd als de gestructureerde en gestandaardiseerde uitwisseling van gegevens tussen computer applicaties over een electronisch transmissie-medium. EDI wordt vaak, alhoewel zeker niet exclusief, tussen organisaties toegepast. Organisaties die met behulp van EDI gegevens uitwisselen noemen we een EDI-samenwerkingsverband.
In de tweede helft van de jaren tachtig werd het toepassen van EDI in de eerste plaats voorgeschreven om concurrentievoordeel te behalen. In de eerste helft van de jaren negentig worden hierop enkele nuances aangebracht. Zo blijken de meeste EDI-applicaties helemaal niet direct te worden ingezet om concurrentievoordeel te behalen. Daarenboven zijn de voordelen van EDI in het algemeen niet zo heel groot of duidelijk omschreven. Als belangrijkste factoren om van het EDI-systeem toch een success te maken worden gezien het mede veranderen van de bedrijfsprocessen en het aanpassen van de organisatiestructuur.
In deze dissertatie staat de relatie tussen organisatiestructuur en EDI in EDI-samenwerkingsverbanden centraal. De doelstelling van dit onderzoek is drieledig. In de eerste plaats willen we bepalen welke organisatie-ontwerpparameters kunnen worden beïnvloed door EDI. In de tweede plaats wordt een conceptueel raamwerk ontwikkeld waarin de mate van EDI-gebruik in verband wordt gebracht met deze parameters. Dit model is intra-organisatorisch. In de derde en laatste plaats willen we daarom het model

uitbreiden naar inter-organisatorisch beschouwingsniveau en het model aanpassen indien nodig.

De aanpak van het onderzoek bestaat uit een theoretische verdieping en een confrontatie van de theorie met de praktijk. In hoofdstuk twee, drie en vier van de dissertatie wordt het conceptuele raamwerk stapsgewijs opgebouwd. Daarbij is gekozen voor de informatieverwerkingsbenadering, een benadering die afkomstig is uit de organisatie-ontwerpliteratuur. De confrontatie van het theoretische onderzoeksmodel geschiedt aan de hand van twee cases uit de praktijk. De eerste case is reeds eerder beschreven en bevat een herontwerp van het logistieke besturingsconcept. Voor de tweede case is onderzoek gedaan bij een EDI-dienstverlener. Deze case betreft een herontwerp van de informatievoorziening bij internationaal transport.

In het tweede hoofdstuk van deze dissertatie wordt bepaald welke organisatie-ontwerpparameters beïnvloed kunnen worden door EDI-gebruik. Bij het vaststellen van de parameters baseren we ons op grotendeels op Mintzberg's werk uit 1979, "the structuring of organisations". In dat werk onderscheidt Mintzberg vier aandachtsgebieden, of *clusters* van parameters.

Na een analyse van eerder werk op het kruispunt informatietechnologie vs. organisatieontwerp observeren we dat de relaties tussen variabelen niet helemaal duidelijk zijn, en dat dit onderzoek verschillende, en soms zelfs conflicterende relaties laat zien. Niettemin kan worden geconstateerd dat informatietechnologie tenminste van invloed kan zijn op het gebruik van verschillende coördinatiemechanismen en op de graad van formalisatie binnen de organisatie.

In het derde hoofdstuk wordt een voorlopig raamwerk opgesteld waarin het gebruik van EDI wordt gerelateerd aan deze variabelen. Bij het opstellen van dit raamwerk wordt dankbaar gebruik gemaakt van de informatieverwerkings-benadering. Deze benadering conceptualiseert organisaties als informatie-verwerkende netwerken en geeft aan dat organisaties hun informatie-verwerkende capaciteit in overeenstemming moeten brengen met de eisen die taken en omgeving aan de informatieverwerking stellen. De "fit" tussen

informatieverwerkingseisen en informatieverwerkende capaciteit van de organisatie bepaalt de effectiviteit van de organisatie.

De informatieverwerkingseisen aan de organisatie worden, zoals gezegd, bepaald door de taken die de organisatie heeft en de omgeving waarin zij verkeert. In het model wordt dit gerepresenteerd door taak onzekerheid en omgevingsonzekerheid. Taakonzekerheid kan worden gedecomposeerd in taak complexiteit en onderlinge taakafhankelijkheid. De complexiteit van een taak wordt gedefinieerd als de mate waarin het mogelijk is de uitkomst van de taak vooraf vast te stellen. Wat betreft de onderlinge afhankelijkheid van taken bestaan er drie mogelijkheden. In het eerste geval, *pooled interdependence*, zijn de taken wel onafhankelijk, maar putten ze uit dezelfde schaarse middelen. In het tweede geval, *sequential interdependence*, zijn de taken sequentieel van elkaar afhankelijk: een taak kan niet worden volbracht zonder dat een andere taak volbracht is. In het derde en laatste geval, *reciprocal interdependence*, zijn de taken wederzijds afhankelijk. Een taak kan niet worden volbracht zonder dat een andere taak volbracht is, en vice versa. In het algemeen kan gesteld worden dat de informatieverwerkingseisen stijgen naarmate de taak complexiteit toeneemt, de onderlinge taakafhankelijkheid toeneemt, en de omgevingsonzekerheid toeneemt.

