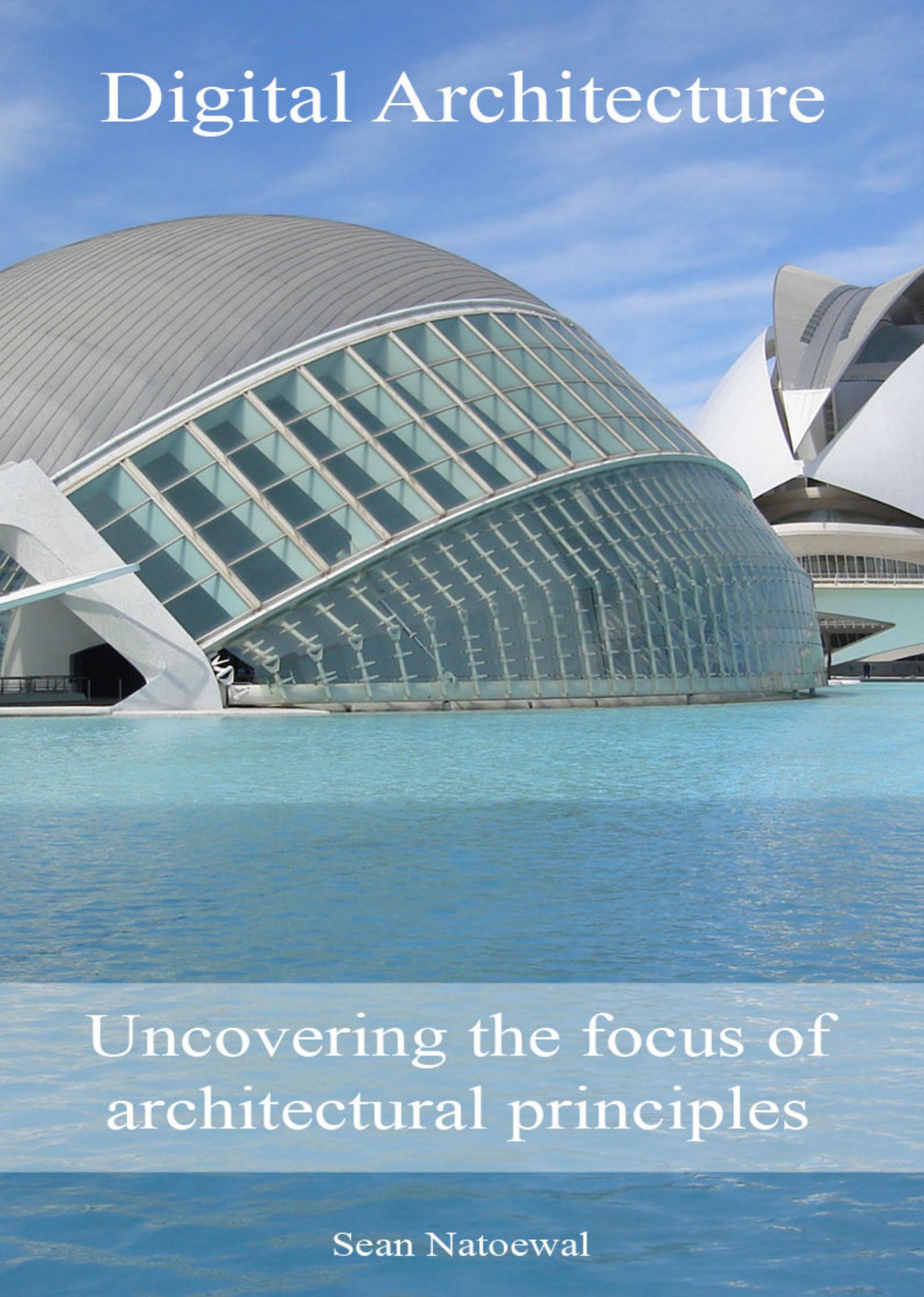


# Digital Architecture

The image shows a large, modern architectural structure with a curved, metallic facade and a grid of glass panels. The structure is situated on a body of water, and the sky is blue with some clouds. The overall scene is a photograph of the Esplanade - Theatres on the Bay in Singapore.

Uncovering the focus of  
architectural principles

Sean Natoewal

# Digital Architecture

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# Digital Architecture

## Uncovering the focus of architectural principles

Master's thesis in Information Science

by

Sean Natoewal

Nijmegen, January 2007

Radboud University Nijmegen

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## Abstract

In recent years much attention has been paid to the field of digital architecture as, among others, described by Rijsenbrij (2004; 2005). A central component in digital architecture is the use of principles that can be described as guiding statements, which affect the use of IT in organizations. However, until today, hardly any research has been conducted in trying to identify the concepts that are/can be addressed in such principles. This, in turn, makes it a complicated task for the digital architect to determine what is/can be addressed in the principles formulated. In this thesis, I present the findings of a research trying to identify these concepts, which was conducted over a period of almost nine months, based on thirteen semi-structured interviews and IT-related literature. The findings are presented based on Rijsenbrij's four worlds concepts, and cover three of the four worlds: the B-, I-, and A-world.

The findings of this research show that there is a wide variety of concepts that are/can be addressed, of which the relevance is dependent upon the issues an organization faces today or expects to face in the future. Although being related to three different worlds, the findings also show that most of the identified concepts are in some way related to each other. Thereby, they support Rijsenbrij in arguing for principles to form a consistent and coherent whole. Part of the findings, those related to the B-world, show that IT has offered organizations many opportunities. However, they also show that although there is a relationship between changes in the B-world and the use of IT, this is no necessity, but rather a choice. This choice, in turn, should be expressed in the principles formulated. The most important findings of this research are those related to both the I- and A-world. Although many of the principles gathered only addressed IT from a technological perspective, a majority of the identified concepts in these worlds are related to human behavior. Therefore, this research suggests that both the information supply and the use of IT should be adapted to the preferences of individuals, where possible. This, in turn, is associated with many business benefits and also supports Rijsenbrij in arguing for addressing the human aspects of IT. Finally, with respect to business-IT alignment, the findings of this research also show that it is possible to formulate business oriented principles, while ensuring that both the I- and A-world are addressed appropriately; in a human-oriented way.

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# Preface

Dear reader,

The master's thesis you are reading, is the result of an almost nine month during research that I have worked on under the supervision of prof. dr. Daan Rijsenbrij at the Radboud University Nijmegen. Also, it is the last requirement for obtaining my master's degree in Information Science at the Radboud University Nijmegen. With it, I hope to leave a very important and educative period behind me, and finally (at the age of 24) start my professional career. As I have experienced this period as one that allowed me to increase and broaden my knowledge in my field of interest even further, next to the regular Information Science program, working on this thesis was more than only the last requirement for obtaining my master's degree. More specifically, the interviews held and the relatively large amount of literature studied, provided me with valuable insights from which I hope to benefit during my professional career.

Before ending this preface, I want to convey my gratitude to those who have contributed to this thesis. Herewith I would like to thank Serge Bouwens, Henk Dado, Gert Florijn, Jaap van der Heijden, Jan Herbrink, Marc Lankhorst, Wouter Mellink, Ben Noordzij, Martin Op 't land, Mark Paauwe, Harry Richards, Erica Rietveld and Pieter Wisse for providing me with valuable (corporate) information and the insights required in writing this thesis. Last but not least, I would like to especially thank dr. Stijn Hoppenbrouwers and prof. dr. Daan Rijsenbrij, my second examiner and supervisor, respectively, for their support during the period I have worked on this thesis.

Sean Natoewal  
Nijmegen, January 2007

## Reading guide

In this section I will provide some basic information related to reading this thesis. The topics that are subsequently addressed in the following paragraphs relate to this thesis's intended audience, its structure, references to research data, the terminology used and to its digital version.

### Intended audience

This thesis is written for all those interested and/or involved in the field of digital architecture. However, although it does not require one being familiar with the field of digital architecture to read this thesis, it should be noted that the terminology used expects one to be at least familiar with the fields of computer and/or information science. This, in turn, is reflected in this thesis not containing a glossary explaining terminology commonly used in these fields.

### Structure

The research as described in this thesis basically consists out of two parts: one part describing its foundations and one part describing its findings. With respect to the former, chapter 1 and 2 describe the theoretical and research foundations, respectively. With respect to the latter, chapter 3, 4 and 5 describe the findings answering research questions 1.1, 1.2 and 1.3, as described in paragraph 2.3, respectively. Finally, this thesis ends with an overall conclusion, a personal evaluation and recommendations for future research, that are described in chapter 6, 7 and 8, respectively.

### Research data

As described in chapter 2, the findings presented in this thesis are partially based on thirteen semi-structured interviews. It should be noted that as the interviewed persons and the companies they are associated with considered the information provided as a valuable corporate asset, I refer to them as '*the interviewed companies*'. By doing so, I have tried not to reveal any relationship between the information gathered from these interviews and the interviewed companies. Finally, it should be noted that the view on principles as described in this thesis in paragraph 1.2.1 might differ from the ones expressed by the interviewed companies and in the literature studied. However, since the principles cited are only meant to stress the importance of the concepts identified, I have put no effort in rephrasing them.

### Terminology

Please note that when the abbreviation IT (Information Technology) is used in this thesis, its meaning might differ based on the chapter being read. By that I mean that whereas I speak of IT in chapter 3, I refer to both information (being reflected in chapter 4) and technology (being reflected in chapter 5). On the other hand, whereas I speak of IT in chapter 4, I only refer to technology (being reflected in chapter 5). Finally, as already mentioned, because I expect the reader to be at least familiar with the terminology used in the fields of computer and/or information science, this thesis does not contain a glossary.

## Digital reading

A CD-ROM containing a digital version of this thesis is supplied with the printed version of this thesis, for those who find it more convenient to read this thesis digitally.

# Chapter 1

# Digital

# architecture

*‘Architecture differs from design in that it is geared to a long-term goal, represents a broad perspective, and addresses requirements rather than a specific solution.’*

(Stecher, 1993)

The research as described in this thesis is primarily based on the theory of digital architecture as, among others, described by Rijsenbrij (2004; 2005); however, it is not solely based on this theory. In the following paragraphs I will briefly outline Rijsenbrij's theory, and more specifically describe how this research fits in. It should be noted that the purpose of this thesis is not to question Rijsenbrij's theory, nor to propagate it.

## 1.1 Definition and purpose

Digital architecture can be described as '*a coherent, consistent collection of principles, differentiated to rules, guidelines, and standards which describe how an enterprise, the information supply, the applications, and the infrastructure are shaped and behave in their usage*' (Overbeek, Rijsenbrij and Proper, 2007). This clearly indicates that digital architecture is concerned with the use of IT in organizations. In stressing the need for digital architecture, Rijsenbrij argues that, like in the physical world when constructing artifacts such as cities, buildings and landscapes, architecture is also required for the construction of artifacts in the digital world.

Basically, Rijsenbrij argues that the current approach towards the use of IT in organizations should radically change from implementing ad hoc solutions, that show poor linkage with the overall business(-strategy), to that of a structural approach in which the use of IT is guided by so-called principles, with the purpose of trying to achieve/maintain business-IT alignment; principles are described in more detail in paragraph 1.2.1. Rijsenbrij's vision includes that the design and use of IT should be based on a set of architectural principles that provide guidance, since they have a limiting character. In describing the use of IT, Rijsenbrij does not only address the structural aspects, but also the human aspects. For example, he considers applications not only as being functional collections of code, but also as digital artifacts that should be usable for their users. Therefore, he argues for also addressing those aspects of IT that contribute to its usefulness and beauty. Finally, Rijsenbrij argues that by having a digital architecture in place, organizations will be able to stay agile with respect to their use of IT, guarantee their business continuity and ensure the correct functioning of their business processes.

As might have become clear, digital architecture is concerned with IT, and more specifically with the use of IT in the organization. Therefore, from the perspective of digital architecture, one has to find a balance between both organizational and technological aspects. This balance, in turn, should be expressed in the principles as formulated by the organization.

## 1.2 Components of digital architecture

Since digital architecture covers a large part of the organization, Rijsenbrij and others (e.g. Sogeti; The Open Group) divide the overall architecture into different sub-architectures; Rijsenbrij calls these sub-architectures '*the four worlds*'. Next to these sub-architectures, Rijsenbrij also distinguishes different levels of abstraction that can be used to keep the architectural challenge feasible. Moreover, as described in the previous paragraph, Rijsenbrij also addresses the human aspects associated with the use of IT in the organization. Finally, in addition to this, Rijsenbrij argues that security and governance aspects should also be addressed appropriately. All of these components are depicted in Figure 1.1, and are subsequently described in the following paragraphs.

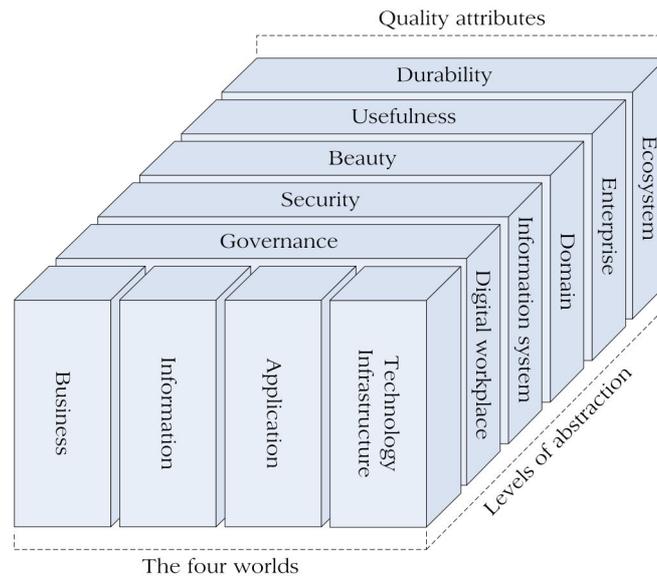


Figure 1.1 Components of digital architecture

Please note that, although principles are a central component in digital architecture, they are not depicted in Figure 1.1, since they are an integral part of digital architecture.

### 1.2.1 Principles

Rijsenbrij describes principles as statements that provide guidance with respect to essential decisions, that directly influence the way in which IT will be used. Basically, principles are high-level guiding statements that limit the options one has with respect to the use of IT, and that are expected to express the vision an organization has with respect to its use of IT. Next to providing guidance, principles should also form a consistent and coherent whole. Moreover, these principles should be formulated for each of the sub-architectures; these sub-architectures are described in more detail in the next paragraph. With respect to these sub-architectures, they should also ensure that these sub-architectures are constructed in a simple and elegant way. Finally, principles should also be durable in terms of them being able to withstand the test of time. However, this characteristic of principles holds to a certain extent, in that principles are not statements that should hold for an everlasting period; principles are to be changed when required.

One of the interviewed companies argued that principles are related to several other concepts (hereinafter to be referred to as constructs): *'need'*, *'rationale'* and *'implications'*. Indeed, after having seen different principles, I must agree with this view towards the basic constructs that make up for a principle. However, I prefer to use the term *'context'* whereas the interviewed company used the term need. Moreover, the same approach, with the exception of the context-construct, is the recommended approach in formulating principles according to The Open Group. This view towards principles is depicted in Figure 1.2.

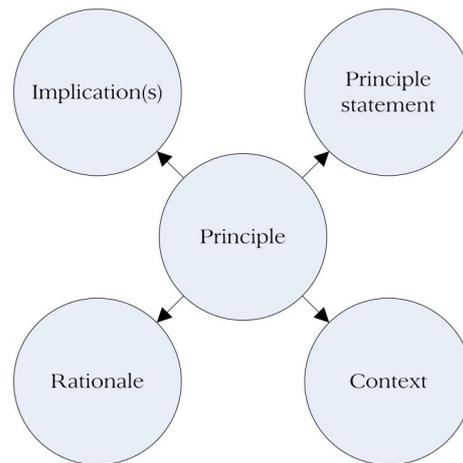


Figure 1.2 The basic structure of a principle

A description of each of the constructs as depicted in Figure 1.2 is given below:

- **Principle statement**  
The principle statement-construct is the statement providing guidance with respect to the use of IT, preferably no longer than a single sentence.
- **Context**  
The context-construct describes the situation that formed the basis for the principle being formulated. This construct basically expresses the need/urge for having the principle in place. For example, it could describe that the organization is operating in a highly competitive business environment.
- **Rationale**  
The rationale-construct describes the reasoning underlying the principle being formulated. Basically, it relates the context-construct to the principle statement-construct. For example, a principle statement-construct stating that '*IT should solely be employed to reduce costs*', would be justified by the context-construct as described previously. The rationale-construct, in turn, might state that by solely employing IT to reduce costs, chances of survival in the highly competitive business environment increase.
- **Implication(s)**  
Finally, the implication(s)-construct describes the consequences associated with the principle statement-construct. In doing so, it should provide directions on what is to be done in order to support the chosen direction expressed in the principle statement-construct, thereby implicitly indicating what is not to be done; those things that are not mentioned.

The research as described in this thesis is directly related to principles, since it tries to identify the concepts that are/can be addressed in these principles.

### 1.2.2 The four worlds

As described previously, Rijsenbrij divides the overall architecture into different sub-architectures, which he calls the four worlds:

- the business-world (hereinafter to be referred to as B-world);
- the information-world (hereinafter to be referred to as I-world);
- the application-world (hereinafter to be referred to as A-world);

- and the technology infrastructure-world (hereinafter to be referred to as T-world).

Others, however, only distinguish three sub-architectures (e.g. Sogeti), or even more sub-architectures (e.g. The Open Group). Although others might distinguish fewer sub-architectures, the distinction Rijsenbrij makes in the IT sub-architecture (A- and T-world) is not very strange, since this is also common practice in the field of IT-management<sup>1</sup>. Moreover, since Rijsenbrij also addresses the human aspects associated with the use of IT, it is important to make this distinction, because, in addressing the human aspects, next to the I-world, it are also the applications (A-world) in an organization that should address these aspects. The four worlds are briefly described in the following subparagraphs.

First, the B-world refers to the part of the organization where business activities take place, ranging from strategic planning to daily operations, that do not directly relate to IT. Within this part of the organization one is concerned with concepts like processes<sup>2</sup> and culture. As Rijsenbrij argues, this is the part of the organization that should be the driver for decisions made in the I-, A- and T-world.

Second, the I-world refers to the part of the organization that is concerned with the information supply. Examples of concepts in this world include information sharing, information sources and information style<sup>3</sup>. Basically, this world is concerned with the (high-level) information concepts that satisfy the business's need for information, which, in turn, are translated into requirements for the A- and T-world.

Third, in the A-world one is primarily concerned with concepts that are related to the applications in the organization. Examples of concepts in this world include application integration and application development. In this world, business and information concepts are translated into IT solutions, more specifically applications, that support the business's need for information and the business activities taking place. Moreover, since Rijsenbrij also stresses the importance of addressing the human aspects associated with the use of IT, this world also covers concepts related to the usefulness and beauty of applications. Examples of concepts addressing these human aspects, include personalization and navigation.

Fourth and finally, the T-world refers to the part of the organization that supports the A-world. Examples of concepts in this world might include organization-wide data storage, networking and servers. Basically, the T-world binds the A-world together and facilitates efficient data flows. Please note that the examples provided for the T-world are meant for illustrative purposes only, since the scope of this research does not cover this world.

### 1.2.3 Levels of abstraction

In order to keep the architectural challenge feasible, next to the four worlds as described in the previous paragraph, Rijsenbrij also distinguishes five different levels of abstraction. Each of these levels basically provides a viewpoint that can be applied in describing/creating the overall architecture of an organization. The levels Rijsenbrij distinguishes, which are briefly described in the following subparagraphs, are:

- ecosystem level;
- enterprise level;
- domain level;

---

<sup>1</sup> Think of the Information Technology Infrastructure Library and the Application Services Library (Thiadens, 2003).

<sup>2</sup> Including the products resulting from these processes.

<sup>3</sup> The format in which information is presented, as described in paragraph 4.4.7.

- information system level;
- and digital workplace level.

First, the ecosystem level focuses on the organization in its environment. When viewing the organization from this perspective, one might be concerned with its position in the overall value-chain, its relationships with external partners and customers and its connectivity and interaction with its environment.

Second, the enterprise level focuses on the high-level structure of the organization. From this viewpoint, the organization is considered as being as an internal ecosystem in which different domains exchange services with each other. Viewing the organization from this perspective is meant to create a first partitioning of the organization in domains, that consist out of business processes, enterprise applications and the underlying technology infrastructure supporting these applications. This provides insights into the tasks being performed, where they are performed and how they interrelate with each other. Having such insights, in turn, increases the manageability of the organization and eases the process of searching for sourcing possibilities.

Third, at the domain level a closer look is taken at the domains as distinguished at the enterprise level, in terms of focusing on domain-specific aspects. Domains can be considered as autonomous organizational entities that exchange services with each other and with the organizational environment. At this level, these domains are basically divided into outsourceable units<sup>4</sup>.

Fourth, the information system level focuses on the architecture of the individual information systems specific to the domain being considered.

Fifth and finally, the lowest level of abstraction focuses on the digital workplace that allows employees to perform their business activities. Comparing it to physical architecture, the digital workplace should be considered as being a virtual office that allows employees to carry out their business activities and offers the same, and possibly even more, facilities as one has available in a physical office; however, in contrast to the physical office, just a single mouse click away.

## 1.2.4 Quality attributes

Next to the four worlds and the different levels of abstraction, as described in paragraph 1.2.2 and 1.2.3, respectively, Rijsenbrij also argues that digital artifacts should exhibit certain quality attributes, of which the first two are:

- security<sup>5</sup>;
- and governance.

Next to these two attributes, Rijsenbrij adds three more attributes that digital artifacts should exhibit. As Rijsenbrij compares digital architecture with physical architecture, he argues that digital artifacts should also exhibit the same quality attributes as the ones in the physical world. In doing so, Rijsenbrij refers to the three qualities a structure should exhibit according to Marcus Vitruvius Pollio, namely, '*firmitas*', '*utilitas*' and '*venustas*', which in English would translate to:

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<sup>4</sup> Rijsenbrij describes these outsourceable units as collections of coherent functionalities, also being referred to as competence clusters, that can be outsourced or accommodated in a shared service center. Whether these outsourceable units are actually outsourced, according to Rijsenbrij, is a strategic decision.

<sup>5</sup> Please note that Rijsenbrij argues that privacy is closely related to this attribute, and therefore should also be taken into account.

- durability;
- usefulness;
- and beauty.

First, with respect to durability, digital artifacts are ought to be durable; they should be able to withstand the test of time to a certain extent. Examples provided by Rijsenbrij relate to the technologies being used to construct digital artifacts, such as programming languages and integration mechanisms.

Second, with respect to usefulness, digital artifacts are expected to be useful. Rijsenbrij describes this attribute as one that is concerned with the arrangement and relationships of functionalities offered by digital artifacts.

Third and finally, digital artifacts should be appealing in terms of their beauty. However, whereas one might consider beauty solely in terms of visual appearance, a more appropriate translation would be aesthetics, since this also covers the user experience brought by the artifact. Examples provided by Rijsenbrij, include navigation paths, interaction protocols and personalization options.

The principles formulated should ensure that each of these quality attributes is addressed appropriately. As Rijsenbrij argued in the conversations I have had with him, the importance of each of these attributes will differ per world and level of abstraction.

# Chapter 2

# Research

# foundations

*'Research is the process of going  
up alleys to see if they are blind.'*

(Marston Bates)

In this chapter I will describe the foundations underlying the research as described in this thesis. In doing so, I will subsequently address its relevance, its characterization, the research questions underlying it and the approach used in finding answers to these questions.

## 2.1 Relevance

In recent years much attention has been paid to the field of digital architecture as, among others, described by Rijsenbrij (2004; 2005). A central component in digital architecture is the use of principles that can be described as guiding statements, which affect the use of IT in organizations. However, until today, hardly any research has been conducted in trying to identify the concepts that are/can be addressed in such principles. This, in turn, makes it a complicated task for the digital architect to determine what is/can be addressed in the principles formulated. With this research, I intended to create a first inventory of concepts that are/can be addressed in the principles formulated as part of a digital architecture. This, in turn, can be considered as useful input in formulating a sound set of principles. However, it should be noted that it was not my intention to describe an exhaustive set of concepts. Therefore, the concepts as described in this thesis should be considered strictly as a first inventory of concepts that are/can be addressed; they are not all-encompassing.

## 2.2 Research type

The type of research as described in this thesis can be characterized as being exploratory and is based on a combination of both a case and a literature study. However, as described in paragraph 2.4, initially it would only be based on a case study.

## 2.3 Research questions

The research as described in this thesis focused around one main research question:

1. *‘What concepts, that are of interest to the digital architect, are/can be addressed in the principles formulated as part of a digital architecture and why?’*

It should be noted that the original question spoke in terms of *‘archifacts’*, where this question speaks of *‘concepts’*. The reason for me changing this term lies in the fact that I, during the interviews held, found myself getting involved in discussions related to the meaning of the term archifacts, instead of finding answers to the questions in place; moreover, the term archifacts turned out to refer to something different than what was expected<sup>6</sup>. Therefore, I chose to use the relatively neutral term concepts. Yesilada, Stevens and Goble (2003) describe concepts as *‘mental representations, images or ideas’*. This also makes clear why this research did not focused on creating an inventory of material *‘things’*, but instead on abstract (high-level) ideas in a digital architecture that are/can be addressed in the principles formulated.

Finally, it should be noted that I have made an explicit distinction between *‘are’* and *‘can be’* in the research question, since the findings presented are based on both the interviews held and the literature studied. Therefore, the former (are) only refers to the findings from the interviews held and the latter (can be) to both the findings from the interviews held and the literature studied. With respect to the latter, it should be noted that it also covers the findings

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<sup>6</sup> According to some of the interviewed companies.

from the interviews held, since what is considered as being interesting to one company does not necessarily make it interesting to another.

Because of the theory underlying this research, that of Rijsenbrij, the research question was divided into three sub questions addressing three of the four worlds distinguished by Rijsenbrij, as described in paragraph 1.2.2:

- 1.1. *‘What concepts, that are of interest to the digital architect in the B-world, are/can be addressed in the principles formulated as part of a digital architecture and why?’*
- 1.2. *‘What concepts, that are of interest to the digital architect in the I-world, are/can be addressed in the principles formulated as part of a digital architecture and why?’*
- 1.3. *‘What concepts, that are of interest to the digital architect in the A-world, are/can be addressed in the principles formulated as part of a digital architecture and why?’*

Initially, these sub questions also covered the T-world. However, due to time constraints I was allowed to limit myself to the B-, I- and A-world.

## 2.4 Approach

The intended approach in carrying out this research was to have several semi-structured interviews, that would answer the main research question and its sub questions as described in the previous paragraph. With respect to the interviews, Rijsenbrij got me in contact with twelve of the thirteen interviewed companies, which were divided into two groups. The idea was to create an inventory of concepts based on the interviews held with the companies being part of the first group. This inventory, in turn, would then be validated for its practical value based on the interviews with the companies being part of the second group. However, due to the fact that I had great difficulties in creating a sound inventory solely based on the interviews with the first group, plans changed during the research. Instead of creating an inventory solely based on the interviews held with the first group, it would also be based on the interviews held with the second group.

The interviewed companies and the persons associated with them are listed in Table 2.1.

| Group 1              |  |
|----------------------|--|
| Serge Bouwens        | Architect and management consultant at Sogeti  |
| Gert Florijn         | Managing consultant at DNV-CIBIT ICT Consultants   |
| Marc Lankhorst       | Senior member of scientific staff and Group Leader Service Architectures at Telematica Instituut   |
| Martin Op 't land    | Certified Enterprise Architect at Capgemini  |
| Mark Paauwe          | Principal (Enterprise) Information Architect, Visionary and Owner of Paauwe & Partners at Paauwe & Partners, Enterprise Architectenbureau B.V. |
| ir. Erica Rietveld   | Assistant professor at TU/e and partner at Grexx   |
| Pieter Wisse         | Founder and president of Information Dynamics  |
| Group 2              |  |
| Henk Dado            | Head of Concern Information Management at Stichting Pensioenfonds ABP  |
| Jaap van der Heijden | Senior Director at Philips Research Europe   |
| ir. J.B.A. Herbrink  | Information-architect at NS Information-management & -technology   |
| Wouter Mellink       | Enterprise architect at Air France KLM   |
| Ben J. Noordzij      | Enterprise-architect at ABN AMRO Bank N.V.   |
| Harry Richards       | Chief Security Officer and Enterprise Architect at Packard Bell and NEC Computers International B.V.   |

Table 2.1 Interviewed companies

However, although I had decided to use both the interviews with the first and second group as input for creating the inventory, again I had great difficulties in doing so. Although literature was initially considered as being an additional, and not the major, input in answering the research questions, the research had eventually become a combination of both a case and a literature study. Since the approach in conducting the research had changed during the research itself, the type of literature to be studied was not determined upfront, because a literature study was not foreseen.

# Chapter 3

## B-world

*‘Organizations should be thinking about competing power, not computing power.’*

(Luftman, Lewis and Oldach, 1993)

As described in paragraph 1.2.2, the B-world refers to the part of the organization where business activities take place, ranging from strategic planning to daily operations, that do not directly relate to IT. Within this part of the organization one is concerned with concepts like processes and culture. As Rijsenbrij (2004; 2005) argues, this is the part of the organization that should be the driver for decisions made in the I-, A- and T-world.

In this chapter, I will first explain the relevance of this world with respect to digital architecture, after which I will give a brief description on how the concepts identified should be interpreted and finally describe the concepts themselves based on the interviews held and the literature studied.

### 3.1 Relevance

As described by Rijsenbrij, it is a common question to ask why the digital architect should be concerned with the B-world. To stress the importance of the B-world, Rijsenbrij provides an example that relates to the period in which the System Development Methodology was developed, of which the bottom line was that business process reorganization should precede any effort at automation. According to Rijsenbrij, the same applies to digital architecture, that requires having an architectural description of the B-world in place before defining architectures for the other worlds (the I-, A- and T-world). The essence of this is that the business architecture should be driving the other architectures. However, it should be noted that Rijsenbrij explicitly mentions that it is not the task of the digital architect to define the business architecture. Basically, the purpose of the B-world is to gain insights into how IT can and is expected to contribute to the business activities taking place; it focuses on the role of IT with respect to the B-world.

Rijsenbrij's view towards the importance in understanding the B-world is underscored by McDavid (1999), who describes a set of generic business concepts that he considers as being important from an IT perspective. McDavid argues that an understanding of these business concepts is necessary, since they provide insights into how business issues drive information-system requirements. Moreover, this view towards the B-world is also underscored by Cullen, Orlov, Leganza, Young and Hudson (2005) who argue that '*Understanding business plans and challenges is essential when starting an enterprise architecture (EA) effort or when taking stock of an existing effort*' and that '*the value and credibility of the EA effort depends upon how architecture strategies and deliverables are connected to business plans and needs*', and by Leganza, Holmes, Webber and McAulay (2005) who found that '*IT people have not learned to communicate in business terms, and businesspeople assume that IT folks are out of touch with what matters to them.*' Finally, this view was also underscored by many of the interviewed companies.

### 3.2 Interpretation

As already described, the relevance of the concepts identified in the B-world is to provide insights into the role of IT with respect to the B-world. Therefore, this chapter differs from the other chapters, since it does not describe the concepts that can be directly addressed in principles, but rather the concepts that can be addressed indirectly. By that I mean that these concepts are not affected by the principles formulated, but serve as input for principles formulated with respect to the I-, A- and T-world. Directly addressing these concepts, however, should be done in defining the business architecture, which, as I have already mentioned, is not the task of the digital architect.

### 3.3 Approach

This chapter is divided into two parts, one describing concepts related to the main concept of organizational environment and the other those related to the main concept of organizational design; this is depicted in Figure 3.1. Both of these concepts are described by using two separate models covering the concepts specific to each concept; these models are described in paragraph 3.4.1 and 3.4.2, respectively.

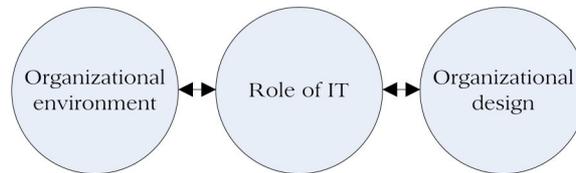


Figure 3.1 B-world concepts

Please note that the role of IT is put at the center of both concepts, since this chapter focuses on the role of IT in the B-world. In doing so, this chapter describes the role of IT both affecting and being affected by the B-world.

The approach chosen, that of viewing the organization as being part of its environment, was reflected in both the interviews held<sup>7</sup> and the literature studied (e.g. Rijsenbrij, 2004; Davenport and Prusak, 1997; van der Zee, Laagland and Hafkenscheid, 2000). From this perspective, the organization should be viewed as an actor being part of a larger system in which it exchanges services with other actors. This view towards organizations is reflected in the open systems theory (Malhotra, 1993). The need for describing organizations in terms of open systems is stressed by Malhotra, citing Scott (1961), who argues that '*the only meaningful way to study [sic] organization is to study it as a system*'.

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<sup>7</sup> Many of the interviewed companies stressed the importance of viewing the organization as being part of its environment.

## 3.4 Findings

### 3.4.1 Organizational environment

Whereas the role of IT with respect to the organizational environment is described in the literature studied, it is often described in terms of Porter's Competitive Forces model (Keuning, 1996), that describes the relationship between an organization and its environment; this model is depicted in Figure 3.2.

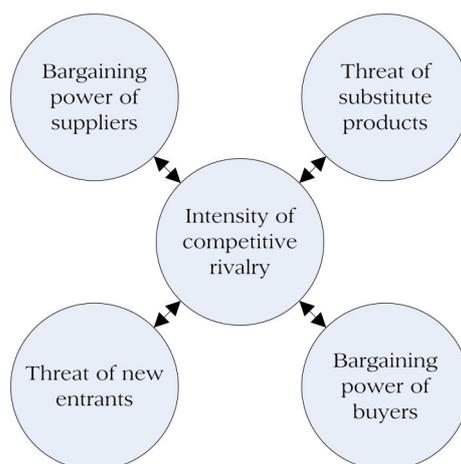


Figure 3.2 Porter's Competitive Forces model

The importance of IT with respect to these competitive forces, for example, is stressed by Moreton and Chester (1996) who argue that '*IT can influence the strategic competitive factors that determine the relative position of the company in its industry*', where the competitive forces being referred to are the ones as distinguished in Porter's model. Next to this, Moreton and Chester consider it, when used as a tool in competitive impact analysis, as being useful to evaluate IT's contribution to generating an organization's vision. Based on such an analysis, according to Moreton and Chester, an organization is supposed to determine its business strategy and the role IT should play with respect to this strategy. Furthermore, they also argue that '*By assessing the relative importance of each of the five strategic competitive forces and the likely impact of IT on each of them, it is possible to identify where IT can be assigned a high priority in the business strategy.*' For each of these forces, they provide examples making clear how these forces are related to IT.

Next to Moreton and Chester, Porter himself and Millar (1985) also stress the importance of IT with respect to these competitive forces, by arguing that '*Information technology can alter each of the five competitive forces*'. In doing so, like Moreton and Chester, they also provide examples making clear how these forces are related to IT<sup>8</sup>. Moreover, Lambert and Peppard (2003) also stress the importance of IT with respect to these forces, by arguing that '*Using IT, suppliers, buyers and competitors, are linked together via a strategy of electronic integration*'.

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<sup>8</sup> However, only for four of the five competitive forces.

Finally, another example in which Porter's model is considered as being a useful model in 'identifying major internal/external opportunities and threats from employees, customers, suppliers, competitors, regulatory agencies, and other stakeholders involved', which, in turn, allows for identifying 'Current and potential business problems and opportunities' in order to 'develop business strategies to capitalize on opportunities and reduce threats' is described by Lee (2004), who considers this analysis, in conjunction with value-chain analysis and prior to business process reengineering, as the input to the IT-strategy. Other literature elaborating on the role of IT with respect to these competitive forces includes Boonstra (2002), Earl (1991) and Ives and Learmonth (1984).

To stress the idea of not all competitive forces being equally important, Moreton and Chester provide a model, derived from Parsons (1983), showing the impact of technology on each of these forces. This model, as depicted in Figure 3.3, uses the terms 'Entrants', 'Rivals', 'Substitutes', 'Buyers' and 'Suppliers', whereas Porter's model uses the terms 'threat of new entrants', 'intensity of competitive rivalry', 'threat of substitute products', 'bargaining power of buyers' and 'bargaining power of suppliers', respectively. It should be noted that, whereas Porter speaks in terms of the intensity of competitive rivalry, the term rivals is quite different, since the former refers to the market in which organizations operate in terms of the level of rivalry, while the latter refers to the competitors it is facing in this market. In addressing this competitive force in this paragraph, in terms of the concept of competition, I only address the latter that refers to the role of IT with respect to an organization's competitors (rivals), which, in turn, might affect the level of rivalry amongst them<sup>9</sup>.

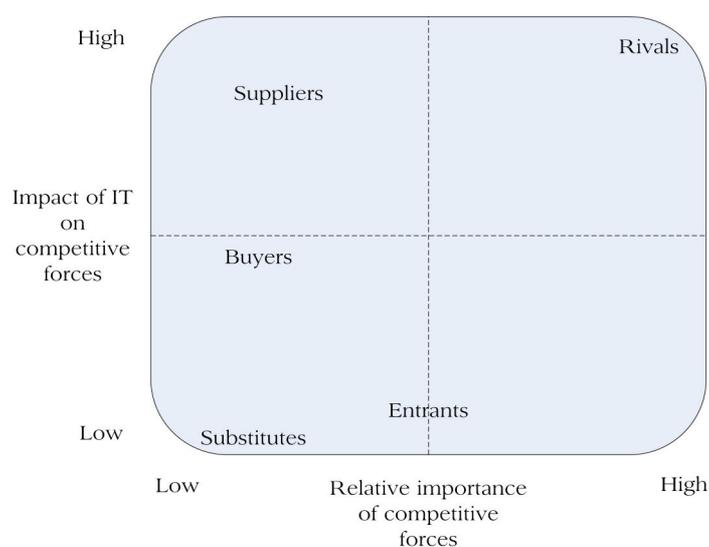


Figure 3.3 Technology impact on competitive forces

Although IT can be considered affecting all of the competitive forces, this model clearly indicates that its impact differs per type of competitive force. This, in turn, is reflected in the model used to describe the concept of organizational environment as depicted in Figure 3.4.

<sup>9</sup> A good example of IT increasing the intensity of competitive rivalry is the emergence of web-stores that compete with traditional retail-stores.

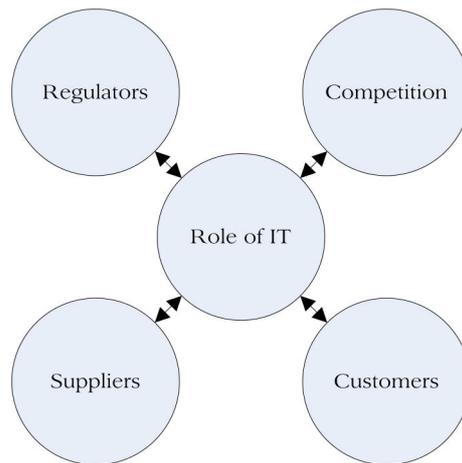


Figure 3.4 Organizational environment concepts

As described previously, this model incorporates the concept of competition, that accounts for the threat of new entrants, rivals and the threat of substitute products. Next to this, whereas Porter's model focuses on competitive forces, it does not account for the important concept of regulators that is part of the organizational model described by Gharajedaghi (1999), is considered by Thiadens (2003) as an external force driving the use of IT and is considered by Davenport and Prusak as a driver for an organization's I-world; therefore, the model was extended with the concept of regulators. Each of the concepts identified in this model are subsequently addressed in the following paragraphs.

### 3.4.1.1 Competition

As described in the previous paragraph, the concept of competition is a broad concept that accounts for the threat of new entrants, rivals and the threat of substitute products. Each of these competitive forces is addressed subsequently in the following subparagraphs. With respect to this concept, based on the literature studied, the following roles of IT emerged:

- IT being a barrier in dealing with new entrants;
- IT being used as a barrier for new entrants;
- IT as an opportunity in entering new markets;
- and IT as an opportunity in introducing substitute products.

The first role is addressed by the respondents in the research of Mulligan and Gordon (2002), who have conducted a qualitative research with respect to the role of IT in supporting relationships between customers and suppliers in the financial service industry. The respondents of this research indicated that their current use of IT posed a threat in dealing with new entrants. They feared that, because of their legacy systems, they couldn't keep up with new entrants who lacked such legacy systems and who would possibly cannibalize their existing relationships with customers. Therefore, IT in terms of legacy systems, was considered as a barrier in their organizations keeping up with new entrants.

The second role is addressed in an example provided by Porter and Millar of the banking industry, that heavily depends on high IT investments in improving their service towards customers. Porter and Millar argue that since some forms of IT require large investments, barriers to entry might be raised by the use of certain forms of IT.

The third role is addressed in an example provided by Moreton and Chester of Comp-U-Card. Comp-U-Card is an example of a company that has successfully bypassed existing bar-

riers to enter a new industry, by introducing a completely new order and distribution service in the traditional store based and mail-order retailing industry.

Finally, the last role is addressed by both Moreton and Chester and Porter and Millar who provide the example of computer aided design having reduced the time-to-market for new products.

One of the interviewed companies addressed the concept of competition in two of its principles, that stated '*Assemble or Build for Competitive Advantage*' and '*Adopt Best Practices and Industry-standards for competitive parity.*' Whereas the first principle provides guidance with respect to create vs. buy decisions, which is reflected in the A-world in terms of the concept of development as described in paragraph 5.4.1.2, the rationale underlying the second one provides guidance with respect to deviating from best practices and industry standards.

### 3.4.1.2 Customers

As Moreton and Chester argue, IT can be used to lock-in customers, thereby decreasing their bargaining power. In doing so, they provide an example of American Hospital Supply<sup>10</sup> that used an online order entry and inventory system for hospitals to lock these hospitals into their company. The same opportunity was seen by the respondents in the research of Mulligan and Gordon, who also considered IT as providing the opportunity of locking-in customers to their companies in terms of increasing customer switching costs, thereby creating a dependency.

Whereas the previous example related to decreasing the customer's bargaining power, an example provided by Porter and Millar shows how IT has increased the customer's bargaining power. They argue that IT, for example Videotex, has allowed customers to more easily evaluate quotations. Since Videotex can be considered as being an outdated technology, the Internet is a more appropriate and recent example of IT enabling customers in comparing products and prices, thereby increasing their bargaining power. This view towards customers is also reflected in the research of Mulligan and Gordon, in which the respondents considered their customers being one of the main drivers for their companies engaging in the use of (new forms of) IT. If their companies wouldn't do so, their competitors would, thereby losing customers. Moreover, referring back to the previous example of Porter and Millar, the respondents also argued that their customers have become more knowledgeable and demanding, which required their companies to offer new IT functionalities such as real-time data. Finally, the respondents also saw many opportunities in the use of IT<sup>11</sup> with respect to their relationship with customers, including improving customer service levels, increasing customer switching costs and increasing their geographic reach<sup>12</sup>. Especially the Internet was considered as offering many opportunities, in that it allowed their companies to serve customers around the globe 24 hours a day.

Next to this, the research of Mulligan and Gordon also stresses that the (inappropriate) use of IT could cause a loss in client-control and a lack of personal touch. Therefore, especially with respect to a lack of personal touch, an organization might need to consider the channels being used in serving its customers. For example, one might need to consider using a multi-channel strategy with respect to serving/retaining customers<sup>13</sup>. This view towards the use of IT is ex-

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<sup>10</sup> Also mentioned by Earl.

<sup>11</sup> In terms of audio-response networks and web-based technologies.

<sup>12</sup> Creating new relationships beyond regional boundaries.

<sup>13</sup> E.g. serving the customer through both the Internet and call centers.

pressed in a principle stating ‘*Multiple Delivery Channels*’, with the purpose of supporting ‘*client delivery channel preferences in accessing government services*’ (TBS, 2001). This, in turn, might be reflected in the I-world in terms of the concept of accessibility as described in paragraph 4.4.6.

One of the interviewed companies addressed the concept of customers in terms of its T-world being impacted; the company argued for having services in place that allowed it to perform tasks on behalf of its customers in its applications. As described in paragraph 3.4.2.1.1, the concept of customers becomes even more important when organizations adopt the ‘*customer intimacy*’ value discipline.

### 3.4.1.3 Suppliers

Whereas IT has allowed customers to easily compare products and prices, the same applies to the organization and its suppliers. Moreton and Chester argue that IT has contributed in organizations being able to ‘*shop around*’, thereby reducing the costs of supplies and their dependency upon suppliers. Moreover, the respondents from the research of Mulligan and Gordon reported that technologies such as electronic data interchange (hereinafter to be referred to as EDI) supported the relationships between their companies and its suppliers. This is underscored by Moreton and Chester who argue that ‘*Companies are increasingly using IT for interorganizational cooperation*’. With respect to the use of IT for interorganizational cooperation, IT has allowed organizations to focus on their core business and acquire additional services/information from their suppliers and partners. This, in turn, might be reflected in the I-world in terms of the concept of source selection at the organizational level as described in paragraph 4.4.2.2. A good example of interorganizational cooperation includes the Dutch Internet broker Alex, that acquires its real-time stock price information from Tenfore Systems, offers competitor’s products such as Turbo’s<sup>14</sup> through an alliance and allows customers to integrate functionalities offered by IEX.NL<sup>15</sup> with its own services. The role of IT with respect to an organization’s external collaboration with suppliers<sup>16</sup> is also stressed by Sander and Premus (2005), who studied the effects of a firm’s IT-capability<sup>17</sup> on both its internal and external collaboration, of which, with respect to this paragraph, only the latter is important. Their research shows that a firm’s IT-capability is positively related with its external collaboration. However, they also argue that collaboration is to not be seen as a synonym for IT. Rather, they argue that IT is a separate construct that promotes external collaborative relationships.

Although IT has offered many opportunities with respect to an organization’s relationships with its suppliers, it also poses threats. Referring back to the previously mentioned example of shopping around, this only applies when an organization has the ability to do so; for example, it is not forced to maintain relationships with certain suppliers due to high (non-industry standard based) EDI-investments. Other threats, as mentioned by the respondents from the research of Mulligan and Gordon, include the alienation of existing distributors by getting closer to end customers, the adoption of wrong standards, increased vulnerability of systems

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<sup>14</sup> A financial product of the ABN-AMRO bank.

<sup>15</sup> A Dutch website providing financial information and services (<http://www.iex.nl/>).

<sup>16</sup> Measured along the variables: sharing of operations information with supplies, sharing of cross-functional processes with suppliers, engagement in collaborative planning with suppliers and the sharing of cost information with suppliers.

<sup>17</sup> Measured along the variables: IT capability relative to industry standards, relative to key competitors, relative to key customers and the level of information networks used with suppliers.

because of interorganizational connections, increased security requirements and difficulties in integrating systems among partners.

Next to these threats, whereas IT offers the opportunity of locking-in customers as described in the previous paragraph, it also poses the threat of an organization itself becoming locked-in. The previously mentioned example of high investments with respect to supplier relations underscores this. Another example, which more specifically focuses on the choice of IT vendors, who should also be considered as suppliers, also stresses the importance of this threat. For example, many organizations nowadays use enterprise resource planning software from market leaders such as Oracle and SAP. By doing so, a company basically locks itself in<sup>18</sup>, which by itself is not necessarily a bad thing. However, it is important to recognize the potential threats associated with choosing certain IT solutions, and more specifically those associated with the vendors of these solutions. For example, whereas PeopleSoft was formerly an independent market leader, it has recently been taken over by Oracle. A possible threat for current owners of PeopleSoft solutions might be that Oracle on the long term will end its support for these solutions, and thereby forces its customers to adopt new solutions. This, in turn, might have several consequences, under which the costs involved in implementing new solutions.

One of the interviewed addressed this potential threat in one of its principles stating '*Reduce integration complexity; maximize interoperability and information sharing*'. The implications associated with this principle included that the company relied on industry standards to integrate applications and interfaces, rather than on proprietary standards. By doing so, it addressed the idea of not becoming dependent upon a single or a few vendor(s). This, in turn, might be reflected in the A-world in terms of the concept of integration as described in paragraph 5.4.1.3. Other principles addressing this potential threat include '*IT solutions will use industry-proven, mainstream technologies*', '*Priority will be given to products adhering to industry standards and open architecture*' (State of CT Architecture Team, 2000) and '*Vendor independence will be promoted through the use of nonproprietary specifications and interchangeable components*' (U.S. Department of Education, 1999).

Examples of principles addressing the concept of suppliers in general, in terms of partners, include '*Systems must be designed, acquired, developed, or enhanced such that data and processes can be shared and integrated across the enterprise and with our partners*' (State of CT Architecture Team) and '*information must be shared to maximize the effectiveness of business decision making throughout the government and beyond to external partners*' (TBS).

#### 3.4.1.4 Regulators

As described previously, whereas Porter's model focuses on competitive forces, it does not account for the important concept of regulators. The importance of this concept is stressed by it being part of the organizational model described by Gharajedaghi, it being considered by Thiadens as an external force driving the use of IT and it being considered by Davenport and Prusak as a driver for an organization's I-world. How regulators and their regulations impact the use of IT in an organization, is elaborately described by Calder and Watkins (2005). Examples of regulations mentioned by them, include the Copyright, Designs and Patents Act 1988, Computer Misuse Act 1990, Data Protection Act 1998, Human Rights Act 1998, Elec-

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<sup>18</sup> It should be noted, however, that since much of these vendors use industry standards, the threat associated with choosing such solutions is somewhat diminished.

tronic Communications Act 2000, Regulation of Investigatory Powers Act 2000, Freedom of Information Act 2000, Telecommunications Regulations 2003 and software licensing regulations. Whereas an organization has a certain amount of freedom with respect to the use of IT in its relationships with suppliers, customers and competition, such freedom hardly exists with respect to regulators and their regulations<sup>19</sup>. As Davenport and Prusak put it, *‘Every firm has to report some information to governmental bodies about employees, sales, importing, hazardous materials, safety, and so on. Some of this information is strictly required, with little room for reporting flexibility.’*

Examples of principles addressing the concept of regulators include *‘Enterprise information management processes comply with all relevant laws, policies, and regulations’* (The Open Group) and *‘Systems will conform to the spirit and letter of all laws and regulations’* (Hennepin County, 2005). Personally, I think that having such principles in place is useless, since I do not consider adherence as a choice, but rather as an obligation. However, if regulators are to be addressed in the principles formulated, these principles should relate to the choice one has with respect to adherence. For example, some regulations, including the Combined Code on Corporate Governance (Calder and Watkins), allow for choice in terms of the *‘comply or explain’*-principle. If an organization decides that compliance will be the norm, the impact on its use of IT will be different from the impact of choosing that explaining will be the norm. Another example relates to the fact that many regulations are announced several months/years prior to them becoming effective. This allows an organization to choose to adhere to these regulations from the moment being announced or until them becoming effective. An example of a principle addressing the concept of regulators in this way, might state that *‘IT should be adapted to the introduction of new regulations as soon as possible.’* Finally, an example of a principle addressing the concept of regulators in general, might state that *‘IT should contribute to reduce the business’s workload involved in meeting regulatory obligations.’*

As described in paragraph 4.4.5.1, 4.4.6 and 5.4.2.4.2, the concept of regulators might be reflected in both the I- and A-world, in terms of the concept of retention, accessibility and universal accessibility, respectively.

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<sup>19</sup> Which, in turn, might also affect its use of IT in its relationships with suppliers, customers and competition.

### 3.4.2 Organizational design

Whereas the previous paragraph described the concept of organizational environment, this paragraph describes the concept of organizational design. The model used to describe the concept of organizational design is depicted in Figure 3.5.

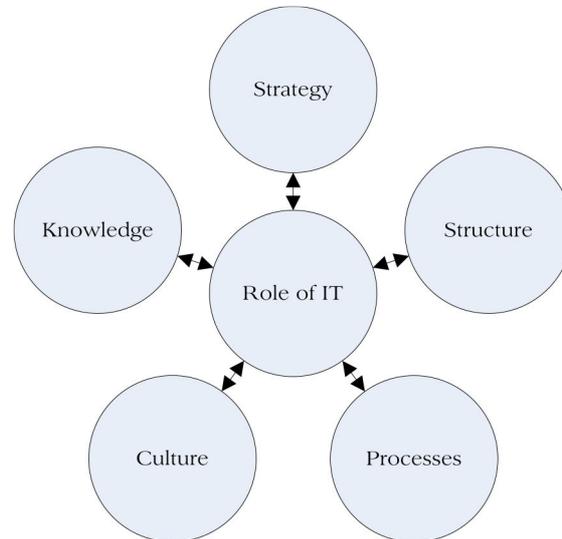


Figure 3.5 Organizational design concepts

The concepts identified in this model are based on both the interviews held and the literature studied. However, it should be that there is no single model or method in describing the organizational design. For example, whereas some consider the concept of organizational structure being defined along the dimensions of formalization, specialization, hierarchy, centralization, professionalization and personnel ratios (Dougan), others consider the organizational structure being defined along the dimensions of centralization, formalization and differentiation (Pfeffer and Leblebici, 1977). Nevertheless, I think that this model is suitable in addressing the major concepts accounting for the organizational design with respect to the role of IT. Although all of the concepts in this model are in some way related to each other<sup>20</sup>, I will not describe these relationships.

#### 3.4.2.1 Strategy

Whereas some of the other concepts, accounting for the concept of organizational design, focus on the role of IT both affecting and being affected by them, the concept of strategy is described in terms of IT being the affected one. Therefore, this concept does not address how IT can be used to change the organizational strategy, but rather how the use of IT is dependent upon the chosen organizational strategy. The model used to describe the concept of organizational strategy is depicted in Figure 3.6. Each of the concepts identified in this model are subsequently addressed in the following paragraphs.

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<sup>20</sup> E.g. the concept of culture being related to the concept of structure.



Figure 3.6 Strategy concepts

Whereas the first concept, that of value disciplines, addresses how the chosen value discipline might impact an organization's use of IT, the second will focus on how IT's contribution to organizational performance is dependent upon the characterization of its strategic activities.

### 3.4.2.1.1 Value disciplines

The concept of value disciplines refers to the strategies as described by Treacy and Wiersma: operational excellence, customer intimacy and product leadership (Eichen, 2006). Each of these value disciplines can serve as the basis for an organization's strategy and, in turn, affects its use of IT. Elam and Moss (1997) have summarized the impact of each value discipline on an organization's use of IT. Not only does the chosen value discipline affects what kind of IT is used, but also where it is used<sup>21</sup>.

First, with respect to the value discipline of operational excellence, which focuses on minimizing costs, maximizing efficiency across the physical value-chain and doing business in a different way, the use of IT is expected to focus on core operating, management and coordination processes, building an integrated information infrastructure and implementing new business models. More specifically, with respect to implementing new business models, such a value discipline might justify the use of new/emerging technologies, since these (sometimes) allow for implementing such new business models.

Second, with respect to the value discipline of product leadership, which focuses on creating and rapidly introducing new products and services, the use of IT is expected to focus on market and product intelligence, design and engineering tools and IT-based products and services.

Third and finally, with respect to the value discipline of customer intimacy, which focuses on tailoring products and services for customers and making it easier for customers to do business with the organization, the use of IT is expected to focus on customer information and analysis, the creation of by-products, product configuration systems and direct communication with customers.

One of the interviewed companies argued in one of its principles for achieving customer intimacy, which was reflected in its use of IT. As a consequence of this value discipline, the company argued for creating a single customer image. This, in turn, was reflected in its I-world in terms of how information was managed across the different business functions and the processes taking place<sup>22</sup>, but also in terms of where customer information was to be stored; the latter is addressed in terms of the concept of retention as described in paragraph 4.4.5.2. Since the growth in diversity of information systems within the organization in the past, as a consequence of market segmentation, acted as a bottleneck in creating such a customer image, the company decided of having one central point where customer information had to be stored. This, in turn, had several implications for its use of IT, since customer in-

<sup>21</sup> Which, in turn, might be reflected in terms of the concept of processes as described in paragraph 3.4.2.3.

<sup>22</sup> Since the company had to deal with cross-functional processes and several channels being used to serve its customers.

formation was gathered from several sources. Moreover, since this value discipline also includes making it easier for customers to do business with an organization, the company argued for having several electronic interfaces in place to satisfy its customers' needs; something that was reflected in both its A- and T-world. Next to this, the value discipline also determined whether new/emerging technologies were allowed to be used within the company. For example, several years ago the company allowed for the use of the emerging technology i-mode in order to satisfy its customers' need of having the information provided by the company available anytime, anywhere. Finally, with respect to value disciplines in general, one of the other interviewed companies argued that its use of IT in the organization differed based on the value discipline applicable to a specific business unit.

Examples of principles addressing the concept of value disciplines, might state that '*IT should support our organization in making a shift from a customer intimacy focus to an operational excellence focus*' and that '*IT should support our organization in reducing costs across the value-chain*', of which the latter is an example of a principle related to the value discipline of operational excellence.

#### 3.4.2.1.2 Characterization of strategic activities

Another concept that relates to the concept of strategy, is the characterization of an organization's strategic activities in terms of the classification scheme of Miles and Snow (Croteau and Bergeron, 2001). As described previously, this concept focuses on how IT's contribution to organizational performance is dependent upon the characterization of strategic activities. Miles and Snow distinguish four types of organizations:

- prospectors;
- analyzers;
- defenders;
- and reactors.

Research focusing on IT's contribution to organizational performance for each of these types of organizations is that of Croteau and Bergeron, who have conducted empirical research under top managers from 223 organizations to identify various profiles of technological deployment specific to the various types of organizations that best supported organizational performance. Their findings are briefly described in the following subparagraphs.

First, with respect to prospectors, the observed profile of technological deployment is more inward than outward oriented, since they focus on finding new ideas, launching new products and taking risks instead of using IT to gain competitive advantage. Moreover, since IT is considered as being an improver, IT-initiatives are assessed for their effectiveness and efficiency. Finally, with respect to IT increasing organizational performance, Croteau and Bergeron argue that '*Information technology might help the firms involved in prospector strategic activities, but, by itself, it will not increase organizational performance.*'

Second, with respect to analyzers, the observed profile of technological deployment is more outward oriented, since strategic activities involve watching competitor's activities closely and carefully evaluating possible organizational innovations. The role of IT is considered as one of being able to increase performance relative to the competition. One of the activities to be supported by IT includes information scanning, in terms of scanning technology markets for information on technologies. Finally, organizations of this type '*encourage their personnel to train in the application of new information technologies.*'

Third, with respect to defenders, the observed profile of technological deployment showed IT being repressed. Therefore, Croteau and Bergeron argue that *'the defender type is counter-productive in terms of organizational performance as it restrains technological development'*. Croteau and Bergeron suggest that such organizations should *'change strategic activities if they wish to improve their organizational performance.'*

Fourth and finally, with respect to reactors, who give no specific orientations to their strategic activities, no specific profile of technological deployment was observed.

The findings of this research suggest that the benefits derived from the use of IT with respect to organizational performance, are closely related to the characterization of strategic activities. Moreover, the results of this research also *'indicate that organizations could enhance their performance by supporting prospector or analyzer strategic activities, and deploying their information technology accordingly'*; IT can give an advantage when applied with an inward and outward profile for prospectors and analyzers, respectively. Whereas organizational performance and IT are positively related for prospectors and analyzers, IT will bring down performance for defenders and will have no effect on performance for reactors, since they lack strategic activities. Next to these findings, this research also makes clear that the principles formulated should show organizational-fit in terms of the characterization of strategic activities. For example, with respect to both the A- and T-world, a principle arguing for using new/emerging forms of IT to face the competition, would be inconsistent if the organization's strategic activities can be characterized as those belonging to a reactor. Moreover, with respect to the I-world, a principle arguing for actively scanning the information environment to become knowledgeable on competitors, would also be inconsistent.