De informatieverwerkingscapaciteit van de organisatie wordt tenminste bepaald door de formalisatie van de taken, de standaardisatie van de coördinatie, en de mate van EDI-gebruik. Formalisatie van taken kan worden gedefinieerd als de mate waarin de taken vooraf zijn gespecificeerd, standaardisatie van coördinatie als de mate waarin de afstemming tussen de taken vooraf is gespecificeerd. Hoe minder de uitwerking van taken en coördinatie vooraf wordt vastgelegd in regels en procedures, hoe beter de organisatie kan omgaan met een grote mate van onzekerheid. In organisaties met eenvoudige taken en een stabiele omgevingen komen we daarom veel taak formalisatie en standaardisatie van coördinatie tegen: de informatieverwerkende capaciteit van de organisatie dient laag te zijn. In organisaties met meer complexe taken en dynamische omgevingen komen we juist weinig formalisatie en standaardisatie tegen: de informatieverwerkende capaciteit van de organisatie dient hoog te zijn. In zijn algemeenheid kan

gesteld worden dat taak formalisatie en standaardisatie van coördinatie de informatieverwerkende capaciteit van de organisatie negatief beïnvloeden. Het is van belang op te merken dat informatieverwerkende capaciteit *geen* indicator is voor effectiviteit en dat de organisatie juist gebaat kan zijn bij lage informatieverwerkende capaciteit (nl. wanneer de informatieverwerkingseisen laag zijn).

In het algemeen kan gesteld worden dat EDI, zoals elke toepassing van informatietechnologie, de informatieverwerkende capaciteit van de organisatie verhoogt. Dit omdat de beschikbaarheid van gestructureerde gegevens met behulp van EDI kan worden vergroot. Omdat ten behoeve van EDI een gestructureerde en gestandaardiseerde gegevensuitwisseling vereist is, wordt daarnaast beargumenteerd dat de mate van EDI gebruik, de mate van taakformalisatie, en de mate van standaardisatie van coördinatie elkaar positief en wederzijds beïnvloeden.

Naast een direct positief effect ontstaat daardoor een indirect negatief effect van EDI-gebruik op de informatieverwerkende capaciteit van de organisatie. Dankzij EDI-gebruik is de organisatie beter in staat met onzekerheid om te gaan. Aan de andere kant echter kan met de toepassing van EDI een dermate substantiële structuring van taken en standaardisering van coördinatie samengaan dat de capaciteit om met een grote mate van onzekerheid om te gaan juist wordt verminderd.

In het vierde hoofdstuk wordt het voorlopige model toegepast op een samenwerkingsverband van meerdere organisaties. In dit hoofdstuk wordt een recent ontwikkeld model besproken waarin de informatieverwerkende benadering wordt toegepast op inter-organisatorische relaties. Positionering van het voorlopig conceptueel raamwerk t.o.v. dit model leidt tot een drietal aanpassingen aan het raamwerk. In de eerste plaats wordt het niveau van analyse opgetrokken van het intra-organisatorisch niveau naar het inter-organisatorisch niveau van het samenwerkingsverband. Dit heeft onder meer tot gevolg dat niet langer de informatieverwerkingseisen en de informatieverwerkende capaciteit van één organisatie worden beschouwd, maar van alle organisaties in het samenwerkingsverband.

In de tweede plaats zijn de taken van andere organisaties in het samenwerkingsverband niet langer onderdeel van de omgeving, zoals ze dat in het intra-organisatorische model waren. In het inter-organisatorische model worden ze van de omgeving losgeweekt en maken ze onderdeel uit van de taken die in ogenschouw worden genomen. Dit heeft repercussies voor taak onzekerheid, taak formalisatie, standaardisatie van coördinatie, en omgevingsonzekerheid.

In de derde en laatste plaats wordt naast taak- en omgevingsonzekerheid nog een derde bron van onzekerheid toegevoegd: partneronzekerheid. Volgens het recent ontwikkelde model wordt partneronzekerheid bepaald door investeringsspecificiteit en onderling vertrouwen. Hoe meer specifiek de investering, en hoe hoger het onderling vertrouwen, hoe lager de partneronzekerheid.