Other empirical research, conducted among respondents from 62 companies by Sabherwal and Chan (2001), focuses on the relationship between business-IT alignment and organizational performance, based on the characterization of strategic activities<sup>23</sup>. An empirical relationship between business-IT alignment and organizational performance was found to exist for prospectors and analyzers; no relationship was found to exist for defenders. Part of their findings suggest that *'the importance of aligning IS strategy with business strategy may not be as universal as previously believed'*; alignment for defenders seems to be of no significance to organizational performance. In their study they also describe what kind of information systems would be appropriate for the different types of organizations, by illustrating their importance. These systems and their importance are listed in Table 3.1. Thereby, their study shows how the characterization of strategic activities might be reflected in the A-world, in terms of an organization's application portfolio.

|                                    | Defenders | Prospectors | Analyzers |
|------------------------------------|-----------|-------------|-----------|
| Operational support systems        | High      | Low         | Medium    |
| Market information systems         | Low       | High        | High      |
| Interorganizational systems        | High      | Medium      | High      |
| Strategic decision support systems | High      | High        | High      |

Table 3.1 Strategy type and application portfolio

<sup>23</sup> In which the research focuses on three of the four types of organizations: defenders, prospectors and analyzers.

Both studies described previously, provide empirical evidence for the characterization of an organization's strategic activities to be considered as a business concept that affects the use of IT<sup>24</sup>, and therefore might be addressed in the principles formulated.

### 3.4.2.2 Structure

As described previously, there are several dimensions along which the organizational structure can be defined. The model used to describe the concept of organizational structure is depicted in Figure 3.7. Since these concepts are frequently addressed in the literature studied, they can be considered as being important concepts that account for the organizational structure. Each of the concepts identified in this model are subsequently addressed in the following paragraphs.

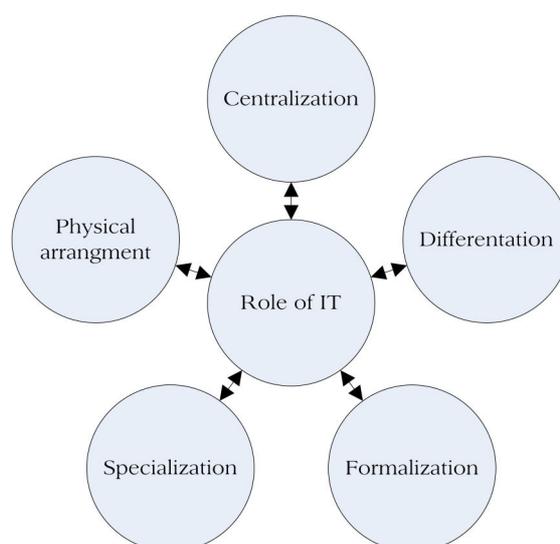


Figure 3.7 Organizational structure concepts

#### 3.4.2.2.1 Centralization

The concept of centralization is described by Dewett and Jones (2001) as the '*extent to which decision making authority is dispersed or concentrated in an organization*'. Therefore, it is important to note that this concept should not be confused with the physical arrangement of the organization and/or the centralization/decentralization of IT-activities, but instead relates to decision making authority in the organization. Conclusions from research focusing on the role of IT with respect to centralization have been diverse. For example, Leavitt and Whisler (1958), being referred to by Markus and Robey (1988), argue that '*information technology would alter dramatically the shape of organizations and the nature of managerial jobs*', which, in turn, would lead to centralization, disappearing levels of middle management and an emerging top-management elite. In addition to this, Simon (1977), also being referred to by Markus and Robey, argues that the use of IT '*would not change the basic hierarchical nature of organizations, but would recentralize decision making.*' Others, like Pfeffer and Leblebici, however, found that the use of IT is positively related to decentralization. Finally, there are also those who argue that the use of IT would allow for both centralizing and decentralizing authority (e.g. Boonstra). I would like to underscore the view as expressed by Boonstra, be-

<sup>24</sup> In terms of increasing organizational performance.

cause centralization and decentralization should not be considered as a necessary consequence of using IT, but rather as a choice that can be facilitated by the use of IT.

One of the interviewed companies addressed the concept of centralization in the rationale underlying one of its principles arguing for information sharing, which, in turn, would *'maximize the effectiveness of business decision making throughout the enterprise and beyond to external partners, thereby creating competitive advantage'*, and in one of its principles arguing for seamless information access *'to reduce decision-making cycle times (both on tactical and operational level).'* With respect to the former, this concept might be reflected in the I-world in terms of the concept of sharing at the organizational level as described in paragraph 4.4.8.2, and with respect to the latter in terms of the concept of accessibility as described in paragraph 4.4.6. Another example of a principle addressing the concept of centralization, that might be appropriate for organizations that can be characterized as machine bureaucracies<sup>25</sup>, might state that *'IT should contribute in sustaining the centralization of decision making authority.'* This, in turn, might be reflected in the I-world in terms of how information flows (horizontal vs. vertical) through the organization.

#### 3.4.2.2.2 Differentiation

The concept of differentiation is described by Dougan as *'the process by which an organization allocates people and resources to tasks and establishes the authority relationships that allow the organization to achieve its goals'*, which comes in two forms: horizontal and vertical. The former is described by Dougan as *'the way an organization groups tasks into roles and roles into subunits (i.e., functions and divisions)'* and the latter as *'the way an organization designs its hierarchy of authority (i.e., reporting relationships).'* In terms of vertical differentiation, this concept is closely related to the concept of centralization as described in the previous paragraph. However, whereas the concept of centralization relates to decision making authority, vertical differentiation relates to reporting relationships that link people, tasks and functions within the organization. Next to Dougan, both Pfeffer and Leblebici and Dewett and Jones consider differentiation as one of the dimensions along which the organizational structure can be defined. With respect to the division of an organization into subunits (vertical differentiation), some of the interviewed companies argued that the concepts being addressed in principles differed based on the business unit applicable, since each business unit was considered having its own vision, mission and goals; this is also stressed in paragraph 3.4.2.1.1 in terms of the concept of value disciplines.

A commonly heard statement is that due to the use of IT, organizations are becoming flatter (e.g. van Vliet, 2005). On the other hand, the research of Pfeffer and Leblebici indicates that the use of IT is positively related to the number of levels in the hierarchy and the number of departments. However, as Davenport (Davenport and Prusak) argues, it is no necessity for organizations becoming flatter due to their use of IT. He argues that he sees *'layers added to organizations as often as'* he sees *'them removed.'* What he does see, however, is that organizational changes lead to changes in the use of IT or that the use of IT allows for organizational changes. This is underscored by Pinsonneault and Kraemer (2002), who have studied the relationship between IT and organizational downsizing in two medium-sized American cities over a period of ten years. One of their conclusions includes that IT facilitated organiza-

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<sup>25</sup> In terms of Mintzberg's organizational forms (Starren, 1999).

tional downsizing, but did not cause it; IT is not a driver for organizational downsizing, but an enabler instead.

An example of a principle addressing the concept of differentiation, might state that '*IT should contribute in bridging the gap caused by vertical differentiation in the organization.*' Such a principle might, for example, be reflected in both the A- and T-world by having IT in place that allows for cross-departmental cooperation and communication to overcome one of the negative side-effects associated with vertical differentiation. Moreover, it might also be reflected in the I-world in terms of coordinating the flow of information. Whereas the concept of (vertical) differentiation was addressed by the interviewed companies, it was often addressed in terms of responsibility, which, in turn, might be reflected in the I-world in terms of the concept of responsibility as described in paragraph 4.4.4.

#### 3.4.2.2.3 Formalization

The concept of formalization is described by Dewett and Jones as '*the process of developing routine responses to recurring problems or opportunities that specify how individuals and functions are to coordinate their actions to accomplish organizational goals.*' Huber (2003) describes the concept somewhat more briefly by arguing that formalization relates to the adherence to standards. As Huber argues, IT '*greatly facilitates the recording and retrieval of information about organizational events and activities and, thus, makes control of behaviors and processes through formalization more viable*'. This view is supported by Dewett and Jones, who argue that IT offers the opportunity to diminish the negative side-effects of formalization, such as the costs involved in searching for standards and procedures. With respect to IT's effect on formalization, Pfeffer and Leblebici found that IT was negatively related to the amount of formalization in the organization; thus, organizations using IT relied less upon formal procedures. This, in turn, might be due to the fact that the IT being used, incorporates these formal procedures. Although the research of Pfeffer and Leblebici shows that the use of IT is negatively related to the amount of formalization, this relationship is not a necessary consequence of using IT; instead, again, it is a choice.

An example of a principle addressing the concept of formalization, might state that '*IT should contribute in decreasing the level of formalization in the organization, while maintaining the benefits of formalization.*' This, in turn, might be reflected in both the A- and T-world, in terms of incorporating procedures into IT solutions.

#### 3.4.2.2.4 Specialization

Both Dewett and Jones and Huber define specialization as the variety in job types in an organization. Dewett and Jones argue that the use of IT will allow for both an increase (e.g. programmers) and a decrease (e.g. bookkeepers) in job types. In contrast to this definition, in terms of specialization being related to the variety of job types, Moreton and Chester and Boonstra describe the concept as the variety of the job type itself. Moreton and Chester argue that whereas traditional approaches with respect to the use of IT mainly focused on task simplification and making tasks more routine, new approaches also consider the ability to enrich job environments. For example, they argue that '*IT can be used to enable employees to perform a range of tasks which cut across or extend traditional skills and job boundaries.*' An example of such enrichment provided by Moreton and Chester is that of Siemens, where the use of IT allowed engineers to deal directly with the organization's suppliers, instead of contacting suppliers through the purchasing department. Another example, provided by Boonstra,

relates to the wide availability of customer data that allows employees to perform cross-selling and increase their level of advice. According to Boonstra, technologies such as workflow-management systems have allowed employees to become responsible for a chain of activities, broadening their task, and thereby increasing the variety of their job. Whereas the previous examples focused on increasing job variety, an example related to a decrease in job variety, namely one-sided data-entry activities, is also mentioned by Boonstra. The relationship between specialization and IT, more specifically in terms of the I-world, is also stressed by Prakken (1997). Prakken argues that an increase in job variety will cause the amount of information being exchanged in an organization to decrease, since organizations will be able to divide tasks over fewer employees, which, in turn, causes a reduction in the number of interface-points. Finally, another view towards the role of IT with respect to specialization is described by Huber, who argues that due to specialization, people's ability to understand the wider context in which they operate, is reduced. Huber argues that IT can mitigate this tendency by providing employees with more information, using technologies such as email, intranets and the internet.

An example of a principle addressing the concept of specialization, might state that '*IT should allow for future variations in job variety.*' Such a principle, in turn, might be reflected in the A-world in terms of the type of applications being used. For example, this principle might require having a single application in place that offers access to different functionalities offered by other applications, as is common in portals. Access to these functionalities, in turn, might be enabled or disabled, depending upon the job variety of an employee. An example of such flexibility in applications is described in paragraph 5.4.2.8 in terms of the concept of personalization. Moreover, it might also be reflected in the T-world in terms of having a role-based authentication scheme in place, which, in turn, allows for determining to which use of functionalities an employee is entitled. By changing the rights associated with a certain role, the organization has the opportunity of increasing and decreasing the job variety with little effort. One of the interviewed companies addressed this concept in terms of role-related access in one of its principles stating that '*Access to services and information is based on a role-related access method and independent of physical location.*' Finally, the concept of specialization might also be reflected in the I-world in terms of the concepts of style and information overload as described in paragraph 4.4.7 and 4.4.9, respectively.

#### 3.4.2.2.5 Physical arrangement

As the last principle mentioned in the previous paragraph makes clear, the concept of physical arrangement<sup>26</sup> was also found to be addressed. Another principle addressing this concept, states '*Provide for Multiple Connectivity Scenarios*' (TBS). The rationale underlying this principle argues that multiple connectivity scenarios are required in providing network access for the mobile and/or telework workforce. Since remote locations do not always offer the network access required, this principle argues for allowing offline working and the synchronization of data upon reconnection. Other examples of principles addressing this concept, include '*User access should be a function of authentication and authorization, not of location*' (State of Arkansas) and '*People will have secure and "easy" access to information systems where they do their work*' (Hennepin County). Next to these examples, the concept is also addressed by Davenport and Prusak in terms of the physical arrangement of an organization being a potential barrier in information sharing.

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<sup>26</sup> Being mentioned as '*physical location.*'

The examples provided in the previous subparagraph make clear that some organizations are aware of the potential barriers associated with their physical arrangement. In trying to overcome such barriers, they expect IT, more specifically in terms of the A- and T-world, to provide the access mechanisms and connectivity required. Examples include identity and access management, mobile device support and desktop integration (Hennepin County). Next to this, a slightly different view towards the physical arrangement of an organization is also reflected in some of the principles gathered. For example, some of these principles address the concept of physical arrangement in terms of applications making no assumptions on their users' location, language, systems training or physical and cognitive capabilities (WEAT; The Open Group). This, in turn, might be reflected in the A-world in terms of the concept of universal accessibility as described in paragraph 5.4.2.4.1.

### 3.4.2.3 Processes

The concept of processes is described by Moreton and Chester as 'a group of logically related, cross-functional, repeatable activities that have measurable inputs and outputs', and by Boonstra as a series of logically coupled tasks with the goal of achieving a certain result.

With respect to processes in general, Sanden and Sturm (1997) argue that IT's role can be described in terms of informing processes, information processing support and storing process results. Also, they argue that the orchestration of business processes drive an organization's communication requirements, which, in turn, is reflected in the I-world. This view towards the relationship between processes and IT was also underscored by many of the interviewed companies. One of the interviewed companies argued that IT should contribute to 'straight through processing', which basically refers to the idea of electronically conducting transactions with a minimum of manual intervention. The same company also argued that the design of processes influences the applications being in place, which, in turn, is reflected in the A-world. Next to this, one of the interviewed companies argued in one of its principles that IT should reduce process-cycle-times. Finally, many of the interviewed companies stressed the importance of the concept of processes in terms of the value-chain; sometimes, the value-chain being referred to was that of Porter (Porter and Millar), as depicted in Figure 3.8.

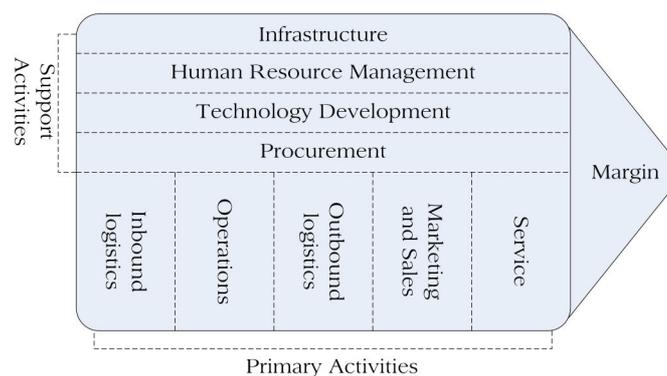


Figure 3.8 Porter's value-chain

Whereas Porter's value-chain distinguishes nine types of activities that fall into two categories, primary and support activities, Porter and Millar argue that IT can affect all activities within the value-chain. In addition to that, they argue that 'To gain competitive advantage over its rivals, a company must either perform these activities at a lower cost or perform them

*in a way that leads to differentiation and a premium price (more value).*' The value-chain might be considered as a useful model in determining on what activities IT should focus and what the expected role of IT should be; this was already stressed in paragraph 3.4.2.1.1 in terms of the concept of value disciplines. Earl also stresses the importance of the value-chain in choosing the organizational focus with respect to IT. In doing so, Earl provides an example of a service providing company that determined that most of the process costs were those related to inbound-logistics activities. As a response to this insight, the company focused on achieving cost reductions in this area, partially by using IT. Earl further argues that the basic idea of using the value-chain is to determine the costs of each of the activities, and then to determine whether a cost reduction or production increase can be achieved by using IT. According to Earl, the second step would be to determine where benefits can be gained by using IT in coordinating, integrating or optimizing these activities.

Whereas Earl speaks solely in terms of costs, Willcocks (2003) argues that the basic question with respect to the value-chain is *'what can be done to add value within and across these activities?'* Because all of the activities within the value-chain have both a physical and an information processing component, Willcocks argues that *'it is clear that the opportunities for value-added IT investment may well be considerable.'* According to Willcocks, applying value-chain analysis will allow an organization to focus on where these opportunities will be; Willcocks's vision with respect to the value-chain is in line with the one of Porter and Millar and Earl. The use and role of IT with respect to the activities within the value-chain might differ per organization. For example, market-focused firms perceive their highest payoffs from IT in customer relations and those with a focus on operations perceive most payoffs in production and operations (Tallon, Kraemer and Gurbaxani, 2000). The basic idea behind describing the value-chain was to illustrate that the role of IT might differ per organizational process. Therefore, an organization might address the concept of processes in terms of determining on which parts of the value-chain IT should focus and what its expected role is. An example of a principle addressing the concept of processes, might state that *'IT should contribute in reducing the costs involved in marketing and sales processes.'*

Next to this, one might also consider the value-chain as a system of interdependent activities that are connected by linkages that need to be coordinated, for example, to achieve on-time delivery, thereby gaining a competitive advantage (Porter and Millar). The focus on these linkages was stressed by one of the interviewed companies that argued that IT should contribute in reducing the number of linkages within its customer-oriented processes. This example makes clear that these linkages are not limited to connecting activities in the organization, but also to those outside the organization. Porter and Millar underscore this role of IT with respect to these linkages by arguing that *'Information technology not only affects how individual activities are performed but, through new information flows, it is also greatly enhancing a company's ability to exploit linkages between activities, both within and outside the company'* and by arguing that *'Information systems allow companies to coordinate value activities in far-flung geographic locations.'* Finally, this role of IT with respect to (inter)organizational processes is also underscored by Bakos and Treacy (1986), who argue that *'Coordination can be achieved with information systems that couple functional areas in two distinct firms.'* The example provided by them, to illustrate the role of IT as a coordination mechanism, is that of two distinct firms where *'one might couple the production planning system of a firm with the order entry system of suppliers to lower the amount of inventory in process and the turn-around time for new orders.'*

Since processes are activities that produce outputs, much emphasis was also placed on the outputs, in terms of services and/or products. As van der Zee, Laagland and Hafkenscheid (2000) make clear, organizations should be thinking in terms of what products (outputs) they produce; how do they add value within the larger system of which they are part of? They argue that the products of an organization should determine how it organizes its processes, which, in turn, drives its information requirements. Moreover, they argue that IT should be considered as one of the components that can support these processes. Next to van der Zee *et al.*, many of the interviewed companies also underscored the idea of an organization's products being a major driver for its use of IT. For example, one of the interviewed companies argued that its products influenced what functionalities are to be offered by its applications, being reflected in the A-world, and also the information to be available, being reflected in the I-world.

Another one of the interviewed companies also described a same sort of relationship, in terms of technological support being offered in the T-world that is able to support a full product range. This company argued that the product lifecycle and IT<sup>27</sup> are closely related to each other. The relationship between products and IT seemed to be especially relevant for those organizations that offered products with a high information density. Finally, many of the interviewed companies also stressed the importance of upcoming trends such as the Service Oriented Architecture (hereinafter to be referred to as SOA) and the Service Oriented Enterprise, which cause IT being organized along the services being delivered in and across the organization. This, in turn, might contribute to the agility of organizations with respect to changes in their processes. Research focusing on the role of IT with respect to an organization's agility in terms of its processes, includes that of Broadbent, Weill and St. Clair (1999), Mendonca (2004), Lee and Bhatt (2000). Their conclusions show that IT can be an enabler in process agility by arguing that '*Limited IT infrastructure capability can hinder process innovation*' (Broadbent *et al.*), '*an integrated technology environment is one of the important considerations in business improvement initiatives*' and that '*higher levels of data integration and communication networks integration significantly contribute to process improvement initiatives*' (Bhatt).

One of the interviewed companies addressed the concept of processes in one of its principles arguing for scalability. The implication associated with this principle, in turn, argued for having the flexibility to support different business processes. Other examples of principles addressing this concept, include one arguing for the tight coupling of IT to streamline processes (DIS, 2004) and one arguing for a holistic approach towards IT, in terms of the T-world, which, in turn, would allow for facilitating changes in processes more easily (TBS). Finally, one of the interviewed companies argued in one of its principles for business-event driven IT solutions. The rationale underlying this principle argued that a change in a process would thereby not affect the applications supporting this process, which would ensure linkage with the process. This, in turn, might be reflected in the A-world in terms of the concept of change as described in paragraph 5.4.1.1.

#### 3.4.2.4 Culture

Leidner (2003) describes the concept of culture as '*a shared mental model which influences how individuals interpret behaviors and behave themselves, often without their being aware*

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<sup>27</sup> In terms of the T-world.

*of the underlying assumptions.*' So, culture is something that affects the behavior of individuals and the organizations they work in, based on an underlying set of assumptions. It is important to note that culture can and probably will differ based per business unit. Next to this, culture can also differ based on the level within the organizational hierarchy. For example, Harris and Ogbonna (1998), based on three case studies in retail companies, argue that '*culture change initiatives should be directed at different levels of the organizational hierarchy.*'<sup>28</sup> In contrast to the other concepts<sup>29</sup>, the role of IT with respect to this concept is limited, in terms of IT hardly affecting the concept of culture; IT is considered as being the affected one.

Boonstra argues that different cultures have a different perception of IT. To underscore this, Boonstra provides several examples under which those derived from research conducted by Cooper (1994). Cooper, for example, found that the use of IT with the purpose of getting '*in-control*' is welcomed by managers who operate in a '*stability-culture*', because of the emphasis on internal order and control. Managers operating in a '*survivor-culture*', however, would see such use of IT as a threat to their flexibility and creativity. Also Hodas (1993) addresses this relationship between culture and IT by arguing that technology is not '*value-free*' and therefore technology's '*values and practices must always either support or subvert those of the organization into which it is placed*'. The conclusions of Hodas's research include that technology and culture should be in line with each other to prevent implementation issues. Moreover, Hodas stresses that technology acceptance will differ per (group of) organizational member(s), by arguing that '*a technology that is favorable to one faction at a given moment may be resisted by another which might favor it for different reasons under different circumstances*'; this underscores the view of Harris and Ogbonna as described previously. Therefore, it will probably be insufficient to only take into account the overall organizational culture.

Whereas culture was addressed in the principles gathered, it was addressed in the implications associated with technology-oriented principles. Examples of such implications, include '*establishing a "culture of reuse" through the use of incentives*', '*making a culture shift towards setting and monitoring standards and compliance*', '*making a culture shift in adaptive thinking*' (TBS) and '*Access to data does not necessarily grant the user access rights to modify or disclose the data. This will require an education process and a change in the organizational culture, which currently supports a belief in "ownership" of data by functional units*' (The Open Group). While not being addressed in their principles, several of the interviewed companies stressed the importance of recognizing culture as a concept that is related to the use of IT. For example, one of the interviewed companies argued that the introduction of mobile forms of IT, to be used by its employees, is closely related to this concept. The company argued that, since its employees have a certain way of working and norms and values underlying their behavior, one has to discover what expectations emerge from them and how to meet these expectations in terms of the IT-solution used. Finally, another one of the interviewed companies also stressed the importance of culture, by arguing that culture is a determinant of its use of IT.

As the previous subparagraphs make clear, culture is closely related to the use of IT. This, in turn, is reflected in both the I- and A-world in which a majority of the concepts described are in some way related to the concept of culture.

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<sup>28</sup> Please note that successfully transforming culture is questionable (Starren; de Caluwé and Vermaak, 2001; Gharajedaghi).

<sup>29</sup> With the exception of the concept of strategy as described in paragraph 3.4.2.1.

### 3.4.2.5 Knowledge

As Alavi and Leidner (2001) argue, *'defining knowledge has occupied the minds of philosophers since the classical Greek era and has led to many epistemological debates.'* In addition to this, Davenport and Prusak refuse to make a distinction between data, information and knowledge, since they consider it as being imprecise. Likewise, I will put no effort in trying to define the exact meaning of the concept of knowledge. However, the examples described, provide some guidance on how to interpret this concept.

Boonstra argues that IT can have different roles with respect to generating, storing and distributing knowledge. Examples, mentioned by Boonstra, include the use of groupware-tools to generate knowledge and intranets and knowledge bases for the distribution of knowledge. Although recognizing the importance of IT with respect to knowledge management, Boonstra argues that successful knowledge management depends upon more factors than IT alone. According to Boonstra, IT by itself will not cause a change in the behavior of people with respect to knowledge sharing, especially when knowledge is considered as a source of power. Reward structures are one of the other factors Boonstra considers being part of a successful knowledge management strategy. This shows that this concept is closely related to the concept of sharing at the individual level as described in paragraph 4.4.8.1.

One of the interviewed companies addressed the concept of knowledge in its goal for systematically recording knowledge on organizational domains, in a way that it is accessible to everyone and, in turn, can be used to facilitate changes within a domain. This, in turn, might be reflected in the I-world in terms of the concepts of retention and accessibility as described in paragraph 4.4.5 and 4.4.6, respectively. Another view towards the concept of knowledge, in terms of being knowledgeable, was expressed by one of the other interviewed companies. The company argued that, since the information density of its products was high, it needed to keep track on historical information (mutations) that was related to its products. This, in turn, might also be reflected in the I-world in terms of the concept of retention. Finally, another one of the interviewed companies addressed this concept in terms of becoming knowledgeable on trends that are emerging in the organization's environment and in terms of knowledge on technologies. With respect to the latter, the company argued that it would only use technologies for which it had in-house expertise. This implies that the company would probably not use new/emerging technologies, which might be reflected in the A-world in terms of the concept of development as described in paragraph 5.4.1.2.

Whereas knowledge was addressed in the principles gathered, it was addressed in terms of implementing content and knowledge frameworks that *'address the creation, capture, maintenance, accessibility, dissemination, and use of information'* to support a principle stating that *'ICT systems and services must facilitate legitimate access to information while providing strict control over the collection, management, and security of this information in accordance with freedom of information and privacy (FIPPA & PHIA) legislation'*, and in a guideline arguing for the transfer of *'knowledge to development and development personnel'* to support a principle stating that *'Consistent application development, integration and maintenance processes will be used across government'* (MICT, 2005). Finally, knowledge was also addressed in terms of the knowledge required to use the applications in the organization (The Open Group).

The previous subparagraphs show that the concept of knowledge might be reflected in both the I- and A-world. With respect to the I-world, this concept, next to the concepts mentioned previously, might also be reflected in terms of the concept of source selection at the organizational level as described in paragraph 4.4.2.2. Finally, with respect to the A-world, making applications usable for their users partially relies upon taking advantage of people's existing knowledge. Therefore, the concept of knowledge might be considered as an important concept to address in the principles formulated.

## 3.5 Recap

In this chapter I have tried to answer research question 1.1, that stated ‘*What concepts, that are of interest to the digital architect in the B-world, are/can be addressed in the principles formulated as part of a digital architecture and why?*’ In answering this question, I have made a distinction between those concepts that are related to the concept of organizational environment and those that are related to the concept of organizational design. With respect to the former, I have identified the following concepts:

- competition;
- customers;
- suppliers;
- and regulators;

and with respect to the latter, the following:

- strategy;
  - value-disciplines;
  - and characterization of strategic activities;
- structure;
  - centralization;
  - specialization;
  - differentiation;
  - formalization;
  - and physical arrangement;
- processes;
- culture;
- and knowledge.

Next to having identified these concepts, more important, I have also tried to make clear why they are important. In doing so, I have provided several examples of principles addressing these concepts and references to both the interviews held and the literature studied stressing their importance. Moreover, I have also tried to show how decisions with respect to these concepts might be reflected in the I-, A- and T-world, and also how the use of IT can affect these concepts. The most important findings with respect to these concepts are briefly described in the following subparagraphs.

With respect to the organizational environment, this chapter showed that IT has offered organizations many opportunities, including using it as a means in facing their competition, in serving their customers and in doing new ways of business with their suppliers. However, at the same time it also poses threats, including not being able to adapt to new trends due to legacy systems, being forced to maintain relationships with suppliers due to high investments and getting locked in by IT vendors. Overall, the organizational environment can be considered as being a major driving force for the use of IT. For example, it might affect the electronic services being offered to the environment, whether organizations engage in using new/emerging technologies and whether and which standards are used in communicating with the environment. Next to customers, competitors and suppliers driving the use of IT, also regulators and their regulations become increasingly important. For example, the Sarbanes-

Oxley Act affects how information is managed in the organization, which is reflected in an organization's I-world. Also other regulations might affect the use of IT, for example, those that require organizations of having applications in place that meet certain standards, under which accessibility standards, thereby also affecting the A-world.

Next to this, this chapter also showed that IT has offered organizations many opportunities with respect to the organizational design. For example, due to the use of IT some organizations have become flatter, reduced the number of formal procedures and increased the variety of jobs. Also, with respect to the concept of processes, it became apparent that IT can be used for different purposes, under which reducing process cycle-times, orchestrating them and increasing their agility. Next to this, this chapter also showed that the use of IT should be in line with the B-world. For example, the concepts of characterization of strategic activities and culture showed that the benefits derived from using IT are dependent upon such alignment. The most important findings, however, are those related to the concept of culture. In describing this concept, it became clear that adapting the IT solutions employed to the behavior of individuals is a requirement for them actually being used; there is no point in employing IT solutions if they aren't used. Finally, with respect to the concept of knowledge, this chapter showed that IT can aid the process of knowledge management, but also that successfully managing knowledge takes more than IT alone. For example, a successful knowledge management strategy should also address the behavior of people with respect to information. This, in turn, might be reflected in the I-world and is also closely related to the concept of culture. The importance of the concept of culture becomes even more apparent in the following chapters, since a majority of the concepts identified in both the I- and A-world are related to human behavior.

Overall, this chapter showed that although there is a relationship between changes in the B-world and the use of IT, this is no necessity, but rather a choice. This choice, in turn, affects whether and how IT is changing the B-world or the other way around, and should be expressed in the principles formulated. However, with respect to certain concepts, under which the concepts of strategy and culture, this choice is somewhat limited in terms of IT being considered the affected one. Therefore, it is equally important to also consider the alignment between the B-world and IT.

# Chapter 4

## I-world

*'Information is a difference  
that makes a difference'*

(Gregory Bateson)

As described in paragraph 1.2.2, the I-world refers to the part of the organization that is concerned with the information supply. In the I-world one is concerned with concepts like information sharing, information sources and information style. As Rijsenbrij (2004; 2005) argues, this is the part of the organization that connects the B- to the A- and T-world, in terms of translating the business's need for information into requirements for the A- and T-world. Moreover, according to Rijsenbrij, this is the part of the organization that is vital to the (successful) functioning of the organization (B-world).

In this chapter, I will again first explain the relevance of this world with respect to digital architecture, give a brief description on how the concepts identified should be interpreted and finally describe the concepts themselves based on the interviews held and the literature studied.

## 4.1 Relevance

As Rijsenbrij argues, providing information in a smooth and timely manner is vital to the (successful) functioning of an organization. One aspect of the I-world mentioned by Rijsenbrij relates to having the right (amount of) information in place to support decisions and the tasks being performed in the B-world. Next to this, Rijsenbrij argues that the I-world should also be concerned with knowledge management. Moreover, Rijsenbrij argues that a large part of behavior in organizations is dependent upon having the right information in place. Basically, the I-world is concerned with supporting the business activities taking place in the B-world, causing it to reflect what happens in the B-world. Finally, Rijsenbrij also argues that it is the I-world which is at the core of the business-IT alignment problem.

## 4.2 Interpretation

Whereas the previous chapter focused on the business concepts that might affect or are affected by IT, this chapter focuses on the concepts that are relevant from an information perspective.

In the previous chapter I have argued that the concepts described, should be interpreted as concepts that are/can be indirectly addressed in the principles formulated. This chapter, however, describes those concepts that are/can be addressed directly in the principles formulated. Addressing these concepts directly is based on the assumption that the I-, A- and T-world are the worlds in which the digital architect is knowledgeable enough and has enough mandate, and therefore is able to formulate principles directly addressing these concepts. In doing so, however, the digital architect is expected to also take into account the business concepts as described in the previous chapter by addressing them indirectly. This, in turn, might result in the business and IT becoming/staying in line with each other.

## 4.3 Approach

Whereas information within organizations was addressed in the literature studied, it was mainly described in terms of knowledge management (Probst, Raub and Romhardt, 2000; Sabherwal and Sabherwal, 2005) and organizational learning (Balasubramanian; Choo, 1995; Slater and Narver, 1995). While the focus of each of these approaches to information in the

organization differs<sup>30</sup>, the structure underlying them shows great resemblance. Initially, the approach chosen to describe the concepts identified in the I-world, was based on the processes<sup>31</sup> as identified in both the literature on knowledge management and organizational learning. However, while this approach might be useful for organizations in identifying information concepts, it did not provide a logical structure to categorize the concepts as identified during the interviews held and in the literature studied. Therefore, I chose to describe the concepts in the I-world without using such a high-level categorization scheme. The concepts, as identified during the interviews held and in the literature studied, are depicted in Figure 4.1. These concepts are subsequently addressed in the following paragraphs.

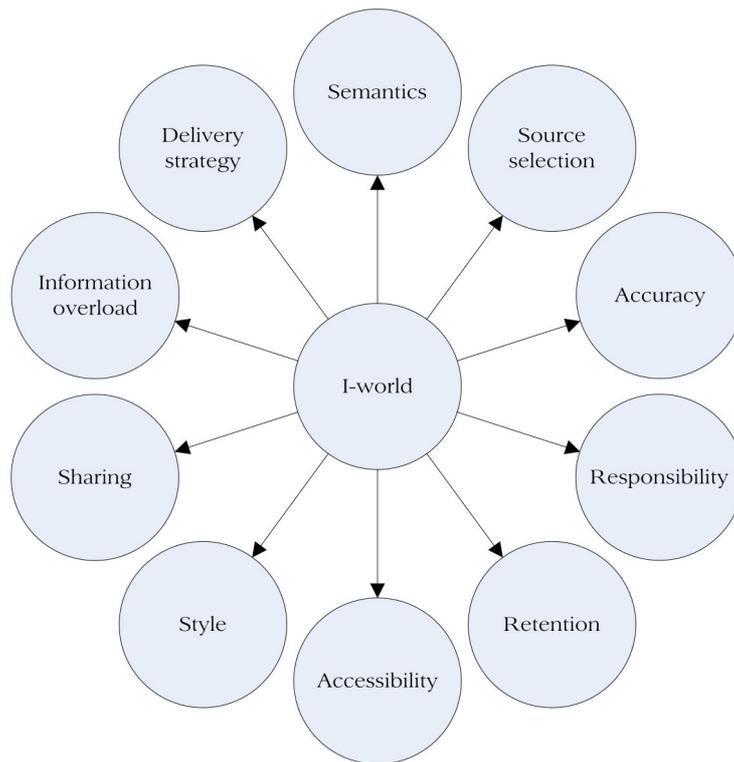


Figure 4.1 I-world concepts

Please note that, whereas the literature studied sometimes made a distinction between data, information and knowledge, information, where possible, is used as an interchangeable term for all three in this chapter.

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<sup>30</sup> In terms of them focussing on knowledge management and organizational learning, respectively.

<sup>31</sup> Information requirements, information acquisition, information retention, information distribution and information utilization.

## 4.4 Findings

### 4.4.1 Semantics

Whereas the literature studied described why organizations process information, two purposes are mentioned: to reduce uncertainty and equivocality (Choo, 1991; Daft and Lengel, 1986). With respect to these two basic reasons underlying the information processing behavior of organizations, the latter, that of reducing equivocality in terms of semantics, was frequently addressed by the interviewed companies and in the literature studied (Hoogervorst, 2004; Davenport and Prusak, 1997; Sanden and van der Sturm, 1997). One of the interviewed companies, for example, argued that its IT people used a different language than its business people did. In order to resolve this issue, the company was working on a common language set to be used within the company. Next to this, another one of the interviewed companies addressing this concept, argued in one of its principles for defining the meaning of common information at the enterprise level. Smildiger (2005), in describing norms to assess the quality of an information architecture, also addresses the concept of semantics in this way, by arguing for standardizing the meaning of information. Smildiger argues that by creating a uniform meaning of information, information is suitable for being used for multiple purposes.

Next to the reasons mentioned in the previous subparagraph, there might be several other reasons underlying organizations to argue for reducing equivocality. For example, Davenport and Prusak mention the creation of new databases, each of which uses its own definition for the same piece of information, different managers presenting different results and sending multiple communications about a new product offering to the same customer. However, on the other hand, they also argue that having multiple meanings for the same piece of information is not negative per se. For example, they argue that it allows serving the interests of different people.

### 4.4.2 Source selection

The concept of source selection refers to the location from where the organization and the individuals operating within it gathers its/gather their information. Since the reasoning underlying the selection of information sources differs at the organizational and the individual level, the following paragraphs will address both levels separately.

#### 4.4.2.1 Individual level

As Probst *et al.* make clear, there are numerous studies that have shown that an individual's use of information<sup>32</sup> sources depends primarily on convenience. They argue that '*People are likely to seek knowledge if it only takes a short telephone call, or perhaps an informal request to a colleague who is close enough to hear, or only a short walk away.*' With respect to these sources, Choo argues that the '*selection of information sources, channels, and media is strongly influenced by individual preferences as well as the biases that are formed as a result of the individual's participation in the organization.*' Choo underscores this view by referring to Gertsberger and Allen (1968), who have studied the information source selection behavior

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<sup>32</sup> Please note that Probst *et al.* speak in terms of knowledge instead of information.

of research and development engineers. Their research shows that those information sources that are the most accessible ones, are used first in the course of information search.

Choo also refers to empirical research conducted by O'Reilly (1982), among 163 subjects employed in four branch locations of a county welfare agency, to determine the relationship between the use of information sources and their quality and accessibility. One of the conclusions of this research includes that accessibility is positively related with the frequency of use of information sources, rather than quality. Moreover, O'Reilly argues that individual characteristics, such as experience and motivation, and information source use are also related. As an example, O'Reilly mentions that more motivated workers are willing to use external information sources, which require more effort to obtain and use, compared to files or group members as an information source. This, in turn, might be reflected in the A-world in terms of the concept of accessibility as described in paragraph 5.4.2.4. Moreover, as becomes clear, the concept of source selection at the individual level is closely related to the concepts of accessibility and information overload as described in paragraph 4.4.6 and 4.4.9, respectively. An example of a principle addressing this concept, might state that *'IT should contribute in reducing the time employees spend on acquiring external information.'*

#### 4.4.2.2 Organizational level

Whereas the previous paragraph focused on the selection of information sources at the individual level, this paragraph describes the same concept at the organizational level.

In choosing where to acquire information, organizations might choose between acquiring it from internal and/or external sources. Research focusing on the choice between internal and external sources is that of Choudhury and Sampler (1997), who tried to answer the question whether to acquire information in-house (create) or to outsource such activities (buy), based on a slightly modified version of the traditional transaction cost theory. In doing so, they raise the following question: *'when does an organization choose to monitor an environmental source within its hierarchy, and when does it outsource the task?'* Based on their modified version of the traditional transaction cost theory, they argue that *'In deciding between outsourcing the task of monitoring an environmental information source and retaining the responsibility internally, an organization will choose the option that minimizes the sum of the surveillance costs, the coordination costs, the behavioral contractual costs, and the cognitive transaction costs'*, and based on this define the following proposition: *'Organizations will outsource the acquisition of environmental information that is low in organizational knowledge specificity but will retain internally the responsibility for acquiring information that is high in organizational knowledge specificity.'*<sup>33</sup> The rationale underlying this proposition is that the costs involved in acquiring environmental information externally that is high in organizational knowledge specificity, are higher compared to those involved in acquiring the same information that is low in organizational knowledge specificity.

Other research focusing on the choice between internal and external sources is that of Belich and Dubinsky (1995), who have conducted empirical research among 108 small- and medium-sized exporting manufacturers from a Midwestern US state, to determine the potential factors influencing whether these companies utilize in-house or external sources to obtain market information. Their conclusion includes that *'To protect proprietary work and knowl-*

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<sup>33</sup> *'Information is high in knowledge specificity in acquisition if it can be acquired only by individuals possessing specific knowledge'* (Choudhury and Sampler).

*edge, small companies appear willing to invest in establishing internal market scanning when they adopt a strategy of product differentiation, sell more complex (i.e., high technology) products, have products in early stages of their life cycles, pursue export operations relatively aggressively, are somewhat separated from their foreign markets, and have employees with sufficient levels of international expertise*, and that *'although managers are usually expected to seek more cost-effective sources for necessary material, concerns pertaining market opportunism may cause them to internalize some functions.'*<sup>34</sup> With respect to the former, this shows that the purpose of protecting organizational knowledge might influence the choice of the information sources being used. Moreover, in general, their research also shows that both organizational and environmental characteristics are related to the choice of the sources being used. From the perspective of their research, an example of a principle addressing the concept of source selection, might state that *'Information acquisition activities should contribute to the protection corporate knowledge.'* This, in turn, might be reflected in outsourcing only those information acquisition activities that do not endanger the value of the organization's corporate knowledge. Moreover, it might also be reflected in security measures and contracts being in place when acquiring information from external sources. Viewing the concept of source selection from this perspective is a good example of how a business concept, in this case the concept of knowledge as described in paragraph 3.4.2.5, might be reflected in the I-world. Whereas the research of Choudhury and Sampler argued that costs might be considered as a driver for choosing to acquire information from internal and/or external sources, that of Belich and Dubinsky shows that the protection of corporate knowledge might be considered as another factor driving such decisions.

Finally, other research focusing on where to acquire information is that of Sabherwal and Sabherwal (2005), who relate the industry innovativeness, firm-specific instability and firm diversification to the concepts of knowledge utilization, sharing and creation<sup>35</sup>; with respect to the concept of source selection, only the last one is considered as being important. Their conclusions include that *'firms that place a low level of emphasis on efficiency should concentrate on IT-based KM efforts that facilitate knowledge creation.'*<sup>36</sup> The reasoning underlying this relationship is that the creation of information is costly, and therefore is less appropriate for firms that focus on high efficiency. For example, a principle arguing for increasing efficiency across the whole organization, might be reflected in information being acquired preferably from external sources, instead of creating it internally. Thereby, their research provides yet another view towards the choice between acquiring information from internal and/or external sources.

The previous subparagraphs described some of the many reasons guiding decisions such as *'create vs. buy'*, *'reuse vs. create'* and *'reuse vs. buy'* with respect to information. Other reasons might include gaining competitive advantage (internal) and becoming less dependent upon the organizational environment (internal). With respect to the latter, one of the interviewed companies argued for becoming less dependent upon its environment. Since its way of doing business involved acquiring large amounts of information externally, the company argued for the use of industry standards only in acquiring external information. This, in turn, allowed the company to acquire information externally while having the option to easily switch between vendors. Next to stressing how to cope with the dependency upon the organ-

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<sup>34</sup> TCA is the abbreviation for Transaction Cost Analysis.

<sup>35</sup> Information creation refers to *'the development of new knowledge from data, information, or prior knowledge'*, which *'may also be created by hiring new employees or by forming external alliances'* (Sabherwal and Sabherwal).

<sup>36</sup> Efficiency, along with innovativeness, accounts for the concept of characterization of strategic activities as described in paragraph 3.4.2.1.2.

izational environment, this example also makes clear how choices with respect to information sources affect the T-world; in this case, in terms of interfaces being based on industry standards.

As IT has allowed organizations to establish digital networks, limiting themselves to their core-business might also be considered as a legitimate reason for guiding decisions with respect to source selection. For example, it might be useful to consider the organizational environment as an information market in which information can be bought (Davenport and Prusak). An example provided by Davenport and Prusak includes that of Xerox and Digital Equipment who *'have outsourced the task of identifying and structuring commercial customer information to Dun & Bradstreet Information Services.'* Prior to this decision, Xerox, for example, had tried to use its own standard for identifying and structuring commercial customer information. However, as Xerox faced problems with this standard, it realized that adapting Dun & Bradstreet's standard offered many opportunities, such as it having worldwide authority, better maintenance, allowing for more integration with business partners and so on.

This example makes clear how the focus of an organization on its core-business<sup>37</sup> might be reflected in the choice of its information sources. One of the interviewed companies underscored this view towards an organization's I-world, by arguing that organizations should view themselves as being part of a larger value-chain in which information can be exchanged, whether this concerns buying or selling information<sup>38</sup>. According to this company, this should be reflected in an organization's T-world in terms of allowing for exchanging information with its environment.

### 4.4.3 Accuracy

Another concept that emerged focused on the accuracy of information. As Davenport and Prusak argue, at the individual level, the accuracy of information is important in information being perceived as valuable. This, in turn, might also influence the sources individuals use for acquiring their information; those which they value and trust. Thereby, this concept can be considered as being closely related to the concept of source selection at the individual level, as described in paragraph 4.4.2.1. Moreover, the accuracy of information might also be considered as being vital to the (successful) functioning of (some) organizations. One of the interviewed companies, that relied heavily upon its information being accurate, addressed the concept of accuracy in a principle arguing for validating information as close to its source as possible.

Other examples of principles addressing the concept of accuracy, include *'All enterprise data will have an authoritative, official, primary data source that is the location for all Create, Update and Delete actions'*, *'Authority to create and maintain the data will reside with those most knowledgeable about the data or those most able to control its accuracy'* (NIH, 2005) and *'All information must have defined "authoritative sources." These sources will act as information stewards'* (TBS). As these examples make clear, the accuracy of information is closely related to the concept of source selection as described in the previous paragraph. Moreover, the concept of accuracy is also related to the concept of responsibility as described

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<sup>37</sup> Identifying and structuring commercial customer information clearly was not part of Xerox's core-business, however, for Dun & Bradstreet it was.

<sup>38</sup> Selling information, in terms of information crossing organizational boundaries, is addressed in terms of the concept of sharing at the organizational level as described in paragraph 4.4.8.2.

in the next paragraph. Finally, accuracy might also be reflected in the A-world in terms of arguing for less error-prone applications; eliminating error-prone conditions is briefly addressed in paragraph 5.4.2.7, describing the concept of user control.

#### 4.4.4 Responsibility

Many of the interviewed companies stressed the importance of assigning responsibility for information within the organization. For example, one of the interviewed companies argued in one of its principles for assigning responsibility for the contents of each piece of information to exactly one responsible entity. This, in turn, made it easier for the company to manage its I-world.

Smildiger also stresses the importance of assigning responsibility for information within the organization. In doing so, Smildiger argues that the responsibility for the correctness of a single piece of information should be assigned to exactly one organizational unit. The choice of who is responsible, in turn, according to Smildiger, is dependent upon the type of information applicable. In addition to this, Smildiger also argues that responsibility should be assigned to those who are most interested in the information having a certain quality. According to Smildiger, assigning responsibility in this way might contribute in making information more useful for its intended audience.

#### 4.4.5 Retention

Another concept that emerged is the retention of information<sup>39</sup>. Literature focusing on organizational learning and knowledge management addresses this concept in terms of the ‘*organizational memory*’, which can be described as ‘*the repository where knowledge is stored for future use*’ (Balasubramanian). It is important to note that the concept of retention goes beyond decisions related to storing explicit (e.g. computerized) information. As Alavi and Leidner (2001) argue, ‘*Organizational memory includes knowledge residing in various component forms, including written documentation, structured information stored in electronic databases, codified human knowledge stored in expert systems, documented organizational procedures and processes and tacit knowledge acquired by individuals and networks of individuals*’. The importance of the concept itself is stressed by Choo (1995), who argues that ‘*Well integrated archival policies and records management systems will enable the organization to create and preserve its corporate memory and learn from its history.*’ Obviously, IT can aid in the retention of information. As Alavi and Leidner argue, ‘*Advanced computer storage technology and sophisticated retrieval techniques, such as query languages, multimedia databases, and database management systems, can be effective tools in enhancing organizational memory.*’ Also they stress the importance of retaining information by arguing that ‘*basing and relating organizational change in past experience facilitates implementation of the change*’ and that it helps in ‘*storing and reapplying workable solutions in the form of standards and procedures, which in turn avoid the waste of organizational resources in replicating previous work.*’

On the other hand, however, they also argue that retaining information might have negative side-effects such as a ‘*potential negative influence on individual and organizational performance*’, which, in turn, might be reflected at the individual level in a decision-making bias and

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<sup>39</sup> E.g. for future usage.

at the organizational level to maintaining the status quo, and eventually might result in ‘*consistent organizational cultures that are resistant to change*’. Both the positive and negative side-effects described, can be considered as examples of purposes being expressed in the principles addressing this concept.

During the interviews held and in the literature studied, two viewpoints from which the concept of retention can be viewed emerged: what to retain and where to retain it. Both are subsequently addressed in the following paragraphs.

#### 4.4.5.1 *What*

In discussing what information to retain, Probst *et al.* argue that because of the huge amount of information being available to the organization, it is simply impossible to keep track of all this information. Therefore, they argue that organizations have to make decisions on what information to retain and what not. In determining what information needs to be retained, they argue that it is helpful to consider the situation in which some information is no longer available. Also, they argue that ‘*The important thing is to concentrate knowledge around certain key factors, and to relate it clearly to special problems.*’ By taking a problem-solving approach in defining what is to be retained and what is not, the purpose of retention becomes clear. They, for example, mention the retention of information to serve the purpose of meeting regulatory obligations.

One of the interviewed companies expressed the same purpose of retaining information in one of its principles, that argued for having information required for legal purposes available at all times. The same purpose of retaining information was also addressed in a principle arguing for business-event driven systems, which required application systems keeping ‘*the operational data necessary to allow the government to re-create any business event*’ (TBS). The rationale underlying this principle argued that from a legal and liability perspective, retention should be supported since it is of ‘*paramount importance*’. Next to stressing possible purposes of retention, these principles also show how a business concept, in this case the concept of regulators as described in paragraph 3.4.1.4, might be reflected in the I-world. The interviewed company mentioned previously also had another principle in place, addressing the retention of information, which argued for not storing derived information. Finally, in addressing this concept, the same company also argued that it stored historical information to keep track of mutations within its information. This, in turn, served the purpose of being able to track down errors.

#### 4.4.5.2 *Where*

As described previously, information retention was also found to be concerned with where information is to be stored. One of the interviewed companies, as described in paragraph 3.4.2.5, addressed this concept in its goal for making tacit knowledge explicit (e.g. computerized). In doing so, it basically argued for making a shift in where information is to be retained. This, in turn, might be reflected in both the A- and T-world in terms of implementing groupware tools, databases and so on. Moreover, it might also be reflected in the I-world in terms of the concept of sharing at the individual level as described in paragraph 4.4.8.1, by encouraging people to share their tacit knowledge and making it explicit. This is a good example of how a business concept, in this case the concept of knowledge as described in paragraph 3.4.2.5, might be reflected in the I-world.

Another example includes one of the interviewed companies that had a principle in place which argued for achieving customer intimacy, as described in paragraph 3.4.2.1.1. This, in turn, was reflected in its I-world in terms of where customer information was to be stored. In this case, the company decided of having one central point where customer information had to be stored and expected none of its business units to store their own information on customers. This, in turn, allowed the company for creating a single customer image which it needed to achieve customer intimacy.

Next to this, another example of a business purpose driving where information is to be retained might include future outsourcing decisions. If it is likely that certain business functions will be outsourced in the future, organizations might choose to assign responsibility for information retention at business-unit level. This, in turn, might ease the process of demerging the organization when outsourcing its business functions. In this case, a principle stating that *'Information storage should facilitate the ease of future outsourcing decisions'*, might imply that information specific to certain business units is to be stored at business unit level.

Finally, it should also be noted that the location of where to store information is closely related to the accessibility of information; the concept of accessibility is described in the next paragraph. For example, some principles argued for the use of data warehouses to facilitate the accessibility of information (e.g. The Open Group).

#### 4.4.6 Accessibility

As Davenport and Prusak argue, *'If the information is too difficult or time-consuming to obtain, it may not be worth the effort to use.'* The accessibility of information was frequently (implicitly) addressed in the principles gathered. For example, one of the interviewed companies stated in the implications associated with one of its principles that *'Business units must provide enterprise access to information, whenever added value can be created in the information value chain.'* Moreover, the same company also addressed accessibility in terms of providing access independent of the physical location in a principle stating that *'Access to services and information is based on a role-related access method and independent of physical location.'* In arguing for making information accessible, the company also made clear how accessibility is to be organized: based on a role-related access method. This, in turn, increased its flexibility in terms of allowing its staff to use workstations and other devices anywhere in the organization, while guaranteeing access to the required information. Also, this principle is a good example of how two business concepts, in this case the concepts of specialization and physical arrangement as described in paragraph 3.4.2.2.4 and 3.4.2.2.5, might be reflected in the I-world. However, such access also required the company of having IT in place that allowed for the control and administration of who is entitled to what information; something which might be reflected in the T-world. Next to increasing the company's flexibility, this principle also served the purpose of reducing decision-making cycle times by providing seamless access to information. A good example of how the concept of accessibility might be reflected in an organization's T-world, includes one of the other interviewed companies arguing for using a multi-channel strategy in delivering information by using technologies such as facsimile, SMS, WAP and so on. From this perspective, the concept of accessibility is closely related to the concept of delivery strategy as described in paragraph 4.4.10.

The concept of accessibility is also addressed by Bouwman, van den Hooff, van de Wijngaert and van Dijk (2005), in terms of knowledge management, who argue that *'Knowledge management aims at increasing access to knowledge and people's ability to perform certain*

tasks.’ To address the role of IT in achieving such accessibility, they mention the Internet, the World Wide Web and browsers that have allowed for access to large collections of unstructured information. This is underscored by Davenport and Prusak, who argue that the most critical factor technology investments have caused, is simple access to information.

For information being accessible, Davenport and Prusak argue that accessibility also involves understandability and retrievability. This is underscored by Culnan (1984), who has empirically studied the dimensions of accessibility for online systems and the relationship between physical system access and access to the actual information. Culnan found that mere system accessibility is an insufficient factor to measure the perceived accessibility of the information itself. Fidel and Green (2004) refer to this distinction as physical accessibility (accessibility) and intellectual accessibility (ease of use). As this makes clear, accessibility goes beyond mere connectivity. Davenport and Prusak underscore this by arguing that solely focusing on connectivity does not guarantee that *‘the actual end user of the information will get what he or she wants from the information.’* They argue that the form in which information is presented, its style, next to connectivity, also determines its accessibility; a concept that is described in the next paragraph. Moreover, they argue that the structure of information systems also determines the accessibility of information. Next to the former being described in the next paragraph, both aspects are also reflected in the A-world. Not only was accessibility addressed in terms of making information accessible to humans, but also in terms of IT solutions. For example, one of the interviewed companies argued in one of its principles that its applications should not directly access each other’s databases; instead, they should use standard interfaces. This, in turn, might be reflected in the T-world in terms of IT being in place that allows for such accessibility.

Whereas the examples described previously focused mainly on the accessibility of information within the organization, some principles also addressed this concept in terms of information being exchanged across organizational boundaries. An example of such a principle includes *‘Information systems should enable and enhance the provision of government information and services to citizens, business, and other jurisdictions to the maximum extent possible’* (Government of Tasmania). This example shows how yet another business concept, in this case the concept of customers as described in paragraph 3.4.1.2, might be reflected in the I-world. Other examples of principles addressing the concept of accessibility, include *‘Enhance and simplify access to information’* (FSA, 2004) and *‘Data stored in information repositories within the extended enterprise should be widely available and accessible by all entities within the state extended enterprise, by federal agencies, and by other appropriate partners and entities’* (WEAT). The latter makes clear that the concept of accessibility is closely related to the concept of retention as described in the previous paragraph, in terms of where to store information.

#### 4.4.7 Style

The way in which information is presented, its style, is a good example of how two of the three Vitruvian quality attributes, usefulness and beauty, being referred to by Rijsenbrij are reflected in a concept, since the style of information can be considered as being dependent upon both its structure and its visual appearance. The style of information is partially what contributes to information being usable and affects whether it is actually (going to be) used. In determining what makes information usable, there is no single answer. However, the usability of information, next to the sources from which it is expected to be gathered as described para-

graph 4.4.2, seems to be dependent upon its processability, which, in turn, is partially affected by its style.

Bettman and Kakkar (1977), who have conducted empirical research on the effects of the information presentation format and consumer information acquisition patterns, found that these patterns are strongly affected by the format used. They argue that mere availability is not enough for information being usable. What they stress is the importance of information being processable, by arguing that *'information must be not only available to consumers, but also processable'* and that *'processability depends upon format'*; this, in turn, is in line with the view expressed by Davenport and Prusak with respect to the concept of accessibility as described in the previous paragraph. Therefore, they argue that *'if certain methods of processing information are easier to carry out or more effective for customers than others, information must be presented in a format congruent with those methods of processing.'* Finally, their research also shows that the format used to present information should be considered as a moderating variable in the preferred way of information processing, thereby affecting how people handle information. This, in turn, might be reflected in the A-world in which many of the concepts described, are related to the way in which information is presented.

Other research addressing the concept of style is that of Speier, Vessey and Valacich (2003), who have empirically studied the effect of interruptions on different types of decision making and the ability of presentation formats to alleviate them. One of their conclusions includes that the *'format can be used to mitigate the deleterious effect of interruptions on the quality of decision making'* and that *'The interaction effect between interruptions and information presentation format demonstrates that features of the information system can influence the manner in which interruptions are processed and that the effects of interruptions can therefore be mitigated using features of information systems.'*

Finally, also Peng (2005), who empirically studied the effects of data hierarchy and information presentation format on performance evaluation judgments, addresses the concept of style. The results of Peng's research indicate that by using the same underlying performance evaluation data, different data hierarchies to organize this data can cause systematic differences in judgments. According to Peng, this *'suggests that after controlling for potential co-variables, data hierarchy affects performance evaluation judgment, regardless of task type.'* Another conclusion from Peng's research includes that *'for different types of tasks, users make better judgments if provided with appropriate presentation format.'*

The research described in the previous subparagraphs shows that the style in which information is presented, influences its usability. In turn, the appropriate style is dependent upon several factors, under which the work environment and the task at hand. Also, this research shows how a business concept, in this case the concept of specialization as described in paragraph 3.4.2.2.4, might be reflected in the I-world. Next to this, the concept of style is also related to the concepts of accessibility and information overload as described in paragraph 4.4.6 and 4.4.9, respectively. Finally, as already mentioned, this concept might also be reflected in the A-world in which many of the concepts described, are related to the way in which information is presented.

Examples of principles addressing this concept, might state that *'The presentation format of information should contribute to increasing the efficiency of the task at hand'* and *'The style of information should contribute to its processability.'*

## 4.4.8 Sharing

Since much of the literature studied addressed information in terms of knowledge management and organizational learning, a frequently mentioned concept was that of information sharing, more specifically at the individual level. However, next to sharing at the individual level, sharing was also found to be addressed at the organizational level. Both forms of sharing are subsequently addressed in the following paragraphs.

### 4.4.8.1 Individual level

With respect to sharing at the individual level, Choo argues that sharing of information will lead to *'new insights to be created by relating disparate items of information'*; a view that is underscored by Huber (1991), cited by Lee and Hong (2002), who argues that sharing *'leads to new information or understanding.'* As Davenport and Prusak argue, there are several factors that might affect sharing, under which technology and politics. They argue that *'All of a company's information behaviors, good or bad, make up its information culture. Particular information cultures determine how much those involved value information, share it across organizational boundaries, disclose it internally and externally, and capitalize on it in their businesses.'* Indeed, whereas one might argue that information sharing should be encouraged solely by means of using IT, one might encounter problems when political structures prevent such sharing. This view is also underscored by Probst *et al.*, who argue that *'creating the infrastructures is not in itself enough to set the process in motion, since there a number of individual and cultural barrier to sharing knowledge.'*

As described in the previous subparagraph, information sharing takes more than IT alone. This view is also underscored by Leidner (2003), who focuses on the relationship between culture and the implementation and use of knowledge management systems. In doing so, Leidner describes different cultures and the associated information sharing behavior. The relationship between these cultures and information sharing behaviors, is depicted in Figure 4.2.