In het vijfde hoofdstuk passen we het resulterende raamwerk toe op een case die handelt over een logistiek herontwerp. Meer specifiek betreft het een geval waarin de wijze van toelevering van banden wordt aangepast aan de volgorde van assemblage van vrachtwagens. De bandenleverancier wordt met behulp van EDI geïnformeerd over het assemblageschema van de vrachtwagenfabriek.

Toepassing van het model op deze case laat zien dat met behulp van EDI de informatieverwerkende capaciteit van het samenwerkingsverband werd vergroot. Het logistiek herontwerp leidde tot een verandering van taken die complexer waren, en werden geformaliseerd en gestandaardiseerd. De invloed van de toepassing van EDI op taak formalisatie en standaardisatie van coördinatie was positief en wederzijds. Door de verandering van taken als gevolg van het logistiek herontwerp kon een negatieve invloed van formalisatie en standaardisatie niet worden vastgesteld. Wat betreft partneronzekerheid kon een additionele factor worden onderkend: de onderlinge machtsverhoudingen tussen de bandenleverancier en de vrachtwagenfabriek.

In het zesde hoofdstuk wordt het raamwerk toegepast op een case in het internationaal transport. Meer specifiek betreft het hier een EDI-toepassing die is opgezet tussen o.m. een tweetal expediteurs en een grote electronica-leverancier. De expediteurs vervoeren componenten van Amerikaanse leveranciers naar Europese vestigingen en houden m.b.v. EDI het Amerikaanse inkoopbureau van de electronicaleverancier op de hoogte van de status van de goederen gedurende het vervoer. Het inkoopbureau maakt dankbaar gebruik van deze informatie om te voldoen aan de vragen van de Europese vestigingen.

In deze toepassing konden de twee effecten van EDI duidelijk worden geobserveerd. In de eerste plaats werd de informatieverwerkende capaciteit vergroot doordat met behulp van EDI gestructureerde gegevens omtrent het goederenvervoer beter en sneller beschikbaar waren. Aan de andere kant leidde de EDI-toepassing tot meer gestandaardiseerde en geformaliseerde procedures omtrent de informatievoorziening tussen de expediteurs en de electronicaleverancier. Hierdoor werd de informatieverwerkende capaciteit van de organisaties verlaagd.

Deze afname in informatieverwerkende capaciteit ging samen met een afname in informatieverwerkingseisen. Meer specifiek hield dit in, dat de taak complexiteit werd verlaagd en dat de onderlinge afhankelijkheid van de organisaties voor wat betreft de informatievoorziening terugging van *reciprocal* naar *sequential*. Tevens liet ook deze case zien dat partneronzekerheid voor een deel kon worden teruggebracht op de bestaande, onderlinge machtsverhoudingen.

In het zevende en laatste hoofdstuk worden uit het voorafgaande vier conclusies getrokken. In de eerste plaats lijken de mate van het EDI-gebruik en "mechanistische" waarden van ontwerpparameters elkaar wederzijds en positief te beïnvloeden. In een mechanistische organisatiestructuur is de mate van taak formalisatie en standaardisatie van coördinatie hoog. Voor gestructureerde berichtuitwisseling tussen organisaties is een zekere mate van gestructureerdheid van taken en standaardisatie van coördinatie vereist. EDI is derhalve een minder effectieve toepassing voor die samenwerkings-

verbanden waarin taken niet zeer wel gestructureerd kunnen worden en waar veel afhangt van wederzijdse afstemming.

In de tweede plaats wordt vastgesteld dat EDI een positief effect heeft op het vermogen van organisaties om met een grote mate van onzekerheid om te gaan, maar dat niet uit het oog verloren mag worden dat de positieve invloed op formalisatie en standaardisatie dit vermogen juist zou kunnen verminderen. Het is van belang nogmaals op de merken dat het verminderen van de informatieverwerkingscapaciteit de organisatie niet noodzakelijkerwijs minder effectief maakt. Integendeel, bij lage onzekerheid maakt een verdere "mechanisering" van de organisatiestructuur de organisatie juist effectiever.

Een derde conclusie die getrokken kan worden is dat, onder voorwaarde van effectiviteit, het effect dat EDI heeft op de informatieverwerkende capaciteit samengaat met eenzelfde verandering in de informatieverwerkingseisen aan de onderneming. Is de toename in formalisatie en standaardisatie laag, dan kunnen we een positief totaal effect verwachten, en dientengevolge bijvoorbeeld een hogere mate van taakonzekerheid of omgevingsonzekerheid aantreffen. Is aan de andere kant de toename in formalisatie en standaardisatie relatief hoog, dan kunnen we een negatief totaal effect verwachten, en dientengevolge bijvoorbeeld een lagere mate van taakonzekerheid of omgevingsonzekerheid.