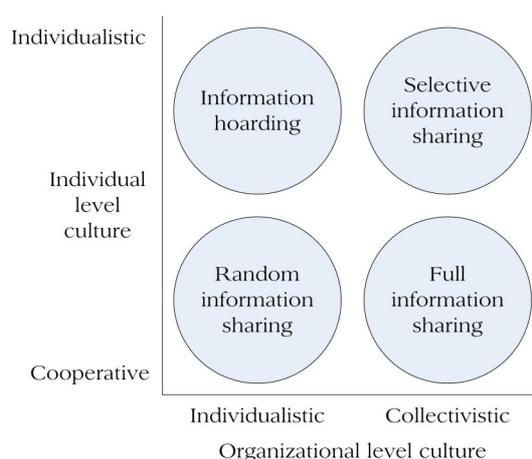


Figure 4.2 Individual and organizational culture influence on information culture

Leidner argues that *'organizational subunit and individual culture, influence the successful implementation and use of knowledge management systems.'* Next to this, Leidner argues that the first step in implementing knowledge management systems is to evaluate where and why barriers might exist, and that the implementation of such systems should be tied to the organizational subunit culture. Such (cultural) barriers, in turn, might be addressed in the principles

addressing this concept. Finally, to underscore the importance of culture with respect to information sharing, Leidner argues that *‘To understand the potential organizational effect of systems designed to harness knowledge, it is argued that the traditional paradigms of structures and decision making are insufficient, but a perspective incorporating organizational culture is needed.’*

Therefore, it is important to recognize cultural barriers to information sharing and, in turn, adapt the chosen technology to these barriers. An example of a principle addressing the concept of sharing, might state that *‘IT should contribute in promoting individuals to share information.’* Such a principle might imply that the applications used in information sharing need to take into account the idea of giving credits for sharing information. From my personal experience, having developed an intranet system, I know that solely associating the name of individuals to their contributions<sup>40</sup> can encourage them in sharing information. Prior to the implementation of this system, information was hardly shared, since those who shared information did not or only in a few cases got credited for their contribution(s).

Finally, the concept of sharing at the individual level is a good example of how two business concepts, in this case the concepts of culture and knowledge as described in paragraph 3.4.2.4 and 3.4.2.5, respectively, might be reflected in the I-world.

#### *4.4.8.2 Organizational level*

As previously described, sharing was also addressed at the organizational level. An example of a principle addressing the concept of sharing at the organizational level includes *‘Data must be shared to the maximum degree possible, without jeopardizing security and confidentiality’* (WEAT). Whereas sharing at the individual level focuses on sharing information within the organization, sharing at the organizational level is concerned with sharing information with third parties such as suppliers, partners and customers. This, in turn, might be reflected in the T-world in terms of adopting industry standards for transporting and storing information, interfaces being in place that allow for such sharing and also in security measures being in place that allow for safely exchanging information; the last being reflected in the principle cited. Finally, information sharing at the organizational level is closely related to the concept of retention as described in paragraph 4.4.5, in terms of sharing information not requiring information to be stored multiple times (The Open Group).

#### **4.4.9 Information overload**

Another concept that was addressed is the concept of information overload, which refers to the situation *‘when an employee receives more information than he or she can process’* (Bouwman *et al.*). The importance of this concept was already stressed in paragraph 4.1 by referring to Rijsenbrij, who argues that one aspect of the I-world relates to having the right amount of information in place. Whereas too much information might be considered as an issue that needs to be resolved (Davenport and Prusak; Prakken, 1997; Bouwman *et al.*; Probst *et al.*; Hiltz and Turoff, 1985; Ho and Tang, 2001; Edmunds and Morris, 2000) it can also have a positive effect on the feeling of satisfaction (O’Reilly, 1980).

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<sup>40</sup> Which was visible to everyone using the system.

The literature studied often mentioned information overload as a consequence of the numerous information resources employees have available today, such as the internet, intranets, personal communications and paper mail. Next to this, it is also related to the information delivery strategy organizations employ, as described in the next paragraph. However, next to the quantity of information, Ho and Tang also mention the information format and quality as two factors that contribute to information overload. This, in turn, makes clear that the concept of information overload is closely related to the concept of style, as described in paragraph 4.4.7.

An example of a negative side-effect that is caused by information overload is mentioned by Bouwman *et al.*, who argue that information overload will *'divert users from their key tasks and activities, affecting personal and organizational productivity.'* This diversion, in turn, might cause employees not being able to respond to certain information, ignore information and so on (Hiltz and Turoff). Hiltz and Turoff argue that part of handling information overload is related to the ability of filtering information<sup>41</sup>, in which IT is considered to be only part of the solution. They argue that *'Overload, within the context of an organization, is essentially a behavioral phenomenon. It makes more sense to address inappropriate behavior through social norms and sanctions than to obscure the problem with software.'* Basically, they argue that much depends upon the individual's behavior; something which is also stressed by Davenport and Prusak. This, in turn, is a good example of how a business concept, in this case the concept of culture as described in paragraph 3.4.2.4, might be reflected in the I-world.

As an example in managing information overload within a centralized organization *'with personnel performing routine (programmed) tasks'*, Hiltz and Turoff argue that *'efficiency might be increased by restricting information to official channels.'* Next to this, they also argue that *'Conversely, for professionals performing complex, diverse, and nonroutine tasks, high feedback with much horizontal and out-of-hierarchy communication may produce the best results.'* The former makes clear that information overload is also related to the concept of source selection as described in paragraph 4.4.2. Next to this, these examples also make clear how yet another business concept, in this case the concept of specialization as described in paragraph 3.4.2.2.4, might be reflected in the I-world.

Another measure in dealing with information overload as described by Hiltz and Turoff, includes structuring the content of information; again, this relates to the concept of style. However, according to Hiltz and Turoff this might also destroy many potential benefits. Therefore, they argue that *'Tools for limiting overload should be based on structuring processes and should allow individuals to control content.'* The real problem in handling information overload, according to Hiltz and Turoff, is *'understanding the group and organizational objectives and providing the tools that allow individuals and groups to structure their own communications.'* Allowing individuals and groups to structure their own communications, in turn, might be reflected in the A-world in terms of the concept of personalization as described in paragraph 5.4.2.8.

Finally, another possible solution in handling information overload, mentioned by Edmunds and Morris, citing Etzel (1995), is the use of personal information management strategies. With respect to such strategies, according to Etzel, it is of prime importance *'to decide which medium to use, while consideration should be given to the characteristics of tools that appear most favourable to the individual, for example, whether visual or spatial recall is used.'* This,

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<sup>41</sup> Be it by accepting/ignoring information.

in turn, has its obvious implications for application design, according to Edmunds and Morris. Again, also this might be reflected in the A-world in terms of the concept of personalization. However, as Edmunds and Morris argue, IT should be seen *‘as tool and not the driver, while increased information literacy may provide the key to reducing information overload.’*

Whereas the literature referred to in the previous subparagraphs considered information overload as something negative, O’Reilly argues that too much information is not negative per se. O’Reilly has conducted two empirical field studies related to both the relationship between information overload/underload and the performance of employees, and the relationship between information overload/underload and employee satisfaction<sup>42</sup>. The results of this research show that information overload is associated with a decrease in performance<sup>43</sup> and an increased feeling of satisfaction, and information underload is associated with lower satisfaction. However, while it might be tempting to argue that employees within the organization need more or less information, O’Reilly’s results also suggest *‘a more careful dissemination of information available within the organization, with particular attention to information-dependent jobs or units.’*

Examples of principles addressing the concept of information overload, might state that *‘The amount of information distributed should contribute to increasing our employees’ performance’* and that *‘The amount of information distributed should contribute to preventing employees neglecting important information.’*

#### 4.4.10 Delivery strategy

Finally, another concept that was addressed is the concept of delivery strategy (Davenport and Prusak). As Davenport and Prusak argue, the most high-level general decision managers need to make is what kind of information delivery strategy to employ. The strategies being referred to are the push and pull strategy. Whereas the push strategy does not require an active attitude from the receiver of information, because it is delivered, the pull strategy requires the receiver to actively engage in gathering information. Using a push strategy, for example, might be considered useful when employees are not able or willing to spend time on gathering information required for their job. However, this should be done with care in order to prevent pushing too much information, which might cause (important) information to be neglected. This, in turn, makes clear that this concept is closely related to the concept of information overload as described in the previous paragraph. With respect to choosing between these two strategies, Davenport and Prusak argue that many organizations adopt a combination of both a push and a pull strategy. As an example of such a combination, they mention information maps<sup>44</sup> being pushed and waiting for the information being pulled. However, since the use of information is primarily dependent upon individual preferences, the best strategy is the one that is tailored to the individual’s needs.

Examples of principles addressing this concept, might state that *‘Our information delivery strategy should contribute in increasing our employees’ awareness on the location of information’* and that *‘The information delivery strategy should allow our employees to keep focused on the task at hand.’* The latter might be reflected in using a push strategy, which requires little effort from employees and, in turn, allows them to keep focused on the task at

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<sup>42</sup> In terms of job satisfaction and overall satisfaction with communication in the organization.

<sup>43</sup> In terms of poor decision making accuracy.

<sup>44</sup> Indicating where resources are located.

hand. However, organizations should not limit themselves to choosing one strategy over another, and therefore might need to consider using a combination of both.

## 4.5 Recap

In this chapter I have tried to answer research question 1.2, that stated ‘*What concepts, that are of interest to the digital architect in the I-world, are/can be addressed in the principles formulated as part of a digital architecture and why?*’ In answering this question, I have identified the following concepts:

- semantics;
- source selection (organizational and individual level);
- accuracy;
- responsibility;
- retention (what and where);
- accessibility;
- style;
- sharing (organizational and individual level);
- information overload;
- and delivery strategy.

In describing these concepts, this chapter showed that some of the business concepts, as described in chapter 3, might be reflected in the I-world. Thereby, this chapter provides useful insights required in formulating principles that are in line with the B-world. Moreover, it also described how the concepts identified, in turn, might be reflected in both the A- and T-world, but also how the concepts themselves are related to each other. Since a majority of the concepts identified are related to human behavior, most of them will be reflected in the A-world. The most important findings with respect to these concepts are briefly described in the following subparagraphs.

With respect to the use of information by the organization as a whole, this chapter showed that organizations might need to make decisions on where to acquire their information (internal vs. external), and that such decisions can be guided by the costs involved in information acquisition activities and the protection of corporate knowledge. Next to this, this chapter also showed that organizations might need to decide what kind of information they want to retain and where it should be retained. With respect to the former, this chapter showed that some organizations decide to retain information for legal purposes or to track down errors. With respect to the latter, it became clear that an organization’s decision on where to retain information can be affected by future outsourcing decisions and the need to make the knowledge possessed by individuals available to other organizational members. With respect to the last, an important concept is the concept of sharing at the individual level. In describing this concept, it became apparent that, while IT can aid the process of information sharing, IT alone is insufficient. Instead, organizations need to recognize the cultural barriers to information sharing<sup>45</sup> and adapt the technology used to these barriers. Also, this chapter showed that when the organization as a whole, for example with the purpose of achieving economies of scale, engages in sharing information with its environment, some issues, including those related to security and confidentiality, need to be addressed appropriately.

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<sup>45</sup> E.g. political structures might prevent individuals from sharing information.

With respect to individuals using information, this chapter showed that especially individual preferences determine the actual use of information. These preferences seemed to influence the information source selection behavior of individuals, their perceived accessibility of these sources, how they prefer to acquire their information, what makes information accessible and the preferred style of information. Finally, it also became apparent that, while information offers organizations many opportunities, too much information can result in the phenomenon of information overload, which can cause individuals getting diverted or even to neglect important information. In dealing with this issue, again, IT is considered as being only part of the solution. Instead, it was argued that information overload is basically a behavioral phenomenon. Nevertheless, it seemed that the style in which information is presented, its quality and allowing individuals to structure their own communications might contribute to resolving this issue. All of this, in turn, has its obvious implications for the A-world.

These findings suggest that the I-world should primarily be concerned with the behavior of individuals. In describing the identified concepts, this chapter showed that both the information supply and the use of IT should therefore be adapted to the preferences of individuals, where possible. In the end, this affects how people handle information and is associated with many business benefits, including better decision making quality and an increase in organizational performance. Thereby, it also affects their functioning.

Finally, as described previously in this chapter, initially, the approach chosen to describe the concepts identified in the I-world, was based on the processes identified in both the literature on knowledge management and organizational learning: information requirements, information acquisition, information retention, information distribution and information utilization. However, while this approach might be useful for organizations in identifying information concepts, it did not provide a logical structure to categorize the concepts as identified during the interviews held and in the literature studied. Nevertheless, I would recommend using these five processes as a guideline in formulating a structured set of principles.

# Chapter 5

## A-world

*'It's not computer literacy that we should  
be working on, but sort of human-literacy.  
Computers have to become human-literate.'*

(Nicholas P. Negroponte)

As described in paragraph 1.2.2, in the A-world one is primarily concerned with concepts that are related to the applications in the organization. Within this part of the organization one is concerned with concepts like application integration and application development. Moreover, since Rijsenbrij (2004; 2005) also stresses the importance of addressing the human aspects associated with the use of IT in the organization, this world also covers concepts related to the usefulness and beauty of applications. Examples of such concepts are described in the next paragraph and include navigation, visual aesthetics and personalization. As Rijsenbrij argues, this is the part of the organization where business and information concepts are translated into IT solutions, more specifically applications, that support the business's need for information and the business activities taking place.

Also in this chapter, I will first explain the relevance of this world with respect to digital architecture, give a brief description on how the concepts identified should be interpreted and finally describe the concepts themselves based on the interviews held and the literature studied.

## 5.1 Relevance

Rijsenbrij puts much emphasis on the A-world in which he goes beyond traditional application requirements which mainly focus on applications being functional collections of code; something in which Rijsenbrij is supported by Tractinsky (2004) who argues that '*Traditionally, the various computing and information technology disciplines have emphasized areas related to the firmness, correctness, stability, and internal logic of their products.*'

In describing the A-world, Rijsenbrij argues that application architects should not solely focus on functional and structural requirements, but also on the user experience and beauty<sup>46</sup> that an application brings/exhibits. In doing so, he argues that many of today's applications are boring and show poor usability characteristics; not taking into account any of the user's preferences. This, in turn, according to Rijsenbrij, is due to the vision of application engineering approaches that consider the user as being a slave to the machine. Rijsenbrij argues that an application should fit like a protease: it doesn't belong to the user, but it feels like. Moreover, he argues that as technology has evolved at such a high rate, the time has come to focus on creating user-friendly applications. In doing so, Rijsenbrij argues that digital artifacts<sup>47</sup> should exhibit the three Vitruvian quality attributes: firmitas (durability), utilitas (usefulness) and venustas (beauty), as described in paragraph 1.2.4. With respect to the user experience and beauty brought/exhibited by applications, he specifically focuses on concepts such as the graphical user-interface (hereinafter to be referred to as GUI), navigation paths, interaction protocols, personalization options<sup>48</sup> and so on. So, he puts much emphasis on the last two quality attributes; therefore, this chapter will also put much emphasis on these two quality attributes.

As already mentioned in the previous subparagraph, Rijsenbrij's view towards applications is supported by Tractinsky, who argues that of the three Vitruvian quality attributes, the third one, beauty '*was almost completely absent from research in the various IT disciplines.*' A possible reason for neglecting this quality attribute, according to Tractinsky, '*may lie in the computing disciplines' origins in disciplines that emphasize hard science, efficiency, and util-*

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<sup>46</sup> Look and feel.

<sup>47</sup> In this case, applications.

<sup>48</sup> E.g. like those encountered in portals.

ity.’ According to Tractinsky, addressing this attribute ‘*is often the only way to make a product stand out*’; this is especially important when it becomes a commodity. Whereas one might interpret the third attribute in a narrow sense, solely in terms of visual appearance, Rijsenbrij interprets it in a broad sense by also taking into account the user experience.

Others that also stress the importance of Rijsenbrij’s view towards the A-world are Wieringa, Blanken, Fokkinga and Grefen (2003), who describe a framework ‘*of operational concepts and guidelines that encompasses business architecture as well as application architecture.*’ In this framework, they make a distinction between the processes that result in the product (an application) and the product itself. Indeed, whereas one might solely focus on the product itself, the processes from which such a product results can also be taken into account when speaking in terms of an application architecture. However, due to time constraints, I will focus mainly on the latter (the product itself). The part of their framework focusing on the product itself shows great resemblance with the quality attributes an artifact should exhibit according to Rijsenbrij. This part of the framework divides the product properties into external and internal properties. First, with respect to the external properties, Wieringa *et al.* make a distinction between an application’s functionality (accounting for its usefulness) and its quality (accounting for its beauty). Second, with respect to the internal properties, they describe these in terms of an application’s composition (also accounting for its usefulness).

These examples make clear that Rijsenbrij’s view towards the A-world, focusing on the three Vitruvian quality attributes, is not uncommon. While one might think that the A-world, viewed from this perspective, is primarily of interest to usability gurus/researchers such as Nielsen, Garrett and Shneiderman, it has shown to be a major concern for organizations such as IBM and Apple as becomes clear later on. Although both are involved in software development focused on delivering useful and beautiful applications to their customers, the same principles underlying their way of working might be beneficial to apply in any other organization. Why would an organization take into account these principles in serving its customers through websites and portals<sup>49</sup>, but neglect them with respect to the applications used by its own employees in the organization?<sup>50</sup> Moreover, the concepts identified offer many opportunities in terms of business benefits, thereby making the A-world viewed from this perspective important to address in the principles formulated. Finally, while one might consider this view towards the A-world as a new trend which hasn’t proven its value, most of the concepts identified have been studied and considered being important for a long period of time. For example, most of these concepts are from the 1980’s (e.g. IBM’s Common User Access model) and 1990’s (e.g. Nielsen).

## 5.2 Approach

Although Rijsenbrij argues for addressing the three Vitruvian quality attributes, it is a hard job to make a clear distinction between what contributes to the usefulness and overall beauty of an application. When this distinction was made in the literature, however, beauty was often solely described in terms of the visual design of the GUI (e.g. Ngo, Teo and Byrne, 2003). Moreover, whereas Rijsenbrij argues that aspects such as interaction protocols and navigation paths contribute to the overall beauty of applications, it is more common to address these aspects in terms of usability. To overcome the problem of making a clear distinction between

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<sup>49</sup> If taken into account at all.

<sup>50</sup> Please note that I do not suggest that the concepts described in this chapter should solely be considered with respect to applications serving employees, since they also apply to applications serving customers, suppliers, partners and so on.

usefulness and beauty, the concepts which I consider to account for both, are described in a single paragraph.

Therefore, this chapter consists out of two paragraphs: one addressing the concept of durability and the other the concept of usefulness and beauty. With respect to the former, I have chosen to address this concept in terms of an organization's application landscape; thereby, not focusing on the individual application. With respect to the latter, however, this chapter focuses on the individual application. The model used to describe the A-world is depicted in Figure 5.1.

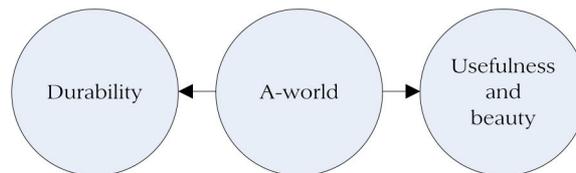


Figure 5.1 A-world concepts

### 5.3 Interpretation

As described previously, the concepts identified in the A-world relate to the translation of business and information concepts into applications that support the business's need for information and the business activities taking place. Whereas I argued for directly addressing the concepts as identified in the I-world, the same applies to the A-world. Although some of the concepts, especially those as part of the usefulness and beauty concept, described in this chapter were described in the literature studied in terms of the web, the findings presented might be considered useable and valuable for applications in general, since web applications are becoming more common nowadays. Moreover, web applications do not differ that much from traditional applications. Finally, while sometimes speaking in terms of websites and web GUI's, I have tried to speak in terms of applications and GUI's where possible.

## 5.4 Findings

### 5.4.1 Durability

As Rijsenbrij argues, the durability attribute refers to the technologies being used to construct digital artifacts, such as programming languages and integration mechanisms. In paragraph 3.4.1.3, describing the concept of suppliers, it has become clear that such choices (e.g. vendor choices) might influence an organization's agility, but also the durability of its applications. The concepts as identified with respect to the concept of durability are depicted in Figure 5.2<sup>51</sup>. These concepts are subsequently addressed in the following paragraphs.

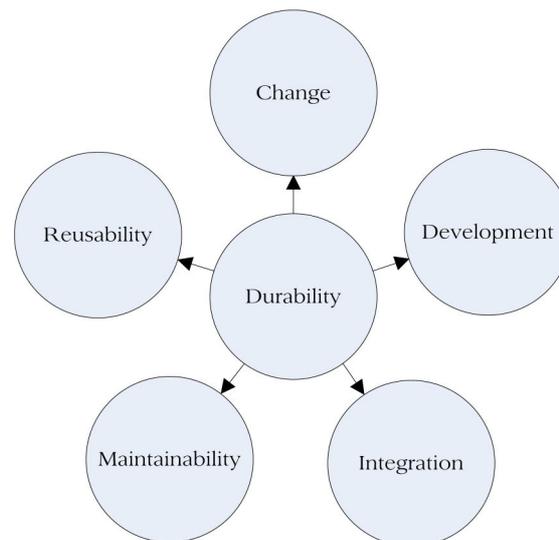


Figure 5.2 Durability concepts

#### 5.4.1.1 Change

Whereas I, in the B-world, have described both the organizational environment and organizational design concepts, one of the concepts that might be addressed is the ability of applications to cope with changes in both; this, however, is not the same ability as described in paragraph 5.4.1.4 in terms of the concept of maintainability.

One of the interviewed companies addressed this concept in one of its principles, that stated '*Stay Loose: make no assumptions about the implementation, location and availability of the other application.*' While the principle itself does not express its purpose, its purpose was expressed in the rationale underlying the principle, that stated '*design to change.*' Thereby, the company basically argued for designing applications that are able to cope with business changes; this, in turn, might have the implication of loosely coupling applications. The same company also addressed this concept in one of its other principles, which stated that '*All IT solutions must be business event driven.*' The rationale underlying this principle argued that a change in a process would thereby not affect the applications supporting this process, which would ensure linkage with the process. Next to addressing the concept of change, this example also shows how a business concept, in this case the concept of processes as described in

<sup>51</sup> Please note that Rijsenbrij does not consider these concepts to be related to architecture, but rather to engineering.

paragraph 3.4.2.3, might be reflected in the A-world. Finally, another principle from the same company, also addressing this concept, stated that ‘*All ICT components and services must be designed in such a way that changes in service delivery remain an option.*’

Next to this, one of the other interviewed companies addressing this concept, argued in one of its principles that its applications should not directly access each other’s databases; instead, they should use standard interfaces. By doing so, the company addressed the concept of change in terms of making the dependency of applications less complex and more transparent, allowing for a fast response to changes. Finally, another one of the interviewed companies that addressed this concept, argued for adopting SOA-principles in the implications associated with one of its principles, in order to be able to cope with changes.

#### *5.4.1.2 Development*

As described in paragraph 5.1 when referring to Wieringa *et al.*, besides the application itself, the processes that result in the application might also deserve attention. One of the interviewed companies addressed the concept of development in one of its principles, that stated ‘*Assemble or Build for Competitive Advantage.*’ Although one might question this principle, in terms of Commercial Off The Shelf solutions (hereinafter to be referred to as COTS-solutions) never providing competitive advantage, since they are available to everyone, this principle implies that COTS-solutions should preferably be bought instead of being developed in-house, because they don’t offer any competitive advantage. Next to stressing the importance of the concept of development, this example also makes clear how a business concept, in this case the concept of competition as described in paragraph 3.4.1.1, might be reflected in the A-world.

With respect to the in-house development of applications, one of the other interviewed companies also addressed the concept of development, in terms of the development methods being used, in one of its principles that stated ‘*Adopt Formal Methods of Engineering.*’ The rationale underlying this principle argued that by using formal methods of engineering, training costs are reduced, benchmarking is enabled and so on. Moreover, adopting formal methods of engineering might ease outsourcing application development activities and finding personnel that is able to maintain/further develop existing applications. Finally, another one of the interviewed companies also addressed this concept from this perspective, by arguing that it would only use technologies for which it had in-house expertise. These examples make clear how yet another business concept, in this case the concept of knowledge as described in paragraph 3.4.2.5, might be reflected in the A-world.

#### *5.4.1.3 Integration*

Another concept that was addressed, is the concept of integration. One of the interviewed companies addressing this concept, had a principle in place that stated ‘*Reduce integration complexity; maximize interoperability and information sharing*’; the same company even had a complete document in place, specifically focusing on the integration of applications. The implications associated with this principle included that the company relied on industry standards to integrate applications and interfaces, rather than on proprietary standards. This, in turn, allows for greater use of standard, shareable components and COTS-solutions (TBS, 2001). Another implication included that the number of vendors, products and configurations should be limited in order to reduce complexity and allow for easy integration. However, as described in paragraph 3.4.1.3, limiting the number of vendors (e.g. choosing a single vendor)

might create a certain dependency, which in the long run might have negative side-effects. Since the company also argued for using industry standards, diminished these negative side-effects.

The concept of integration, in terms of ease of integration, is also addressed in one of the example principles as part of the TOGAF-framework (The Open Group), that states '*Applications are independent of specific technology choices and therefore can operate on a variety of technology platforms.*' The rationale underlying this principle argues that an organization's application functionality should be driven by user requirements instead of vendor dependency. With respect to applications being independent of specific technology choices, this, in turn, might be reflected in the technologies being used in application development. For example, the Java language might be used as a consequence for the need of interoperability, since it is considered as being platform independent. It might also be reflected in the T-world, in terms of using middleware that allows for different technologies being used in the A-world. Finally, the examples described make clear how a business concept, in this case the concept of suppliers as described in paragraph 3.4.1.3, might be reflected in the A-world.

#### 5.4.1.4 Maintainability

As part of the durability of applications it might be important to allow for future extension, in terms of the concept of maintainability. This concept was addressed by one of the interviewed companies in a principle arguing for modules and functions being based on the Open-Closed principle. The Open-Closed principle refers to the one as formulated by Meyer, which argues that '*Modules should be both open (for extension and adaptation) and closed (to avoid modification that affect clients)*' (Larman, 2001). Applying this principle, is considered as increasing the software's flexibility and adaptability (Xu and Hughes, 2005), which, in turn, might be considered as contributing to its maintainability. While the principle formulated by the company does not express a purpose, arguing for applying the Open-Closed principle implies that applications should be designed to allow for future extension, while not endangering existing application dependencies. Such a principle might, for example, affect the technologies being used in application development, since not all technologies meet the requirements of the Open-Closed principle. Moreover, it might also be reflected in the T-world in terms of using middleware that enables applications to be extended in the future.

Another principle from the same company that addressed the concept of maintainability, argued for applications being based on a layered model. As described by Blackburn (2004), layering is a '*Common technique to break apart a complicated software system*' into understandable parts that can be substituted. The downside, however, is that (some) changes will have to be added to all layers separately and using layers can also harm performance. While maintainability might increase on the one hand by using layering, on the other hand it might decrease in terms of the effort required to implement (some) changes. With respect to the layering of applications, the same company also had another principle in place that argued for separating the business and presentation logic in applications. Finally, layering was also addressed by one of the other interviewed companies in a principle that stated '*Use a layered and service oriented architecture for all new IT solutions and supporting infrastructure.*'

Whereas the examples described relate mainly to the applications themselves, the first company being referred to also addressed the concept of maintainability in terms of the relationship between applications and information. This company had a principle in place that argued for having exactly one application responsible for the creation, mutation and removal of a

single piece of information. The rationale underlying this principle argued that changes in the information upon which the applications in the organization relied, can thereby easily be implemented since the dependencies are clear. This, in turn, contributes to the maintainability of the application landscape.

#### 5.4.1.5 Reusability

Another concept that might be addressed, is the concept of reusability. One of the interviewed companies, for example, had a principle in place that argued for reusing before buying applications. Having such a principle in place not only has practical implications in terms of actually reusing existing components, but also in terms of offering the facilities that enable for such reuse<sup>52</sup>. Another principle from the same company, also addressing the concept of reusability, argued for standardizing and offering common application functions in the form of services. This is clearly related to the reusability of applications in terms of being able to reuse common application functions. An implication associated with such a principle might include that the range of services in the T-world, allows for being (easily) changed.

### 5.4.2 Usefulness and beauty

Before describing the concepts as identified with respect to the concept of usefulness and beauty, this paragraph starts with providing a high-level insight in what factors influence people's use of applications and how one is able satisfy their expectations.

With respect to what makes people engage in using applications, the Technology Acceptance Model (hereinafter to be referred to as TAM-model) (Davis, 1986) provides some useful insights. The TAM-model, as depicted in Figure 5.3, is based on the Theory of Reasoned Action model that originates from the field of social psychology and was developed to predict human behavior across a wide variety of domains.

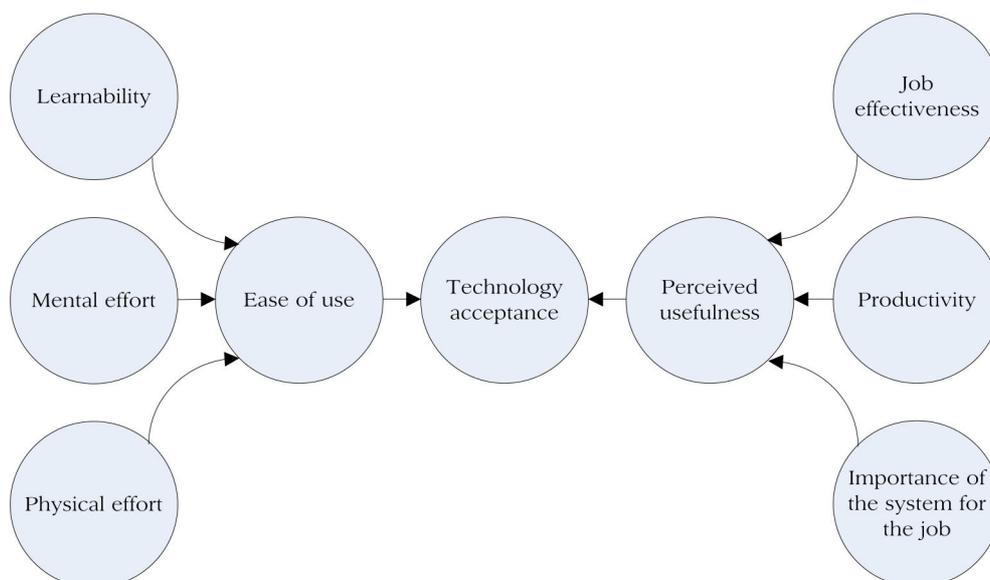


Figure 5.3 TAM-model

<sup>52</sup> E.g. directories for finding existing components and technologies that allow for reuse.

The TAM-model itself specifically focuses on human behavior related to applications<sup>53</sup> and provides empirical evidence with respect to why people engage in using applications, and is widely recognized as a sound model to analyze such issues (Hodas, 1993; Legris, Ingham and Colletette, 2003; Boonstra, 2002; Orlikowski and Gash, 1994; Davis, Bagozzi and Warshaw, 1989; Venkatesh, Davis, Davis and Morris, 2003). As Szajna (1996) argues, the TAM-model has *'consistently done well in predicting intentions.'* Finally, being retested for its validity by Hendrickson, Massey and Cronan (1993) supports the reliability of the model.

Being focused around two indicators, ease of use and perceived usefulness, makes it a useful instrument in evaluating what might make up for usable applications. The former indicator is described as *'the degree to which the prospective user expects the target system to be free of effort'* and the latter as *'the prospective user's subjective probability that using a specific application systems will increase his or her job performance within an organizational context'* (Davis *et al.*). Both the ease of use and perceived usefulness were measured along fourteen items each by Davis<sup>54</sup>, which, in turn, were clustered into three categories; these clusters are depicted in Figure 5.3. The clusters identified to account for the ease of use are: learnability, mental effort and physical effort. The clusters identified to account for the perceived usefulness are: job effectiveness, productivity and the importance of the system for the job. Since the TAM-model is recognized as a useful model in determining what factors influence people to engage in using applications, these six factors might be considered as being important to address in the principles formulated with respect to the A-world. Whereas the TAM-model considers both the ease of use and perceived usefulness as the indicators influencing the use of applications, Dishaw and Strong (1999) present an extended version of the TAM-model, including the indicators task-technology fit, task characteristics and tool experience from the Task-Technology Fit-model. With respect to this extension, I only consider experience as a useful addition, since the clusters in the TAM-model might already account for the other two. The importance of experience is stressed by Davis *et al.* and Szajna, who consider it as an important factor influencing the eventual acceptance of a system.

Whereas one might consider addressing all six clusters identified in the TAM-model, it should be noted that users are sometimes willing to tolerate insufficiencies. For example, the data of Davis *et al.* indicate that users *'may be willing to tolerate a difficult interface in order to access functionality that is very important.'* Therefore, one might need to consider the context in which the application is (going to be) used, and based on this determine which clusters require to be addressed. Although the concepts as described in the following paragraphs are not always formulated in terms of the clusters identified in the TAM-model or its extension, it becomes clear that most of them do directly or indirectly relate to these clusters. Having provided insights into what factors influence people's use of applications, the following subparagraphs briefly describe how one is able satisfy their expectations.

Basically, in designing applications that meet the expectations of their users, there are several techniques. However, the essence is to apply these techniques in a way that they reflect the user's mental model, which can be described as *'a model that evolves in the mind of a user as he or she learns and interacts with a computer system'* (Jih and Reeves, 1992). Next to this model evolving from the interaction with an application, according to Apple, this model also evolves from real-world experiences, previous experiences with other applications and with computers in general. According to Jih and Reeves, the mental model *'represents the struc-*

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<sup>53</sup> Please note that Davis speaks in terms of computer-based information systems.

<sup>54</sup> For reasons of clarity, these fourteen items are not mentioned in this thesis.

*ture and internal relationships of a system*’ and *‘is the source of the user’s expectations.’* This makes clear why Rijsenbrij considers the arrangement and relationships of functionalities as being important. So, basically, if one is able to reflect the user’s mental model, one is able to meet the user’s expectations. Berry (2000) stresses the importance of reflecting the user’s mental model by arguing that, in using applications, *‘the first hurdle any user must overcome is to map his or her goals to the available capabilities.’* According to Berry, these capabilities can be described in terms of the of the *‘things’* (hereinafter to be referred to as elements) that are provided to the user and their characteristics, including their properties, behaviors and relationships. More important, Berry argues that in reflecting the user’s mental model, all these aspects should be described *‘in a cohesive manner, and ideally in a way that users find intuitive.’*

With respect to the behavior of these elements, Apple (2006), in describing the characteristics an application should incorporate to reflect the user’s mental model, argues that elements within the GUI should *‘provide users with a familiar environment in which they know how things behave and what to do with them’*, and also that the application should provide clues on how to use the elements. As suggested in the literature studied, the use of metaphors can contribute to this. For example, Shneiderman (2004) argues that techniques using metaphors *‘enable users to forget about the interface and concentrate on their tasks.’*

Having described what factors influence people’s use of applications and how one is able satisfy their expectations, the following paragraphs describe how this might be reflected in the design of applications. The concepts focusing on the usefulness and beauty of applications, as described in the literature studied, are depicted in Figure 5.4. These concepts are subsequently addressed in the following paragraphs.

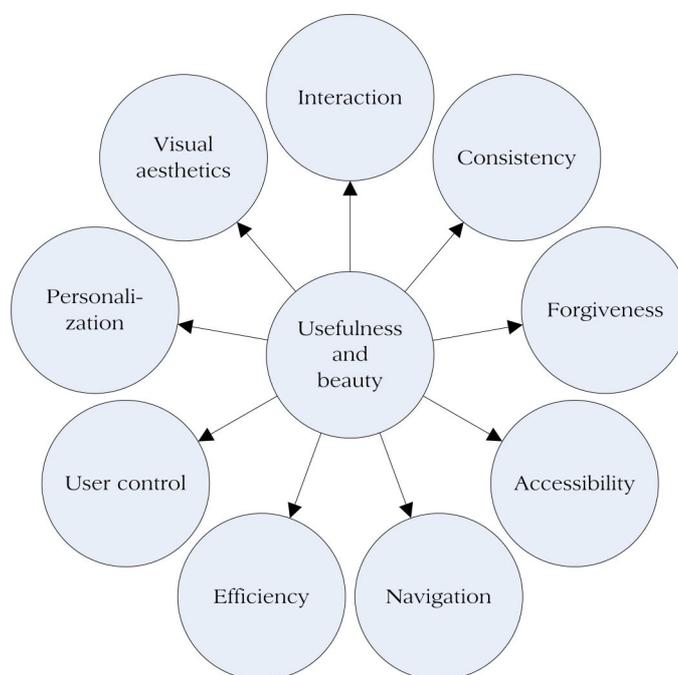


Figure 5.4 Usefulness and beauty concepts

### 5.4.2.1 Interaction

Interaction, in terms of feedback and communication, was frequently mentioned as an important concept with respect to the usability of applications. For example, the importance of this concept is stressed in one of the principles underlying IBM's Common User Access model (hereinafter to be referred to as CUA-model) as described by Berry (1988), which argues that feedback should be provided for almost every user interaction. As Apple argues, feedback goes beyond simply alerting users when things go wrong. According to Apple, this concept should also be concerned with keeping the user informed about what is happening with(in) the application. This, in turn, according to Apple, also contributes to the user's perceived stability of the application. Also IBM stresses this, in arguing for reflecting the results of actions immediately to '*Create a feeling of progress and achievement*'. Finally, this concept is also addressed by Tognazzini (2003), who argues that feedback can be used in reducing the user's experience of latency, for example, by showing loaders and displaying the system's status.

Research focusing on interaction in terms of providing feedback is that of Crystal and Kalyanaraman (2004), who studied the effect of feedback on the attitude towards a website, task performance and the participant's memory. Their research shows that the overall attitude towards the website studied, was positively related with providing feedback. Moreover, when feedback was provided, the participants seemed to memorize the site's contents better.

### 5.4.2.2 Consistency

Consistency is a concept that can be applied to several aspects of applications. For example, IBM's CUA-model argues for consistency across three domains: semantic, syntactic and physical. IBM's CUA-model was developed in the early 1980's as part of IBM's Systems Application Architecture, that IBM used as a framework for its applications in order to run consistently on major IBM computing systems (Wheeler and Ganek, 1988). The CUA-model is elaborately described by Berry and is meant to '*establish a degree of standardization that is compatible with the differences in the three environments and that supports transfer of user experiences*'; the three environments being referred to are IBM's major computer system families in the 1980's. Whereas the CUA-model argues for consistency, it stresses its importance in terms of learnability; a factor that contributes to the ease of use in the TAM-model.

With respect to consistency in GUI-design, Berry argues that this offers designers with the opportunity for supporting the transfer of the user's learning; one of the goals of the CUA-model. The importance of consistency across GUI's was also stressed by some of the respondents from the previously described research of Mulligan and Gordon (2002), in terms of the customer and industry's pressure to develop '*one-look, one-feel*' technology for service delivery. In describing the foundations of the CUA-model, Berry describes several principles upon which the CUA-model is based. With respect to the concept of consistency, the last principle mentioned by Berry, '*consistency across definitions in terms of concepts, appearance of displayed information, interaction techniques, and terminology*', might be considered as being important. This principle clearly indicates that consistency goes beyond consistent GUI's, in terms of their visual appearance. Indeed, as described, the CUA-model argues for consistency across three domains, under which semantic and syntactic consistency. Syntactic consistency relates to the order and position of relationships and includes screen layouts, but also to the consistent use of function keys. This, with respect to screen layouts, shows that this concept is closely related to the concept of visual aesthetics as described in paragraph 5.4.2.9. Semantic

consistency, on the other hand, relates to objects and actions having the same meaning. This is a good example of how an information concept, in this case the concept of semantics as described in paragraph 4.4.1, might be reflected in the A-world.

Also Oppedisano (2002) stresses the importance of consistency with respect to an application's learnability, by arguing that *'If users know what to expect, it will be easier for them to build a conceptual model of what should happen next.'* This, in turn, according to Oppedisano, might cause the user to feel more comfortable with the application, thereby shortening its learning curve. Next to this, the concept of consistency is also addressed by Nielsen (1994) in one of his usability heuristics, in terms of consistency as an aid in preventing users wondering whether different words, situations or actions mean the same thing. Finally, also Apple stresses the importance of consistency with respect to applications. In doing so, Apple describes four questions to determine whether an application is consistent. The first question relates to being consistent with the standards of its operating system, the second to the application being consistent within itself<sup>55</sup>, the third to being consistent with previous versions of the product<sup>56</sup>, and the fourth to being consistent with people's expectations.

An example of a principle addressing this concept, might state that *'Consistency in application design should be promoted to increase the learnability of applications.'*

#### 5.4.2.3 Forgiveness

In describing the characteristics an application should incorporate to reflect the user's mental model, Apple argues that one should encourage the user *'to discover functionality by providing cues [sic] about how to use user interface elements.'* However, according to Apple, such discoverability also requires applications to show a certain amount of forgiveness, in terms of making actions (easily) reversible. The concept of forgiveness is also addressed in one of Nielsen's usability heuristics, in which Nielsen argues that usable applications should prevent users from making errors. This, in turn, might be reflected in applications providing feedback, but also in eliminating error-prone conditions; the former is addressed in terms of the concept of interaction as described in paragraph 5.4.2.1. Methods in making applications show forgiveness, might also include the use of cancel buttons, undo options, options for aborting operations that are in progress and so on.

Forgiveness is also addressed by Tognazzini, who argues that effective GUI's should *'Ensure that users never lose their work as a result of error on their part'*. Oppedisano adds to this that, if an application protects the user from destructive actions, the user will feel more comfortable with the application, which, in turn, contributes to trust within the relation between the user and the application. Trust, in turn, is explained by Apple in terms of an application's reliability, and reliability is explained by Apple in terms of predictable application behavior and keeping the user out of trouble.

The concept of forgiveness is also addressed by Oppedisano in terms of navigation. Oppedisano argues that with respect to navigation, users should be able to reverse any decisions they have made in error. An example of a technique that can contribute to this, mentioned by Oppedisano, is the so-called *'breadcrumb trail'* technique that shows the user's

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<sup>55</sup> In terms of terminology, icons, controls and GUI layout.

<sup>56</sup> Being consistent with previous versions of the products increases an application's learnability for those familiar with the previous version(s).

navigation path on each screen, allowing the user to return to previously visited screens. This shows that the concept of forgiveness is related to the concept of navigation, as described in paragraph 5.4.2.5. Moreover, as becomes clear later on, this concept is also related to the concept of user control as described in paragraph 5.4.2.7.

#### 5.4.2.4 *Accessibility*

Whereas one might think of accessibility in terms of connectivity, accessibility is also concerned with making applications accessible in terms of their use. With respect to the former, while indeed related to applications, it should be noted that such a form of accessibility is actually a concept that should be addressed in the T-world. Therefore, this paragraph will solely focus on the latter: making applications accessible in terms of their use.

The concept of accessibility is elaborately described by both Apple and Nielsen (2000), in terms of international and universal accessibility. Since both make a distinction between these two forms of accessibility, they are addressed separately in the following paragraphs.

##### 5.4.2.4.1 International accessibility

The concept of international accessibility is addressed by Apple in terms of adapting applications to cultural values. In doing so, Apple specifically focuses on the localization of visible elements. For example, Apple argues that designers should take into account regional differences in the use of color, graphics, text and the representation of time. Moreover, Apple also argues that certain symbols, such as electrical outlets and currency symbols, might differ per region. An example provided by Apple, that relates to the use symbols, includes that of the owl, which, in the United States is a symbol for wisdom and knowledge, while in Central America it is considered as a symbol for witchcraft and black magic. According to Apple, this kind of accessibility contributes to the overall adaptability of an application. Other examples of taking into account regional differences, include the text-orientation used (e.g. right-to-left in the Arabian world) and language differences. Whereas Nielsen addresses the concept of international accessibility, he mainly focuses on language issues. However, also he stresses the importance of taking into account regional differences in terms of symbols and time.

##### 5.4.2.4.2 Universal accessibility

Whereas the previous paragraph focused on accessibility in terms of taking into account regional differences, accessibility is also addressed in terms of making applications accessible for users with disabilities<sup>57</sup>. Apple describes three categories of disabilities one has to take into account: visual, hearing and physical disabilities. The same categories of disabilities are also described by Nielsen, who adds two more categories: speech and cognitive disabilities. Whereas one might question the importance of taking into account disabilities like these, the United States have laws requiring some organizations to do so (Apple; Nielsen). This is a good example of how a business concept, in this case the concept of regulators as described in paragraph 3.4.1.4, might be reflected in the A-world.

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<sup>57</sup> Please note that, although described in terms of disabilities, the guidelines provided also apply to the accessibility of applications in general.

Both Nielsen and Apple provide some guidelines that address the disabilities mentioned in the previous subparagraph<sup>58</sup>. To make applications accessible for people with visual disabilities, Nielsen argues that using high contrasts and avoiding busy background patterns, enhances accessibility. Next to this, Nielsen also mentions the use of font sizes as a factor influencing an application's accessibility. While it might seem aesthetically correct to create a state-of-the-art GUI with font sizes adapted to the design, it might be considered as a barrier for those who require larger font sizes; whether these people cope with visual disabilities or not. Apple adds to this that the proper use of spacing, alignment and color might also help users with visual disabilities.

With respect to cognitive disabilities, Nielsen argues that cognitive disabilities have their impact on the user's way of reasoning and in his/her short-term capacity. To address this issue, Nielsen argues for an understandable way of navigation; a concept described in paragraph 5.4.2.5. More specifically, Nielsen refers to the visualization of the structure underlying the information being offered to the user. Although Nielsen refers to a structure such as a sitemap since he focuses on web usability, one might also interpret this in a broader sense, in terms of making the underlying structure of an application transparent<sup>59</sup>.

Finally, to address physical disabilities, Apple refers to the use of so-called '*Sticky Keys*', that provide an alternative to difficult key combinations. Moreover, Apple underscores its operating system's capability of allowing users to perform all actions with the keyboard instead of the mouse or simulating mouse behavior by using the keypad, to address physical disabilities.

#### 5.4.2.5 Navigation

As today's information spaces become increasingly overloaded with information<sup>60</sup>, an important concept that might be addressed is the concept of navigation. Navigation, in terms of ease of navigation, is considered by Lavie and Tractinsky (2004) as one of the five constructs that accounts for usability in their study to determine the factors influencing website aesthetics. The importance of navigation is also stressed by Garrett (2000), who incorporates navigation design as a separate element in his model describing the elements of user experience, with the purpose of designing GUI elements '*to facilitate the user's movements through the information architecture.*' Moreover, its importance is also stressed by Oppedisano who argues that simple and comprehensible navigation is essential for the success of any application; Palmer's (2002) empirical research reveals the same relationship. Finally, Davenport and Prusak also address this concept, in terms of making information accessible, by arguing that '*Access involves not only being able to get both your hands and your mind around information; an information system must be structured in such a way that you can understand it, and retrieve what you need from it, without having to work with piles of data you don't want.*' This, in turn, is a good example of how an information concept, in this case the concept of accessibility as described in paragraph 4.4.6, might be reflected in the A-world. Also, it makes clear that navigation might contribute to the overall accessibility of an application.

Within most modern applications, hypertext is used for navigation, that is described by Nielsen (1992) as a technique which '*interconnects related pieces of information in a computer so that the user can move to new locations in the information space by following the*

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<sup>58</sup> Since hearing and speech disabilities are only important when applications use audio and/or require speech commands as input, something still not common today, I will not describe the guidelines related to these disabilities.

<sup>59</sup> Transparency, in turn, according to The Open Group, allows users to concentrate on the task at hand.

<sup>60</sup> As described in terms of the concept of information overload in paragraph 4.4.9.

*connecting links.* Botafogo, Rivlin and Shneiderman (1992) argue that *'Hypertext systems are used in many applications because of their flexible structure and the great browsing freedom they give to users. However, this same flexibility and freedom is the cause of a major concern: the "lost in hyperspace" problem.'* This is also recognized by Nielsen, who argues that a major issue in designing hypertext systems is how users are supported in navigating through the information space. So, while offering many opportunities, the (wrong) use of hypertext for navigation also poses threats. Potential problems mentioned by Nielsen, include users getting confused of where they are, where they came from and where they can go to.

With respect to the concept of navigation, the following topics emerged in the literature studied and therefore might be considered important to address in the principles related to this concept:

- providing the user access to the required information (IBM; Garrett, 2006; Garrett, 2003);
- providing information on where the user came from (Oppedisano; Nielsen);
- providing information on the user's current location (Oppedisano; Nielsen; Berry);
- providing information on the available movements from the current location (Oppedisano; Garrett, 2006; Nielsen; Garrett, 2003);
- providing a sensible sequence of navigation (IBM; Palmer);
- maintaining consistency (IBM; Palmer);
- and labeling of navigation (IBM; Crystal and Kalyanaraman; Oppedisano; Nielsen, 2000).

With respect to the last topic, that of labeling of navigation, Oppedisano argues that navigation is expected to address the balance between real-life user goals and business goals of the application. More specifically, this balance refers to the language used in the navigation; e.g. formal business language might confuse the user. Empirical research focusing on the effect of labeling of navigation is the previously mentioned research of Crystal and Kalyanaraman, who found that descriptive labeling is positively related to the performance of tasks, task accuracy and memorizing the contents of a website.

Another important aspect with respect to navigation, relates to the *'breadth vs. depth'* approach. The breadth approach relates to providing navigation that lists all top levels of places to which the user can navigate. According to Nielsen, such an approach towards navigation has the benefit of users being *'constantly reminded of the full scope of services available.'* The depth approach, on the other hand, relates to providing navigation that shows the full hierarchical path from the starting point within the application. This approach, according to Nielsen, allows users to *'get a full sense of their current location relative'* to the overall structure, in which they can jump to a higher level with a single click; this is known as what was previously described as the breadcrumb trail technique. Both approaches were studied by Zaphiris and Mtei (1997), who argue that within the navigation scheme it is better to have more items at each level and fewer levels; the breadth approach. Nielsen, however, argues for using a depth approach. This shows that the best method in determining which approach is more beneficial, should be based on the experiences of those who (are) actually (going to) use the application. Finally, noteworthy to mention, since Rijsenbrij and others often compare digital architecture with physical architecture, Benyon (2006) found that the same principles underlying people's navigation through geographical spaces, underlie their preferred way of navigating through information spaces. An example of a principle addressing this concept, might state that *'Navigation design should contribute to reducing the time spent on information retrieval activities.'*

#### 5.4.2.6 Efficiency

Efficiency can be described as the amount of time involved in completing a task. Whereas efficiency is addressed with respect to IT, it is often solely addressed in terms of the efficiency of the system itself<sup>61</sup>, rather than the user's efficiency in carrying out tasks with it. However, Tognazzini argues that since *'People cost a lot more money than machines'*, one should primarily focus on the user's efficiency; nevertheless, Tognazzini acknowledges that system response times are also important. According to Bevan (1995), addressing efficiency from this perspective, *'will allow the user to operate effectively and efficiently rather than lose vital time struggling with a poorly designed user interface and badly thought-out functionality.'* Possible implications associated with the purpose of increasing efficiency, mentioned by Tognazzini, include involving the actual users of the application in the development process and putting the user's efficiency goal upfront, the use of help messages that increase comprehension and menu-buttons and labels that have the key-words first. Other implications associated with pursuing efficiency, might include the use of accelerators (e.g. keyboard shortcuts), logical interface designs, personalization options and so on.

#### 5.4.2.7 User control

The concept of user control is addressed by Nielsen (1994) in one of his usability heuristics, in terms of allowing users to initiate/control actions and allow them to do whatever they want to do (modelessness). Also Apple addresses this concept, in terms of putting the user and not the computer in control. Although any application will provide some assistance to its users, Apple argues that this assistance should be limited, thereby giving the user a feeling of being in-control. However, Apple also argues that the application needs to assist the user in avoiding dangerous, irreversible actions. Moreover, the same concept is also addressed by IBM, in arguing that applications should support users in their actions<sup>62</sup>, but allowing them to become independent whenever they choose to be<sup>63</sup>.

With respect to modelessness, Nielsen found this to be one of the ten most important heuristics explaining serious usability problems in his research. Modelessness is also addressed by Apple in one of its guidelines to *'avoid using modes that lock' the user 'into one operation and prevent' him/her 'from working on anything else until that operation is completed.'* To enable users in doing whatever they want to do without being locked into one operation, Apple argues for the use of windows and alert-boxes that always allow the user to access the parent window in the GUI. However, on the other hand, with respect to eliminating error-prone conditions, it might be more useful to use GUI components such as Microsoft's Modal Dialog Box<sup>64</sup>, which don't allow for such access while the child window is still open.

#### 5.4.2.8 Personalization

While many usability guidelines argue for adapting applications to the user's needs and tasks, it can be a hard job to satisfy this requirement for every user. Personalization<sup>65</sup> can be a useful method/technique in addressing this problem. The importance of personalization is stressed

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<sup>61</sup> E.g. in the ISO/IEC 9126 standard.

<sup>62</sup> Also stressed by Tognazzini in terms of anticipation.

<sup>63</sup> Also stressed by Tognazzini in terms of autonomy.

<sup>64</sup> For more information on the Modal Dialog Box see: [http://msdn.microsoft.com/library/default.asp?url=/workshop/Author/om/windows\\_frames\\_dialogs.asp](http://msdn.microsoft.com/library/default.asp?url=/workshop/Author/om/windows_frames_dialogs.asp).

<sup>65</sup> Also known as customization.

by Kumar, Smith and Bannerjee (2004), who argue that ‘*reactions to interface features are expected to differ from user to user.*’ Next to this, they also stress the importance of personalization by referring to research showing that successful GUI-design, should be based on the user’s tasks and the context in which they are accomplished. Personalization is also addressed by Nielsen, who considers it as an attribute of an application’s flexibility and ease of use, in one of his usability heuristics. However, based on the research of Page, Johnsgard, Albert and Allen (1996), as described later on, it should be noted that the actual use of personalization options is closely related to the frequency of use; users who most heavily/frequently use a certain application, show the highest levels of customization<sup>66</sup>. So, depending upon the intensity/frequency of use, personalization might be considered as being an appropriate method in satisfying the user’s needs.

Thinking in terms of the purpose of personalization, Rivera (2005) found that personalization of content can reduce people’s perceived workload of tasks, in terms of making difficult tasks easier to perform, reduce the mental effort required to perform them and increasing people’s effectiveness and efficiency. Almost all of these, in turn, are part of the clusters identified in the TAM-model, which contribute to the ease of use and perceived usefulness of applications.

Personalization can basically be grouped into two categories: explicit personalization, where the user performs personalization, and implicit personalization, where personalization is performed without the user being (consciously) involved. Whereas both can be considered as being useful methods, the choice between each category of personalization depends upon the purpose one has with respect to personalization. For example, if the purpose of personalization is to provide users with relevant information, while keeping them focused on the task at hand and not distracting them or having them spend valuable time on (time-consuming) personalization, implicit personalization might be more appropriate. On the other hand, if giving a sense of being in-control is important, explicit personalization might be more appropriate. Since personalization depends upon becoming knowledgeable on the user, successfully applying implicit personalization might be somewhat more difficult compared to applying explicit personalization.

As Tognazzini argues, applications should show a certain amount of anticipation. This, in turn, might be reflected in applications adapting to their users, in terms of implicit personalization. A good example of applications using this form of personalization are web stores that offer alternatives and/or upgrades based on the product currently selected/viewed. The same form of personalization might also be applied in a work environment, in which employees are provided with potential relevant information based on their current activity or location in the application.

Research focusing on personalizable elements in applications<sup>67</sup>, is the previously mentioned research of Page *et al.* Their research identified five categories of customization, that might need to be considered in addressing the personalization of applications:

- functionality;
- access to interface tools;
- access to functionality;
- visual appearance;

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<sup>66</sup> A same sort of relationship is described in paragraph 4.4.2.1, in terms of the concept of source selection at the individual level.

<sup>67</sup> The research focused on the user’s customization of a word processor.

- and general preferences.

The first category relates to using macro's and style sheets, the second to the visibility and position of interface tools, the third to the elements shown within these interface tools, and the fourth to customizing the visual appearance of these interface tools, in terms of resizing the elements within them and switching between icon, text and icon-text mode. Finally, the fifth category relates to setting parameters to customize the application, including the default location to store documents and the amount of time between the automatic backup of files.

Also Apple stresses the importance of personalization by arguing that '*Preferences reduce the complexity of the user interface by giving users the ability to customize what they see on the display screen and, to some extent, how the application performs. By providing preferences, you allow both novice and expert users to mold your application to fit their needs.*' Moreover, Apple also argues that remembering the user's general preferences can contribute to the perceived stability of an application. The concept of personalization is also addressed by Manber, Patel and Robison (2000), who describe their personalization experiences with '*My Yahoo!*' As one of their lessons learned, they argue that while personalization might be desired, some users don't use personalization options. Therefore, they stress the importance of not neglecting those users by arguing that '*applications should optimize default settings for casual users.*' Also Apple stresses the importance of using default values, in terms of avoiding lengthy configuration processes where possible, in one of its guidelines stating '*Establish intelligent default settings for your program.*'

Finally, it should be noted that, especially with respect to customers, personalization might raise some issues that need to be addressed appropriately. Examples of such issues, described by Manber *et al.*, include security and privacy. Since explicit personalization often requires the user to provide personal information, this form of personalization can only be successful if both security and privacy are addressed appropriately. If this is not the case, users won't even bother to use any form of personalization. This view towards personalization is supported by Serino, Furner and Smatt (2005), who found that this form of personalization tends to decrease trusting beliefs, thereby making it even more important to address such issues.

An example of how personalization might be reflected in the T-world, includes the use of single-sign on mechanisms. The use of these mechanisms, which allow for storing user preferences at a central point, can offer users with applications matching their preferences independent of time and place. Such freedom, with respect to personalization, is addressed by Manber *et al.* in one of their guidelines stating that '*Customization should follow you as much as possible.*'

#### 5.4.2.9 Visual aesthetics

Finally, the last concept identified is the concept of visual aesthetics. The importance of visual aesthetics is stressed by Tractinsky, Cokhavi and Kirschenbaum (2004) who, based on their research, argue that '*Indirectly, the results suggest that visual aesthetics can play an important role in users' evaluations of the IT artifact.*'

Apple addresses this concept in arguing that its GUI's should show aesthetic integrity. Coincidental, Lavie and Tractinsky mention Apple's iMac product as an example of why visual aesthetics matter. However, it was not that coincidental since Apple itself argues that '*creating attractive hardware and system software is Apple's job*'. Moreover, with respect to its

operating system, Apple argues that *‘One feature that draws users to the Macintosh platform, and to Mac OS X in particular, is the stylish design and attractive appearance of the hardware and software.’* In addressing this concept, Apple argues that screens should be pleasant to look at, even for long periods of time. Moreover, next to referring to the quality of the displayed objects (e.g. color-depth), Apple also stresses the ideas underlying visual aesthetics as described by Lavie and Tractinsky, including the size of elements. Also Garrett puts much emphasis on visual aesthetics, in terms of color, typography and layout. Some of these aspects relate to the concept of universal accessibility, as described in paragraph 5.4.2.4.2. Not only does this concept refer to the GUI, but also to the content displayed within it. This, in turn, is a good example of how an information concept, in this case the concept of style as described in paragraph 4.4.7, might be reflected in the A-world.

Lavie and Tractinsky have conducted research to develop a measurement of perceived website aesthetics. In doing so, they composed a list of factors based on literature and interviews with professional web-designers, human-computer interaction researchers, interior designers and an architect. This list was validated through a series of experiments with engineering students, eventually resulting in their final list of factors. Lavie and Tractinsky distinguished two basic categories of factors: classical and expressive aesthetics. Whereas the classical aesthetics preside from antiquity until the 18<sup>th</sup> century, expressive aesthetics are reflected by the designer’s creativity and originality and the ability to break design conventions. The category of classical aesthetics includes items related to the appearance being clean, clear, pleasant, symmetrical and aesthetic, and the category of expressive aesthetics items related to originality, sophistication, fascination, creativity and the use of special effects.