Een vierde en laatste conclusie is dat de onzekerheid in EDI-samenwerkingsverbanden met betrekking tot de partners relatief laag is, en dat dit naast de investeringsspecificiteit en het onderling vertrouwen bepaald wordt door de onderlinge machtsverhoudingen in het samenwerkingsverband. Weliswaar kan EDI wat betreft technische infrastructuur steeds generieker worden toegepast (bv. via het Internet), de noodzakelijke specifieke afstemming van werkwijzes in het samenwerkingsverband zal, in combinatie met onderling vertrouwen en als helder ervaren machtsverhoudingen, nog steeds aan een lage mate van partneronzekerheid bijdragen.

Curriculum Vitae

Hans van der Heijden werd op 15 september 1969 geboren in Kruisland, gemeente Steenbergen. Hij doorliep het gymnasium aan het Norbertus College in Roosendaal en behaalde zijn diploma in 1987. Daarna studeerde hij bestuurlijke informatiekunde aan de Katholieke Universiteit Brabant. Zijn afstudeerstage betrof het ontwerpen van een expertsysteem bij een middelgrote verzekeringsmaatschappij. In 1991 slaagde hij voor het doctoraal examen. Van 1991 tot 1995 was de auteur werkzaam als assistent-in-opleiding bij de vakgroep Beslissings- en Informatiewetenschappen van de faculteit bedrijfskunde aan de Erasmus Universiteit. Tijdens deze periode was hij o.a. lid van het E-dispuut en vertegenwoordiger van Rotterdam in het Landelijk Aio-overleg Bedrijfskunde.

Hans van der Heijden was born on September 15, 1969 in Kruisland, the Netherlands. In 1987 he began to study management information systems at Tilburg University. His final thesis reported on his stay at a medium-sized insurance company during which he developed an expert system. He graduated in 1991. From 1991 to 1995 the author held a position as a research assistant at the department of decision- and information sciences, faculty of business administration, Erasmus University. During this period he was member of the E-dispuut and the Rotterdam representative in the national association of research assistants in business administration.

Stellingen

behorende bij het proefschrift

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I

Het toepassen van EDI heeft een positief effect op de taak formalisatie en standaardisatie van coördinatie in een EDI-samenwerkingsverband. Dit effect vermindert het vermogen van de organisaties om met een grote mate van onzekerheid om te gaan.

II

Door toepassing van EDI kan de beschikbaarheid van gestructureerde gegevens worden verbeterd. Daardoor wordt het vermogen van de organisaties om met onzekerheid om te gaan vergroot.

III

De toespitsing van het onderzoek in dit proefschrift op EDI illustreert dat het begrip "informatietechnologie" te ruim kan zijn om adequaat in een onderzoeksmodel op te nemen.

IV

In aanwezigheid van een hoge investeringsspecificiteit, wederzijds vertrouwen, en als helder ervaren machtsverhoudingen is partneronzekerheid in een EDI-samenwerkingsverband relatief laag.

V

De relatie tussen het gebruik van informatietechnologie en de structuur van een industrie is niet eenduidig vast te stellen. Dit komt onder meer doordat het gebruik van informatietechnologie zowel de transaktiekosten van de markt als van de hiërarchie kan verlagen.

VI

Partijen in een markt die baat hebben bij marktfragmentatie en marktinefficiëntie zullen weerstand bieden aan de invoering van een elektronische markt.

VII

De agency-theorie is een bruikbare benadering om afwerend gedrag rondom de invoering van een informatiesysteem te verklaren.

J.G.M. van der Heijden, Toepassingen van agency-theorie in de bestuurlijke informatiekunde, Informatie, *Jaargang 36, No. 2, Februari 1994, pp. 126-132*

VIII

Hoewel het via de elektronische snelweg mogelijk wordt om vaker en goedkoper referenda uit te schrijven, blijft niettemin het probleem bestaan dat de burger niet altijd kan of wil meebeslissen.

IX

Op het pleidooi van een amateur-Egyptoloog dat de gezaghebbende zontheorie door een stertheorie diende te worden vervangen volgde een heftige, afwijzende reactie van gevestigde Egyptologen. Dit is kenmerkend voor de structuur van een wetenschappelijke revolutie.

R. Bauval & A. Gilbert, The orion mystery: Unlocking the secrets of the pyramids, *Heinemann, London, 1994*

T. S. Kuhn, The structure of scientific revolutions, *2nd ed., The University of Chicago Press, Chicago, 1970*

X

Bedrijfskundige modeverschijnselen zijn te herkennen aan de felheid waarmee aanhangers de vluchtigheid ervan bestrijden.