Other research focusing on visual aesthetics of GUI’s, in terms of Lavie and Tractinsky’s classical aesthetics, is that of Ngo *et al.*, who propose a theoretical approach to *‘capture the essence of artists’ insights’* In doing so, they identified fourteen aesthetic measures for GUI’s that are based on previous research conducted with respect to visual aesthetics. The fourteen visual aesthetic measures identified by them are balance, equilibrium, symmetry, sequence, cohesion, unity, proportion, simplicity, density, regularity, economy, homogeneity, rhythm, and order and complexity. An explanation of each of them is given in Appendix A. In describing why it is important to address visual aesthetics, Ngo *et al.*, referring to other research, argue that visual aesthetics can aid acceptability, motivation, learnability, comprehensibility and productivity.

Also Oppedisano stresses the importance of visual aesthesis, by referring to some of the fourteen measures as identified by Ngo *et al.* Oppedisano argues that the location of visual elements within the GUI affects the way how users interpret information, and therefore one should, *‘when laying out visual elements, know that the user will attempt to interpret the contents and functions of various page elements and how those elements relate to one another.’* With respect to laying out visual elements, Oppedisano mentions the use of lists (e.g. a bullet-list), subparagraphs and headings. Next to this, Oppedisano also argues that the use of graphic properties like shape, texture, color, size, border and screen location can contribute to quicker location and interpretation of the information being displayed. Moreover, Oppedisano argues that, with respect to the functional grouping of tasks within the GUI, *‘A well-designed program will make it easy to find information on the page by grouping corresponding task functions around one another.’* An example of a principle addressing this concept, might state that *‘The visual appearance of applications should contribute to the comprehensibility of digital information.’*

## 5.5 Recap

In this chapter I have tried to answer research question 1.3, that stated ‘*What concepts, that are of interest to the digital architect in the A-world, are/can be addressed in the principles formulated as part of a digital architecture and why?*’ In answering this question, I have made a distinction between those concepts that are related to the concept of durability and those that are related to the concept of usefulness and beauty. With respect to the former, I have identified the following concepts:

- change;
- development;
- integration;
- maintainability;
- and reusability;

and with respect to the latter, the following:

- interaction;
- consistency;
- forgiveness;
- accessibility (international and universal accessibility);
- navigation;
- efficiency;
- user control;
- personalization;
- and visual aesthetics.

In describing these concepts, based on the principles gathered, it became apparent that organizations put much emphasis on the concept of durability, while neglecting the concept of usefulness and beauty<sup>68</sup>. Although many of the interviewed companies were aware of also taking into account the concept of usefulness and beauty<sup>69</sup>, the principles gathered did not address this concept. Also, this chapter showed how some of the business and information concepts, as described in chapter 3 and 4, respectively, might be reflected in the A-world. In describing the concepts related to the concept of usefulness and beauty, it became clear that many of them are closely related to the concepts identified in the I-world. This is not surprising, since both these concepts and those identified in the I-world are mainly related to human behavior. The most important findings with respect to these concepts are briefly described in the following subparagraphs.

Basically, with respect to the concept of durability, organizations expressed the need for anticipating to the uncertain future. For example, in order to cope with business changes, some organizations addressed the way how applications are mapped to business processes in order to ensure linkage with the B-world. Also, with respect to application development, some argued for using formal methods of engineering, which, in turn, can contribute to future mainte-

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<sup>68</sup> Please note that Rijsenbrij does not consider these concepts to be related to architecture, but rather to engineering.

<sup>69</sup> E.g., many of the interviewed companies recognized the importance of also addressing the human aspects of IT as became clear in describing the concept of culture in paragraph 3.4.2.4. Culture, in turn, is closely related to the concept of usefulness and beauty.

nance and ease the process of future outsourcing decisions. Finally, this anticipation seemed also to be reflected in the structure of applications and their dependencies. Next to this, this chapter also showed that the current interoperability with the organizational environment can be considered as being important. This, in turn, might influence decisions with respect to the use of standards and the choice of IT vendors. Finally, this chapter also showed that the need for realizing competitive advantage seemed to drive create vs. buy decisions, that in-house expertise might determine the technologies being used, and that the need for reuse might affect the T-world.

With respect to the concept of usefulness and beauty, in describing the TAM-model, this chapter showed that there are several factors influencing whether people consider applications being useful and easy to use: learnability, mental effort, physical effort, job effectiveness, productivity and the importance of the system for the job. Next to this, this chapter also described how one is able to meet the expectations that users have with respect to the applications they use; by reflecting their mental model. This mental model, next to evolving from previous experiences, also evolves during the interaction with the application. Therefore, it is important that applications are consistent, because this makes it easier for the user to build a conceptual model of the application's behavior, and thereby knows what to expect from it. This, in turn, also made clear why Rijsenbrij considers the arrangement and relationships of functionalities as being important, since the mental model '*represents the structure and internal relationships of a system and 'is the source of the user's expectations'*' (Jih and Reeves). With respect to this behavior, it was argued that applications should keep the user informed about what is happening within them, in terms of providing feedback. This, in turn, also contributes to giving the user a feeling of progress and achievement. In interacting with the application, this chapter also showed that it is important to give the user a feeling of being in-control. Therefore, although applications should provide assistance when required, it was argued that users need to be able to become independent whenever they choose to be. However, such freedom also poses threats, including users performing irreversible actions and getting into dangerous situations. Therefore, it was also argued that applications should show a certain amount of forgiveness.

As mentioned previously, many of the identified concepts are closely related to the concepts identified in the I-world. For example, in describing the concept of accessibility in the I-world, it was argued that the structure of applications can contribute to the accessibility of information. This, in turn, was reflected in describing what makes applications accessible, by arguing that making the underlying structure of the information offered transparent, contributes to their accessibility. Also, in describing what makes information accessible in the I-world, it became clear that retrievability is one of the factors influencing this. This, in turn, was reflected in this chapter in terms of the concept of navigation. Surprisingly, in describing this concept, it became clear that the same principles underlying people's navigation through geographical spaces, underlie their preferred way of navigating through information spaces. Also, this chapter showed that the visual appearance of applications needs to be considered as being important in making applications both useful and beautiful. For example, it became clear that the arrangement and relationships of functionalities can affect the way how users interpret information, and that visual appearance '*can play an important role in users' evaluations of the IT artifact*' (Tractinsky *et al.*). Finally, since the use of applications, like the use of information, is also primarily dependent upon personal preferences, the best way in making applications meet the expectations their users have, is to make them personalizable. However, this chapter also showed that, although personalization might offer many opportunities, some people don't (want to) use personalization options. Therefore, it was argued that the default

settings of applications should be optimized for those who don't use any personalization options.

These findings suggest that the A-world, like the I-world, should also primarily be concerned with the behavior of individuals. In describing the identified concepts, again, also this chapter showed how and why the use of IT should be adapted to the preferences of individuals. Again, also in this case, addressing the human aspects of IT is associated with many business benefits, including increasing efficiency and reducing training costs.

# Chapter 6

# Conclusions

*'It is better to know some of the  
questions than all of the answers.'*

(James Thurber)

In this thesis I have tried to answer research questions 1.1, 1.2 and 1.3 in chapter 3, 4 and 5, respectively, to find an answer to the main research question, that stated ‘*What concepts, that are of interest to the digital architect, are/can be addressed in the principles formulated as part of a digital architecture and why?*’ In doing so, based on the interviews held and the literature studied, I have identified several concepts that are/can be addressed in the B-, I- and A-world, as summarized in paragraph 3.5, 4.5 and 5.5, respectively.

With respect to the B-world, the findings show that, while there are many business concepts that can be addressed, only few of the principles gathered actually addressed these concepts; nevertheless, many of the interviewed companies were aware of addressing business concepts like the ones identified. Instead, many of the principles only addressed IT from a technological perspective, not linking its use to any specific business purpose. Part of this, might be due to the maturity of digital architectures within many organizations. However, if one is trying to achieve business-IT alignment, I think that part of this requires formulating principles from a business perspective; showing what business purposes are served and how this affects the use of IT. In formulating principles from a business perspective, the findings can be considered as being useful since they revealed some of the many business benefits associated with addressing the concepts identified in the B-, I- and A-world. In addition to this, it also became apparent how the concepts identified in the B-world are related to those in the I- and A-world. This, in turn, might also be considered as useful input in making principles more business oriented. Finally, the descriptions of the concepts identified in the B-world showed that although there is a relationship between changes in the B-world and the use of IT, this is no necessity, but rather a choice. This choice, in turn, should be expressed in the principles formulated. With respect to myself arguing for making principles more business oriented, I have three reasons, which all relate to business-IT alignment.

The first reason relates to Rijsenbrij arguing that architectures such as the enterprise and domain architecture should be considered as an atlas for the boardroom, and also as a means of communication for all stakeholders concerned. With respect to this, I would argue that principles expressing a business purpose will ease communication with business people. For example, it will probably make the issues being addressed more comprehensible for them. Moreover, it might also contribute to IT becoming of interest to business people, since they will become aware of the business benefits associated with it; also those that might not be so obvious.

The second reason relates to creating awareness under those involved in the IT-function(s) in the organization. I would argue that by having principles expressing a business purpose, those involved in the IT-function(s) become aware of the purpose being served and thereby might be encouraged to employ IT solutions that are really suited for this purpose.

Third and finally, I think that formulating principles in this way, enables them to be used in determining whether the business and IT are still in line; thereby, next to providing guidance, they can also be used as an evaluation instrument.

With respect to the I-world, the findings show that many of the principles gathered, addressed the I-world in terms of the data being used by the IT solutions in the organization. However, as Davenport and Prusak (1997) argue, the I-world should focus on the use of information by individuals; therefore, one might consider it being more appropriate to address such issues in the T-world. This view is underscored by the fact that a majority of the identified concepts in the I-world are related to human behavior, and thereby support Rijsenbrij in arguing for addressing the human aspects of IT. However, them being related to human behavior is not surprising, since information is essentially something that is used by humans; this is probably

what makes it different from data. The findings suggest that organizations should make a shift from a data oriented approach towards the I-world, to one that focuses on the use of information by individuals. Therefore, it was argued that both the information supply and the use of IT should be adapted to the preferences of individuals, where possible. In identifying what concepts to address, as described in paragraph 4.5, I would recommend organizations to use the five processes<sup>70</sup> as identified in both the literature on knowledge management and organizational learning as a guideline in formulating a structured set of principles.

With respect to the A-world, the findings show that the principles gathered only addressed the concept of durability, while neglecting the concept of usefulness and beauty. Part of this might be due to the fact that the perceived payoffs in addressing them might be more apparent compared to those associated with the concept of usefulness and beauty. Also, it might be due to the fact that, as Tractinsky (2004) puts it, traditionally *'information technology disciplines have emphasized areas related to the firmness, correctness, stability, and internal logic of their products.'* However, this research showed that, while one might consider the concept of usefulness and beauty to be primarily of interest to usability gurus/researchers such as Nielsen, Garrett and Shneiderman, several business benefits are associated with addressing this concept. Examples of such benefits include increasing efficiency, effectiveness and reducing training costs. Therefore, the findings suggest that the A-world, like the I-world, should also primarily be concerned with the behavior of individuals. Again, also these findings support Rijsenbrij in arguing for addressing the human aspects of IT.

Also, this research showed why principles should form a consistent and coherent whole, since most of the identified concepts are in some way related to each other. Next to this, in conducting this research, it also became apparent that no specific structure was underlying the concepts identified in the principles gathered; it seemed that the concepts being addressed in them, were randomly selected. This might probably be due to two reasons. First, organizations might have actually randomly selected these concepts and second, organizations might have addressed those concepts that mattered most to them at the moment. However, with respect to the second, probably this is not the cause, since many of the principles gathered showed to be similar to each other. Instead of being guiding statements that are more or less unique to a specific organization, they often expressed best-practices.

Referring back to the purpose of this research, determining what is/can be addressed in the principles formulated by the digital architect, this research showed that there is a wide variety of concepts that are/can be addressed. Although the descriptions of these concepts can be considered as providing many useful insights, one might consider the overall findings, as described in this chapter, to be more important. This refers to principles often being formulated from a technological perspective, thereby not expressing a business purpose, neglecting the human aspects of IT and not being specific to the organization. Hopefully, these findings will encourage digital architects to take a more business oriented approach in formulating principles, to also take into account the human aspects of IT and to make principles more specific to their organizations.

Finally, a reasonable question to ask might be what concepts an organization needs to address in its principles. Trying to answer this question, however, is irrelevant since the concepts being addressed should depend on the issues an organization faces today or expects to face in the future; this is what makes them unique to an organization. Also, in the end, since organi-

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<sup>70</sup> Information requirements, information acquisition, information retention, information distribution and information utilization.

zations don't have unlimited resources, it is a matter of setting priorities and making tradeoffs. Therefore, it should be noted that the concepts identified are not equally important.

# Chapter 7

# Personal evaluation

*'The wisest mind has  
something yet to learn.'*

(George Santayana)

In the following paragraphs I will subsequently address my personal experiences with the process of conducting this research, the insights gained from it, how satisfied I am with its result and how the interviewed companies responded to its result.

## The process

To begin with, I have to acknowledge that I underestimated the complexity of the research as described in this thesis. This especially becomes apparent when one realizes that I initially intended to complete this thesis in approximately five months. Part of this, I think, is due to the fact that I only studied a limited amount of literature related to this research prior to writing my research plan. If I would have done this, I would probably have been aware of the difficulties involved in conducting this research and could have taken them into account when writing the research plan. However, at the time of having finished the research plan, I was convinced that it would provide me with the necessary guidance in conducting this research. Eventually, things turned out to be different. For example, I chose to use semi-structured interviews for gathering the required information to answer the research questions in place. However, since I had studied a limited amount of literature, this made me encounter difficulties due to a lack of some of the basic insights required in findings answers to these questions. Also, due to this lack of insights, at the time of conducting the first series of interviews I did not realize how valuable the information derived from them actually was. Next to the lack of insights underlying these difficulties, I should also have been aware of some of the difficulties related to using semi-structured interviews, since I also experienced them in conducting a small research project when attending the Information Architecture course of Rijsenbrij at the Radboud University Nijmegen. At the time of that research, I realized that using semi-structured interviews did not easily provide me with the required information. However, although aware of this, I did not expect that I would encounter such difficulties during this research. Eventually, these difficulties caused me to put a lot of effort in studying literature. In the end, with respect to the last interviews held, this seemed to ease the process of conducting semi-structured interviews.

Next to this, since I had never studied so much literature prior to conducting this research, I also encountered some other difficulties. For example, in the beginning I was reading complete books and articles to, in the end, find out that they did not provide me with usable information. Part of this, I think, is due to the fact that, in the beginning, I did not know exactly what I should be looking for. However, as time progressed also this process seemed to become easier, because the literature studied provided me with insights on what to look for, and thereby I could limit myself to only those parts of the literature that might be interesting. In the end, this allowed me to study a wide variety of literature, ranging from business to computer science that provided me with the necessary insights and information to finish this thesis, but also enormously contributed to my productivity. Also, this made me realize how valuable the information derived from the interviews actually was, and allowed me to incorporate it in this thesis; luckily, I had made both voice recordings and notes during the interviews held.

Moreover, I also encountered some difficulties related to myself not putting anything on paper in the beginning. Instead, I was endlessly thinking of how and what I should put on paper, instead of actually putting anything on paper. Therefore, Rijsenbrij advised me to make a start with putting my findings and thoughts on paper and gradually compose my thesis. Eventually, when I did put my findings and thoughts on paper, things went fast. Although, in the end, I

had to omit large parts of previous writing, I think that this way of working, next to contributing to my productivity, has also eliminated a large amount of frustration related to myself having problems in processing the insights gained and the information gathered.

In the end, these difficulties made me realize how important it is to thoroughly study one's research topic prior to writing a research plan, and carefully determine the approach in gathering the required information.

## Gained insights

Next to the difficulties as described in the previous paragraph, this research has also provided me with some valuable insights. In the following subparagraphs I will describe some of these insights for each of the three worlds as described in this thesis.

With respect to the B-world, although there is no single model in describing what makes up for an organization, this research provided me with insights into what might potentially make up for an organization; at first, I was solely thinking in terms of business functions and business actors. Next to this, although I was familiar with some of the models used to describe the B-world, including those of Porter, I was not aware of the fact that these models can also be used to describe the role of IT in the B-world. Applying these models, in turn, eased the process of identifying concepts in the B-world, in terms of them providing me with a certain structure. I think that these models will and have contribute(d) to my ability in analyzing issues related to the use of IT in the B-world, but also those related to the B-world in general. Moreover, whereas I thought of IT always affecting the organizational structure, the insights gained made me realize that this is no necessity, but rather a choice. Personally I think that the role of IT is often, also at the Radboud University Nijmegen, described in terms of IT changing the B-world; however, the findings suggest otherwise. Finally, I think that, especially with respect to the insights gained in describing the B-world and next to Rijsenbrij getting me in contact with the right person, this research has also contributed in finding myself a challenging position in a large IT company to start my professional career.

With respect to the I-world, this research made me realize that the use of information in organizations goes beyond computing power and is mainly related to human behavior. Although many people associate the study of information science with the use of information in organizations, I think that the study itself neglects the importance of human behavior with respect to information, and puts too much emphasis on aspects related to computer science instead; for example, much emphasis is put on data. However, this research compensated for this by providing me with insights into the relationship between human behavior and information. Thereby, it also allowed me to make a shift from thinking in terms of data to thinking in terms of information, when analyzing the use of information in organizations. Also, it provided me with insights into some of the theories underlying human behavior with respect to information, and also with insights into why organizations process information. For example, prior to this research, I never realized that the basic reasons underlying organizations processing information were related to reducing uncertainty and equivocality.

Finally, with respect to the A-world, although I was already familiar with many of the concepts identified since I encountered them during my previous study, this research has contributed a lot in broadening and deepening my knowledge of them. For example, in contrast to my previous study, this research has provided me with insights into the theories underlying some of these concepts. This, in turn, allows me not only to speak in terms of these concepts,

but also recognize why they are important and how they are related to each other. Also, this research has made me aware of the potential business benefits associated with addressing these concepts. Thereby, I think that this research has contributed to my ability of translating the business's need for information into IT solutions that actually meet this need.

Overall, this research, because of it being so broad, covering the B-, I- and A-world, has provided me with a broader view towards the use of IT in organizations. This, for example, became apparent in rewriting and/or omitting parts of this thesis, that I had written only a few months earlier. Finally, it has also allowed me to gain insights into the different views towards the use of IT in organizations in a relatively short amount of time, by having conducted several interviews.

## Result

First, with respect to the result of this research, I have to admit that I am not completely satisfied compared to what I had in mind at the beginning of this research. For example, initially I thought of being able to propose a framework describing the identified concepts and their relationships. Eventually, I had to limit myself to describing only a few concepts and had to omit elaborate descriptions on their relationships; the initial idea of proposing such a framework is closely related to the fact that I underestimated the complexity of this research. Since I had the idea of proposing such a framework for a long period of time, it frustrated me that I could not find a logical structure to categorize the identified concepts. This especially became apparent when describing the I-world, in which I have struggled with fitting the identified concepts into a certain model. Eventually, this didn't work out and I had to give up. Nevertheless, for future research it can be considered as being useful to create a structured framework to categorize the identified concepts and describe their relationships. Also, I am not completely satisfied with the result, since, although in agreement with Rijsenbrij, this research does not meet the objective Rijsenbrij initially had in mind and it does not cover the T-world; both are also addressed in the next chapter.

Second, with respect to the interviewed companies responding to the result, it should be noted that the feedback received was somewhat limited. Part of this was due to the limited amount of time the interviewed companies had available to review this thesis. Some of the feedback was related to the view adopted in this thesis towards organizations and their use of IT. For example, one of the interviewed companies argued for not only viewing a specific organization in its environment where the emphasis remains on the organization, but also the interactional perspective as such and thus adding an infrastructural approach at the scale of the whole of society. Another one of the interviewed companies provided me with feedback related to the fact that it refused to speak in terms of digital architecture. Instead, the company considers IT as being only one of a variety of components that makes up for an architecture. Also this company argued that the model used, Rijsenbrij's four worlds, tends to be too much of a waterfall model. Basically, a large part of this feedback is related to Rijsenbrij's view towards digital architecture. This makes clear that the view towards the use of IT in organizations can and will vary among different people and organizations. Also, it is one of the factors that caused me having difficulties in gathering the required information.

Next to this, I also received feedback that was not related to Rijsenbrij's view towards digital architecture. For example, with respect to the description of digital architecture in chapter 1, one of the interviewed companies argued that the description of the domain level in paragraph 1.2.3 was too limited to give a good understanding of its purpose; Rijsenbrij provided me with

the same feedback. Therefore, I have more elaborately described this level of abstraction. One of the other interviewed companies argued that the concepts identified are not uniform in terms of some of them referring to phenomena and others to terms. I have to agree with the company in arguing that the concepts identified are not uniform. This was also one of the issues that caused me having difficulties in writing this thesis. However, since these were the concepts identified during the interviews held and in the literature studied, although different, these might be important to address. Nevertheless, this does not change the fact of the concepts not being uniform. However, in the end, this feedback made me decide to change the structure of the chapter describing the concepts identified in the A-world. Another one of the interviewed companies provided me with feedback related to the naming used for the concept of forgiveness as described in paragraph 5.4.2.3. The company argued that this naming is too human oriented and, for example, proposed using fault-tolerance instead; this perfectly illustrates that many people still think from the perspective of the application, instead from the perspective of its users. However, since many of the concepts as described in the A-world are related to human behavior, I think that using forgiveness is more appropriate; especially since it is a common term used in the field of human computer interaction. Finally, with respect to the A-world, another one of the interviewed companies provided me with feedback suggesting to incorporate some of the quality factors as mentioned in the ISO 9126 standard, and more specifically those mentioned in the Extended ISO Model. However, although important, many of the factors described in this model focus on the characteristics of the IT solution itself, instead of its users. Nevertheless, all of the factors in this model that do relate to the user, are addressed in the A-world.

# Chapter 8

## Limitations and future research directions

*'The future is much like  
the present, only longer.'*

(Dan Quisenberry)

To begin with, as described in paragraph 2.3, initially, this research also covered the T-world. However, due to time constraints this research was limited to the B-, I- and A-world. Therefore, it can be considered as being incomplete. To address this limitation, I would suggest for future research also trying to identify the concepts in the T-world that are of interest to the digital architect and that are/can be addressed in the principles formulated as part of a digital architecture.

In describing the concepts identified, this research has revealed many interesting relationships that might need to be more thoroughly studied in future research. For example, this research showed that the concepts identified in the B-world can be addressed with different purposes. An example includes the concept of structure that can be addressed both in terms of using IT to change the organizational structure and in terms of IT adapting itself to the organizational structure. Another example includes the concept of processes, of which the description showed that the role of IT with respect to this concept might differ per organization. However, in describing these relationships, this research limited itself to high-level insights only. Moreover, it did not elaborately describe what organizations consider as being important. Therefore, with respect to the B-world, it might be considered as being important to more thoroughly study what really matters to organizations and even more important, why.

Also, this research showed that especially human behavior with respect to IT might need to be more thoroughly studied. Although many of the interviewed companies considered human behavior as a factor influencing their use of IT, this research did not elaborately describe how it actually affected their use of IT. Therefore, this might be considered as being an interesting relationship to study in future research. Next to this, since a majority of the concepts identified in both the I- and A-world are related to human behavior, I would also suggest for future research focusing on what the actual end users of information and applications consider as being important. For example, with respect to the I-world, it might be interesting to gain more insights into what aspects of information people value most and what they expect from IT in satisfying their need for information, and with respect to the A-world, their preferences in navigating through and interacting with applications. Finally, it might also be interesting to study the perceived payoffs from a business perspective in addressing the concepts identified in both the I- and A-world; e.g. the business benefits associated with them.

In making these relationships more apparent, I would recommend using empirical research to study them. Also, as described in the previous chapter, in contrast to this research, I would also suggest for future research to create a structured framework to categorize the identified concepts and describe their relationships. Studying these relationships empirically, I think, can ease the process of creating such a framework. Next to this, considering the amount of concepts identified in the B-, I-, and A-world, for purposes of feasibility, I would recommend for future research studying these worlds separately. Also, since this research showed that the use of IT in organizations is dependent upon both business and human factors, I would recommend involving people from other disciplines<sup>71</sup> in conducting the proposed future research as described in the previous subparagraphs. Moreover, whereas the selection of the research subjects was randomly conducted for this research, I would recommend for future research making this selection more carefully, in a way that these subjects are in some way related and/or similar to each other; whether this concerns individuals or organizations. I think that a more careful selection allows one to generalize some of the findings, in contrast to the findings of this research.

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<sup>71</sup> E.g. from the fields of social and business science.

Finally, it should be noted that Rijsenbrij's initial intention with this research was to identify those concepts that are affected by the principles formulated (e.g. documents and workflows). However, in agreement with Rijsenbrij, I decided to study those concepts that provide inspiration in formulating principles, instead of identifying the concepts that are affected by them. Nevertheless, this research is closely related to Rijsenbrij's initial intention, because the identified concepts can be considered as influencing the concepts that are eventually affected by the principles formulated. However, in order to present a complete picture of the role of principles and their impact in the four worlds, research focusing on the concepts that are affected by the principles formulated should still be considered as being important to conduct. With respect to such future research, this research can be considered as being useful, since it provides some directions on what these concepts can be.

## References

- Alavi, M., Leidner, D.E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107-136.
- Angeli, A. De, Sutcliffe, A., Hartmann, J. (2006). Interaction, usability and aesthetics: what influences users' preferences? In *Proceedings of the 6th ACM conference on Designing Interactive systems*, 271-280.
- Apple (Apple Computer, Inc.). (2006). *Apple Human Interface Guidelines* [online]. Available from: <http://developer.apple.com/documentation/UserExperience/Conceptual/OSXHIGuidelines/OSXHIGuidelines.pdf>. October 29, 2006.
- Attaran, M. (2004). Exploring the relationship between information technology and business process reengineering. *Information and Management*, 41(5), 585-596.
- Bakos, J.Y., Treacy, M.E. (1986). Information Technology and Corporate Strategy: A Research Perspective. *MIS Quarterly*, 10(2), 107-119.
- Balasubramanian, V. *Organizational Learning and Information Systems* [online]. Available from: <http://www.e-papyrus.com/personal/orglrn.html>. September 12, 2006.
- Becker, S.A., Mottay, F.E. (2001). A Global Perspective on Web Site Usability. *IEEE Software*, 18(1), 54-61.
- Belich, T.J., Dubinsky, A.J. (1995). Factors Related to Information Acquisition in Exporting Organizations. *Journal of Business Research*, 33(1), 1-11.
- Benyon, D. (2006). Navigating Information Space: Web site design and lessons from the built environment. *PsychNology Journal*, 4(1), 7-24.
- Berry, D. (2000). *The user experience: The iceberg analogy of usability* [online]. Available from: <http://www-128.ibm.com/developerworks/library/w-berry/>. November 2, 2006.
- Berry, R.E. (1988). Common user access: a consistent and usable human-computer interface for the SAA environments. *IBM systems journal*, 27(3), 281-300.
- Bettman, J.R., Kakkar, P. (1977). Effects of Information Presentation Format on Consumer Information Acquisition Strategies. *The Journal of Consumer Research*, 3(4), 233-240.
- Bevan, N. (1995). Usability is Quality of Use. In *Proceedings of the 6th International Conference on Human Computer Interaction*, 349-354.
- Bhatt, G.D. (2000). An empirical examination of the effects of information systems integration on business process improvement. *International Journal of Operations & Production Management*, 20(11), 1331-1359.
- Blackburn, I. (2004). Layering Applications [online]. Available from: <http://www.bbitts.co.uk/course/Presentations/LayeringApplications.ppt>. October 22, 2006.

- Bloomfield, B.P., Coombs, R., Knights, D., Littler, D. (1997). *Information Technology and Organizations: Strategies, Networks, and Integration*. Oxford: Oxford University Press.
- Boonstra, A. (2002). *ICT, mensen en organisaties: een managementbenadering*. Amsterdam: Prentice Hall.
- Botafogo, R.A., Rivlin, E., Shneiderman, B. (1992). Structural analysis of hypertexts: identifying hierarchies and useful metrics. *ACM Transactions on Information Systems (TOIS)*, 10(2), 142-180.
- Bouwman, H., Hooff, B. van den, Wijngaert, L. van de, Dijk, J. van. (2005). *Information and Communication Technology in Organizations: Adoption, Implementation, Use and Effects*. London: Sage Publications.
- Broadbent, M., Weill, P., St. Clair, D. (1999). The Implications of Information Technology Infrastructure for Business Process Redesign. *MIS Quarterly*, 23(2), 159-182.
- Buell, B. (1997). The Manager as Juggler: Ambidextrous Organizations. *Stanford Business Magazine*, 65(4).
- Bullen, C.V., Rockart, J.F. (1981). A primer on critical success factors. *Sloan Working Paper 1220-81*, MIT.
- Calder, A., Watkins, S. (2005). *IT Governance: A Manager's Guide to Data Security and BS 7799/ISO 17799*. London: Kogan Page.
- Caluwé, L. de, Vermaak, H. (2001). *Leren veranderen: een handboek voor de veranderkundige*. Alphen aan den Rijn: Samson.
- Choo, C.W. (1991). Towards an information model of organizations. *The Canadian Journal of Information Science*, 16(3), 32-62.
- Choo, C.W. (1995). *Information Management for the Intelligent Organization: Roles and Implications for the Information Professions* [online]. Available from: <http://choo.fis.utoronto.ca/FIS/ResPub/DLC95.html>. August 24, 2006.
- Choudhury, V., Sampler, J.L. (1997). Information Specificity and Environmental Scanning: An Economic Perspective. *MIS Quarterly*, 21(1), 25-53.
- Cooper, R.B. (1994). The inertial impact of culture on IT implementation. *Information and Management*, 27(1), 17-31.
- Croteau, A., Bergeron, F. (2001). An information technology trilogy: business strategy, technological deployment and organizational performance. *The Journal of Strategic Information Systems*, 10(2), 77-99.
- Crystal, A., Kalyanaraman, S.S. (2004). Usability, Cognition, and Affect in Web Interfaces: The Role of Informative Feedback and Descriptive Labeling. *54th annual conference of the International Communication Association (ICA)*.

- Cullen, A., Orlov, L.M., Leganza, G., Young, G.O., Hudson, M. (2005). *Connecting Business Drivers To Enterprise Architecture*. Forrester Research.
- Culnan, M.J. (1984). The dimensions of accessibility to online information: implications for implementing office information systems. *ACM Transactions on Information Systems*, 2(2), 141-150.
- Daft, R.L., Lengel, R.H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32(5), 554-571.
- Davenport, T.H., Prusak, L. (1997). *Information Ecology: Mastering the Information and Knowledge Environment*. New York: Oxford University Press.
- Davis, F.D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. PhD dissertation, Massachusetts Institute of Technology.
- Davis, F.D., Bagozzi, R.P., Warshaw, P.R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, 35(8), 982-1003.
- Dennis, A.R., Valacich, J.S. (1999). Rethinking media richness: towards a theory of media synchronicity. In *Proceedings of the 32nd Hawaii International Conference on System Sciences*.
- Dewett, T., Jones, G.R. (2001). The role of information technology in the organization: a review, model, and assessment. *Journal of Management*, 27(3), 313-346.
- DIS (Washington State Information Services Board). (2004). *Washington State Enterprise Architecture Program: Over-Archiving Architecture Principles Version 1.0* [online]. Available from: <http://isb.wa.gov/committees/enterprise/architecture/overarchingprinciples.doc>. November 8, 2006.
- Dishaw, M.T., Strong, D.M. (1999). Extending the technology acceptance model with task-technology fit constructs. *Information & Management*, 36(1), 9-21.
- Dougan, W.L. *Lecture 2: Design Fundamentals* [online]. Available from: <http://road.uww.edu/road/douganw/250-745%20BUILDING%20EFF%20ORGS/Lecture2%20S04.ppt>. August 19, 2006.
- Earl, M.J. (1991). *Management strategieën en informatietechnologie*. Translated by Andel - van der Vliet, W. van. Schoonhoven: Academic Service, Economie en Bedrijfskunde.
- Edmunds, A., Morris, A. (2000). The problem of information overload in business organisations: a review of the literature. *International Journal of Information Management*, 20(1), 17-28.
- Eichen, M. (2006). Value Disciplines: A Lens for Successful Decision Making in IT. *EDUCAUSE Quarterly*, 29(2), 32-39.

- Elam, J., Moss, S. (1997). *The New Promise of Information Technology* [online]. Available from: <http://www.fiu.edu/~elamj/emba/slides/intro.ppt>. August 6, 2006.
- Etzel, B. (1995). New strategy and techniques to cope with information overload. *IEE Colloquium Digest*, 95/223, 2/1-2/10.
- Falquet, G., Jiang, C.M. (2000). Conflict Resolution in the Collaborative Design of Terminological Knowledge Bases. In *Proceedings of the 12th European Workshop on Knowledge Acquisition, Modeling and Management*, 156-171.
- Fidel, R., Green, M. (2004). The many faces of accessibility: engineers' perception of information sources. *Information Processing and Management: an International Journal*, 40(3), 563-581.
- Flemming, J. (2001). *Web Navigation: Designing the User Experience: Sample chapter* [online]. Available from: <http://www.oreilly.com/catalog/navigation/chapter/ch05.html>. October 30, 2006.
- FSA (Financial Student Aid). (2004). *Welcome to FSA: Enterprise Architecture Homepage* [online]. Available from: [http://fsaextranet.ed.gov/cio/it\\_management/html/technology\\_architecture.html](http://fsaextranet.ed.gov/cio/it_management/html/technology_architecture.html). November 8, 2006.
- Gao, G., Hitt, L.M. (2004). IT and Product Variety: Evidence from Panel Data. In *Proceedings of the 25th Annual International Conference on Information Systems*, 365-378.
- Garrett, J.J. (2000). *The Elements of User Experience* [online]. Available from: <http://www.jjg.net/ia/elements.pdf>. April 24, 2006.
- Garrett, J.J. (2003). *The Elements of User Experience* [online]. Available from: <http://www.adaptivepath.com/events/workshops/businessofux/elements0803.pdf>. April 24, 2006.
- Garrett, J.J. (2006). *The rules of navigation* [online]. Available from: <http://www.netmag.co.uk/zine/develop-culture/the-rules-of-navigation>. October 29, 2006.
- Gertsberger, P.G., Allen, T.J. (1968). Criteria used by research and development engineers in the selection of an information source. *Journal of Applied Psychology*, 52(4), 272-279.
- Gharajedaghi, J. (1999). *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*. Boston: Butterworth-Heinemann.
- Gorelick, C. (2005). Organizational learning vs the learning organization: a conversation with a practitioner. *The Learning Organization: An International Journal*, 12(4), 383-388.
- Government of Tasmania. (2005). *Tasmanian Government Architectural Principles Version 1.0* [online]. Available from: [http://www.go.tas.gov.au/enterprise\\_architecture/architectural\\_principles-v1.0.htm](http://www.go.tas.gov.au/enterprise_architecture/architectural_principles-v1.0.htm). November 8, 2006.
- Harris, L.C., Ogbonna, E. (1998). A three-perspective approach to understanding culture in retail organizations. *Personnel Review*, 27(2), 104-123.

- Hartmann, J., Sutcliffe, A. *Aesthetic Judgement of Interactive Systems* [online]. Available from: <http://www.idc.ul.ie/aesthetics/WSpapers/HartmannAestheticJudgement.doc>. October 25, 2006.
- Henderson, J.C., Venkatraman, N. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, 32(1), 4-16.
- Hendrickson, A.R., Massey, P.D., Cronan, T.P. (1993). On the Test-Retest Reliability of Perceived Usefulness and Perceived Ease of Use Scales. *MIS Quarterly*, 17(2), 227-230.
- Hennepin County. (2005). *Hennepin County Conceptual Architecture Principles: Version 2.0* [online]. Available from: <http://wwwa.co.hennepin.mn.us/>. November 8, 2006.
- Hiltz, S.R., Turoff, M. (1985). Structuring computer-mediated communication systems to avoid information overload. *Communications of the ACM*, 28(7), 680-689.
- Ho, J., Tang, R. (2001). Towards an optimal resolution to information overload: an infomediary approach. In *Proceedings of the 2001 International ACM SIGGROUP Conference on Supporting Group Work*, 91-96.
- Hodas, S. (1993). *Technology Refusal and the Organizational Culture of Schools* [online]. Available from: <http://epaa.asu.edu/epaa/v1n10.html>. August 22, 2006.
- Hoogervorst, J. (2004). Enterprise Engineering & -Architectuur: een antwoord op falende strategie-implementaties. *Holland Management Review*, 98, 20-31.
- Huber, G.P. (1991). Organizational Learning: The Contributing Processes and the Literatures. *Organization Science*, 2(1), 88-115.
- Huber, G.P. (2003). The effects of advanced information technologies on organizational design, intelligence and decision making. In *Strategic Information Management: Challenges and Strategies in Managing Information Systems* (eds. Galliers, R., Leidner, D.E.), Oxford: Butterworth-Heinemann, 460-496.
- IBM. *Ease of Use* [online]. Available from: <http://www-03.ibm.com/easy/>. October 24, 2006.
- Ives, B., Learmonth, G.P. (1984). The information system as a competitive weapon. *Communications of the ACM*, 27(12), 1193-1201.
- Japenga, R. *Principles of Software Driven User Interface Design for Business and Industrial Applications* [online]. Available from: <http://www.microtoolsinc.com/PrinciplesofUserInterfaceDesign.pdf>. October 22, 2006.
- Jarvenpaa, S.L. (1989). The Effect of Task Demands and Graphical Format on Information Processing Strategies. *Management Science*, 35(3), 285-303.
- Jih, H.J., Reeves, T.C. (1992). Mental Models: A Research Focus for Interactive Learning Systems. *Educational Technology Research and Development*, 40(3), 39-53.

Jonkers, H., Lankhorst, M.M., Buuren, R. van, Hoppenbrouwers, S., Bonsangue, M., Torre, L. van der. (2004). Concepts for Modelling Enterprise Architectures. *International Journal of Cooperative Information Systems*, 13(3), 257-287.

Keuning, prof. dr. D. (1996). *Bedrijfskunde: Bedrijfsontwikkelingen en –beslissingsgebieden*. s.l.: Stenfert Kroese.

Kraemer, K.L., Gurbaxani, V., Dunkle, D., Vitalari, N. (1996). *Business Value of Information Technology: Customer Intimacy* [online]. Available from: <http://repositories.cdlib.org/crito/business/319/>. September 3, 2006.

Kumar, R.L., Smith, M.A., Bannerjee, S. (2004). User interface features influencing overall ease of use and personalization. *Information and Management*, 41(3), 289-302.

Lambert, R., Peppard, J. (2003). Information technology and new organizational forms. In *Strategic Information Management: Challenges and Strategies in Managing Information Systems* (eds. Galliers, R., Leidner, D.E.), Oxford: Butterworth-Heinemann, 427-459.

Larman, C. (2001). Protected Variation: The Importance of Being Closed. *IEEE Software*, 18(3), 89-91.

Lau, T., Wong, Y.H., Chan, K.F., Law, M. (2001). Information technology and the work environment – does IT change the way people interact at work? *Human Systems Management*, 20(3), 267-279.

Lavie, T., Tractinsky, N. (2004). Assessing dimensions of perceived visual aesthetics of web sites. *International Journal of Human-Computer Studies*, 60(3), 269-298.

Leavitt, H.J., Whisler, T.L. (1958). Management in the 1980's. *Harvard Business Review*, 36(6), 41-48.

Lee, I. (2004). Evaluating business process-integrated information technology investment. *Business Process Management Journal*, 10(2), 214-233.

Lee, S.M., Hong, S. (2002). An enterprise-wide knowledge management system infrastructure. *Industrial Management & Data Systems*, 102(1), 17-25.

Leganza, G., Holmes, B.J., Webber, A.E., McAulay, S.E. (2005). *Public And Private Sector Business Architecture: Looking For Alignment, Reuse, And Re-Engineering*. Forrester Research.

Legris, P., Ingham, J., Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, 40(3), 191-204.

Leidner, D.E. (2003). Understanding information culture: integrating knowledge management systems into organizations. In *Strategic Information Management: Challenges and Strategies in Managing Information Systems* (eds. Galliers, R., Leidner, D.E.), Oxford: Butterworth-Heinemann, 497-525.

- Luftman, J.N., Lewis, P.R., Oldach, S.H. (1993). Transforming the enterprise: The alignment of business and information technology strategies. *IBM Systems Journal*, 32(1), 198-221.
- Maes, R. (1999). Reconsidering information management through a generic framework. *PrimaVera Working Paper 99-15*, Universiteit van Amsterdam.
- Malhotra, Y. (1993). *Role of Information Technology in Managing Organizational Change and Organizational Interdependence* [online]. Available from: <http://www.kmbook.com/change/>. August 24, 2006.
- Malhotra, Y. (1998). *Business Process Redesign: An Overview* [online]. Available from: <http://www.kmbook.com/bpr.htm>. August 19, 2006.
- Manber, U., Patel, A., Robison, J. (2000). Experience with personalization of Yahoo! *Communications of the ACM*, 43(8), 35-39.
- Markus, M.L., Robey, D. (1988). Information Technology and Organizational Change: Causal Structure in Theory and Research. *Management Science*, 34(5), 583-598.
- McDavid, D.W. (1999). A standard for business architecture description. *IBM Systems Journal*, 38(1), 12-31.
- Mendonca, J. (2004). Organizational impact of information technology: a leadership course for IT. In *Proceedings of the 5th conference on Information technology education*, 244-247.
- MICT (Manitoba Information and Communications Technologies). (2005). *Government of Manitoba Enterprise Architecture: Principles, Strategies and Directions* [online]. Available from: [http://www.gov.mb.ca/est/mict/enterprise\\_arch/pdfs/ea\\_principles.pdf](http://www.gov.mb.ca/est/mict/enterprise_arch/pdfs/ea_principles.pdf). November 12, 2006.
- Mississippi Department of Information Technology Services. *Architecture Principles* [online]. Available from: [http://www.its.state.ms.us/its/EA.nsf/webpages/principles\\_home](http://www.its.state.ms.us/its/EA.nsf/webpages/principles_home). November 8, 2006.
- Moreton, R., Chester, M. (1996). *Transforming the Business: the IT contribution*. Berkshire: McGraw-Hill Publishing Company.
- Mukama, F., Kimaro, H., Gregory, J. (2005). *Organization culture and its impact in information systems development and implementation: A case from the health information system in Tanzania* [online]. Available from: <http://www.hia.no/iris28/Docs/IRIS28-Mukama%20et%20al.pdf>. August 22, 2006.
- Mulligan, P., Gordon, S.R. (2002). The impact of information technology on customer and supplier relationships in the financial services. *International Journal of Service Industry Management*, 13(1), 29-46.
- Ngo, D.C.L., Samsudin, A., Abdullah, R. (2000). Aesthetic Measures for Assessing Graphic Screens. *Journal of Information Science and Engineering*, 16(1), 97-116.

- Ngo, D.C.L., Teo, L.S., Byrne, J.G. (2003). Modelling interface aesthetics. *Information Sciences*, 152(1), 25-46.
- Nielsen, J. (1992). The Usability Engineering Life Cycle. *Computer*, 25(3), 12-22.
- Nielsen, J. (1994). Enhancing the explanatory power of usability heuristics. In *Proceedings of the SIGCHI conference on Human factors in computing systems: celebrating interdependence*, 152-158.
- Nielsen, J. (2000). *Designing Web Usability*. Indianapolis: New Riders Publishing.
- NIH (National Institutes of Health). (2005). *NIH Enterprise Architecture: Guide to NIH Enterprise Architecture*. Available from: <http://enterprisearchitecture.nih.gov/ArchLib/Guide/>. November 8, 2006.
- O'Reilly, III C.A. (1980). Individuals and Information Overload in Organizations: Is More Necessarily Better? *The Academy of Management Journal*, 23(4), 684-696.
- O'Reilly, III C.A. (1982). Variations in Decision Makers' Use of Information Sources: The Impact of Quality and Accessibility of Information. *The Academy of Management Journal*, 25(4), 756-771.
- Opheij, W., Willems, F. (2004). Shared Service Centers: balanceren tussen pracht en macht. *Holland Management Review*, 95, 31-45.
- Oppedisano, R. (2002). *Common Principles: A Usable Interface Design Primer* [online]. Available from: [http://www.usabilityprofessionals.org/upa\\_publications/upa\\_voice/volumes/4/issue\\_3/common\\_principles.htm](http://www.usabilityprofessionals.org/upa_publications/upa_voice/volumes/4/issue_3/common_principles.htm). October 24, 2006.
- Orlikowski, W.J., Gash, D.C. (1994) Technological frames: making sense of information technology in organizations. *ACM Transactions on Information Systems*, 12(2), 174-207.
- Overbeek, S.J., Rijsenbrij, D.B.B., Proper, H.A. (Erik). (2007). *Sophia: Towards a Personal Digital Workspace for Knowledge Workers*. In *Knowledge Workers: Issues and Perspectives* (ed. Rao, N.J.), 2007, Hyderabad: ICFAI University Press.
- Page, S.R., Johnsgard, T.J., Albert, U., Allen, C.D. (1996). User customization of a word processor. In *Proceedings of the SIGCHI conference on Human factors in computing systems: common ground*, 340-346.
- Parsons, G.L. (1983). Information Technology: a new competitive weapon. *Sloan Management Review*, 25(1), 3-14.
- Peng, C. (2005). *The effect of data structure and information presentation format on performance evaluation judgments using business performance management systems*. PhD dissertation, Texas Tech University.
- Pfeffer, J., Leblebici, H. (1977). Information Technology and Organizational Structure. *The Pacific Sociological Review*, 20(2), 241-261.

- Pinsonneault, A., Kraemer, K.L. (2002). Exploring the role of information technology in organizational downsizing: A tale of two American cities. *Organization Science*, 13(2), 191-208.
- Porter, M.E., Millar, V.E. (1985). How information gives you competitive advantage. *Harvard Business Review*, 63(4), 149-160.
- Prakken, prof. dr. B. (1997). *Informatie en de besturing van organisaties: Een bedrijfskundige aanpak van informatievraagstukken*. Assen: Van Gorcum.
- Probst, G., Raub, S., Romhardt, K. (2000). *Managing knowledge: building blocks for success*. Chichester: Wiley.
- Rijsenbrij, prof. dr. D. (2004). *Architectuur in de Digitale Wereld: versie nulpunt drie*. Nijmegen: Radboud University Nijmegen.
- Rijsenbrij, prof. dr. D. (2005). *Kanttekeningen bij 'Architectuur in de Digitale Wereld': versie nulpunt zes* [online]. Available from: <http://www.digital-architecture.net/oratie/update.doc>. October 16, 2005.
- Rivera, D. (2005). The effect of content customization on learnability and perceived workload. In *CHI '05 extended abstracts on Human factors in computing systems*, 1749-1752.
- Robey, D., Boudreau, M.C., Rose, G.M. (2000). Information technology and organizational learning: a review and assessment of research. *Accounting, Management and Information Technologies*, 10(2), 125-155.
- Rockart, J.F., Treacy, M.E. (1981). Executive information support systems. *Sloan Working Paper 1167-80*, MIT.
- Sabherwal, R., Sabherwal, S. (2005). Knowledge Management Using Information Technology: Determinants of Short-Term Impact on Firm Value. *Decision Sciences*, 36(4), 531-567.
- Sabherwal, R., Chan, Y.E. (2001). Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders. *Information Systems Research*, 12(1), 11-33.
- Sanden, W. van der, Sturm, B. (1997). *Informatiearchitectuur: de infrastructurele benadering*. Rosmalen: Panfox.
- Sanders, N.R., Premus, R. (2005). Modelling the relationship between firm IT capability, collaboration, and performance. *Journal of Business Logistics*, 26(1), 1-23.
- Saunders, C., Jones, J.W. (1990). Temporal Sequences in Information Acquisition for Decision Making: A Focus on Source and Medium. *The Academy of Management Review*, 15(1), 29-46.
- Schein, E.H. (1988). Organizational culture. *Sloan Working Paper 2088-88*, MIT.
- Schweitzer, A.L.M., Veldhuizen, E. (1988). *Inleiding bestuurlijke informatiekunde*. Schoonhoven: Academic Service.

Scott, W.G. (1961). Organization Theory: An Overview and an Appraisal. *The Journal of the Academy of Management*, 4(1), 7-26.

Serino, C.M., Furner, C.P., Smatt, C. (2005). Making it Personal: How Personalization Affects Trust Over Time. In *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05) - Track 7*, 170a.

Shneiderman, B. (2004). Designing for fun: how can we design user interfaces to be more fun? *interactions*, 11(5), 48-50.

Simon, H.A. (1977). *The New Science of Management Decision*. Englewood Cliffs, N.J.: PrenticeHall.

Slater, S.F., Narver, J.C. (1995). Market Orientation and the Learning Organization. *Journal of Marketing*, 59(3), 63-74.

Smildiger, R. (2005). Een audit op informatiearchitectuur: waar te beginnen? *de EDP-Auditor*, 3, 9-19.

Sogeti. *DyA: Architecture framework* [online]. Available from: [http://eng.dya.info/Home/dya/what\\_is\\_dya/architecture\\_framework.jsp](http://eng.dya.info/Home/dya/what_is_dya/architecture_framework.jsp). May 27, 2006.

Speier, C., Vessey, I., Valacich, J.S. (2003). The Effects of Interruptions, Task Complexity, and Information Presentation on Computer-Supported Decision-Making Performance. *Decision Sciences*, 34(4), 771-797.

Stal, M. (2006). Using Architectural Patterns and Blueprints for Service-Oriented Architecture. *IEEE Software*, 23(2), 54-61.

Starren, H.G. (1999). *Grootmeesters in management*. s.l.: Uitgeverij Ooievaar.

Starreveld, R.W., Mare, H.B. de, Joëls, E.J., Nimwegen, H. van. (1997). *Bestuurlijke informatieverzorging: deel 2B: Toepassingen, typologie van de bedrijfshuishoudingen*. Alphen aan den Rijn: Samsom BedrijfsInformatie.

State of Arkansas. *Network Architecture Principles and Drivers* [online]. Available from: [http://www.techarch.state.ar.us/domains/network/overview/principles\\_drivers.htm](http://www.techarch.state.ar.us/domains/network/overview/principles_drivers.htm). November 14, 2006.

State of California. (2006). *California Enterprise Architecture Principles* [online]. Available from: [http://www.cio.ca.gov/ITCouncil/Committees/PDFs/CEAP\\_principles\\_FINAL.pdf](http://www.cio.ca.gov/ITCouncil/Committees/PDFs/CEAP_principles_FINAL.pdf). November 8, 2006.

State of CT Architecture Team. (2000). *Enterprise Architecture Strategies: Conceptual Architecture Principles* [online]. Available from: <http://www.ct.gov/doi/LIB/doi/downloads/conarch.pdf>. November 7, 2006.

Stecher, P. (1993). Building business and application systems with the Retail Application Architecture. *IBM Systems Journal*, 32(2), 278-306.

- Sterk, A., Herwijnen, H. van. (1995). *Business information: guide to information sources in the Netherlands*. Den Haag: NBLC Uitgeverij.
- Szajna, B. (1996). Empirical Evaluation of the Revised Technology Acceptance Model. *Management Science*, 42(1), 85-92.
- Tallon, P.P., Kraemer, K.L., Gurbaxani, V. (2000). Executives' perceptions of the business value of information technology: A process-oriented approach. *Journal of Management Information Systems*, 16(4), 145-174.
- TBS (Treasury Board of Canada Secretariat). (2001). *Government of Canada, Federated Architecture, Iteration One* [online]. Available from: [http://www.tbs-sct.gc.ca/fap-paf/documents/iteration/iteration05\\_e.asp](http://www.tbs-sct.gc.ca/fap-paf/documents/iteration/iteration05_e.asp). November 3, 2006.
- The Open Group. *The Open Group Architecture Framework Version 8.1.1* [online]. Available from: <http://www.opengroup.org/architecture/togaf8-doc/arch/>. May 27, 2006.
- Thiadens, T. (2003). *Beheer van ICT-voorzieningen: Infrastructuren, applicaties en organisatie*. Schoonhoven: Academic Service.
- Tippins, M.J., Sohi, R.S. (2003). IT competency and firm performance: Is organizational learning a missing link? *Strategic Management Journal*, 24(8), 745-761.
- Tognazzini, B. (2003). *First Principles of Interaction Design* [online]. Available from: <http://www.asktog.com/basics/firstPrinciples.html>. October 29, 2006.
- Tractinsky, N. (2004). Toward the Study of Aesthetics in Information Technology. In *Proceedings of the 25th International Conference on Information Systems*.
- Tractinsky, N., Cokhavi, A., Kirschenbaum, M. (2004). Using Ratings and Response Latencies to Evaluate the Consistency of Immediate Aesthetic Perceptions of Web Pages. In *Proceedings of the Third Annual Workshop on HCI Research in MIS*, 40-44.
- Tractinsky, N., Katz, A.S., Ikar, D. (2000). What is beautiful is usable. *Interacting with Computers*, 13(2), 127-145.
- Tractinsky, N., Zmiri, D. (2004). Exploring Attributes of Skins as Potential Antecedents of Emotion in HCI. In *Aesthetic Computing* (ed. Fishwick, P.), s.l.: MIT Press (in press).
- U.S. Department of Education. (1999). IT ARCHITECTURE PRINCIPLES GUIDANCE [online]. Available from: [http://www.ed.gov/offices/OCIO/archived\\_information/downloads/prin.pdf](http://www.ed.gov/offices/OCIO/archived_information/downloads/prin.pdf). November 7, 2006.
- Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, 11(4), 342-365.
- Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), 425-478.

Vliet, M. van. Lecture *ERP-pakketten: een introductie SO4*. Nijmegen: Radboud University Nijmegen, October 25, 2005.

Wang, J., Lin, J. (2003). Are Personalization Systems Really Personal? -- Effects of Conformity in Reducing Information Overload. *36th Annual Hawaii International Conference on System Sciences (HICSS'03) - Track 7*, 222c.

Wastell, D.G., White, P., Kawalek, P. (1994). A methodology for business process redesign: experiences and issues. *Journal of Strategic Information Systems*, 3(1), 23-40.

WEAT (Wisconsin Enterprise Architecture Team). (2004). *Wisconsin Enterprise Architecture: EA Strategy and Principles* [online]. Available from: <http://weat.wi.gov/docview.asp?docid=1226&locid=9>. November 26, 2006.

Wheeler, E.F., Ganek, A.G. (1988). Introduction To Systems Application Architecture. *IBM Systems Journal*, 27(3), 250-263.

Wieringa, R.J., Blanken, H.M., Fokkinga, M.M., Grefen, P.W.P.J. (2003). Aligning Application Architecture to the Business Context. In *Proceedings of the 15th International Conference on Advanced Information System Engineering (CAiSE 2003)*, 209-225.

Willcocks, L.P. (2003). Managing information technology evaluation: techniques and processes. In *Strategic Information Management: Challenges and Strategies in Managing Information Systems* (eds. Galliers, R., Leidner, D.E.), Oxford: Butterworth-Heinemann, 239-259.

Xu, C., Hughes, J. (2005). Realizing the Open-Closed Principle. In *Proceedings of the Fourth Annual ACIS International Conference on Computer and Information Science (ICIS'05)*, 274-279.

Yesilada, Y., Stevens, R., Goble, C. (2003). A foundation for tool based mobility support for visually impaired web users. In *Proceedings of the 12th international conference on World Wide Web*, 422-430.

Zaphiris, P., Mtei, L. (1997). *Depth vs Breadth in the Arrangement of Web Links* [online]. Available from: <http://www.otal.umd.edu/SHORE/bs04>. November 5, 2006.

Zee, H. van der, Laagland, P., Hafkenscheid, B. (2000). *Architectuur als managementinstrument: Beheersing en besturing van complexiteit in het netwerkijdperk*. Den Haag: Ten Hagen Stam.

Zee, H. van der, Wijngaarden, P. van. (1999). *Strategic Sourcing and Partnerships: Challenging Scenarios for IT Alliances in the Network Era*. Amsterdam: Addison Wesley Longman.

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## Appendix A: Aesthetic measures

(Ngo, Teo and Byrne, 2003)

- Balance can be defined as the distribution of optical weight in a picture. Optical weight refers to the perception that some objects appear heavier than others. Larger objects are heavier, whereas small objects are lighter. Balance in screen design is achieved by providing an equal weight of screen elements, left and right, top and bottom.
- Equilibrium is a stabilisation, a midway centre of suspension. Equilibrium on a screen is accomplished through centring the layout itself. The centre of the layout coincides with that of the frame.
- Symmetry is axial duplication: a unit on one side of the centre line is exactly replicated on the other side. Vertical symmetry refers to the balanced arrangement of equivalent elements about a vertical axis, and horizontal symmetry about a horizontal axis. Radial symmetry consists of equivalent elements balanced about two or more axes that intersect at a central point.
- Sequence in design refers to the arrangement of objects in a layout in a way that facilitates the movement of the eye through the information displayed. Normally the eye, trained by reading, starts from the upper left and moves back and forth across the display to the lower right. Perceptual psychologists have found that certain things attract the eye. It moves from big objects to small objects.
- In screen design, similar aspect ratios promote cohesion. The term aspect ratio refers to the relationship of width to height. Typical paper sizes are higher than they are wide, while the opposite is true for typical VDU displays. Changing the aspect ratio of a visual field may affect eye movement patterns sufficiently to account for some of the performance differences. The aspect ratio of a visual field should stay the same during the scanning of a display.
- Unity is coherence, a totality of elements that is visually all one piece. With unity, the elements seem to belong together, to dovetail so completely that they are seen as one thing. Unity in screen design is achieved by using similar sizes and leaving less space between elements of a screen than the space left at the margins.
- Down through the ages, people and cultures have had preferred proportional relationships. What constitutes beauty in one culture is not necessarily considered the same by another culture, but some proportional shapes have stood the test of time and are found in abundance today. Marcus [3] describes the following shapes as aesthetically pleasing.
  - Square (1:1)
  - Square root of two (1:1.414)
  - Golden rectangle (1:1.618)
  - Square root of three (1:1.732)
  - Double square (1:2)

In screen design, aesthetically pleasing proportions should be considered for major components of the screen, including windows and groups of data and text.

- Simplicity is directness and singleness of form, a combination of elements that results in ease in comprehending the meaning of a pattern. Simplicity in screen design is achieved by optimising the number of elements on a screen and minimising the alignment points. Tullis [12] has derived a measure of screen complexity for text-based screens based on the work of Bonsiepe [25], who proposed a method of measuring the complexity of typographically

designed pages through the application of information theory. It involves counting the number of different rows or columns on the screen that are used as starting positions of alphanumeric data items. Information theory is then used to calculate the complexity of this arrangement of starting positions.

- Density is the extent to which the screen is covered with objects. Density is achieved by restricting screen density levels to an optimal percent. A measure of density, derived by Tullis [11], is the percentage of character positions on the entire frame containing data.
- Regularity is a uniformity of elements based on some principle or plan. Regularity in screen design is achieved by establishing standard and consistently spaced horizontal and vertical alignment points for screen elements, and minimising the alignment points.
- Economy is the careful and discreet use of display elements to get the message across as simple as possible. Economy is achieved by using as few sizes as possible.
- Entropy was developed in physics in the 19th century and was applied later in astronomy, chemistry and biology. Entropy influenced almost every science. We interpret the statistical entropy concept for screen design.
- Rhythm in design refers to regular patterns of changes in the elements. This order with variation helps to make the appearance exciting. Rhythm is accomplished through variation of arrangement, dimension, number and form of the elements. The extent to which rhythm is introduced into a group of elements depends on the complexity (number and dissimilarity of the elements).
- The measure of order is written as an aggregate of the above measures for a layout. The opposite pole on the continuum is complexity. The scale created may also be considered a scale of complexity, with extreme complexity at one end and minimal complexity (order) at the other.