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Preface

Communication is an essential aspect of human life, and the opportunities provided by information and communications technologies are unprecedented. Information in various forms can now be transmitted across space and time. Paradoxically, to cite Feenberg [FEE 04], a distance has been created between individuals, of "disposable experiences, that can be turned on or off like water from a faucet". Individuals have thus become services, made available to others via a technical system, which can be activated or deactivated at will.

Originally, the computer was not intended as a means of communication. The Internet was not intended to serve as a conduit for this communication, and information technology was not intended for anything other than the automatic processing of information. Nevertheless, computers have become ubiquitous: information technology is everywhere, in our jobs, televisions, watches, telephones and even in our health. The quantities of information involved, unimaginable in previous decades, are now treated using concepts such as Big Data. Computers play an important role in our private lives, and our private lives themselves have become computerized; with data located at distant and unidentified points, they are in the clouds due to the use of techniques such as cloud computing.

Man thus makes use of all available tools to fulfill the essential need for communication. The use of information and communications technologies should not obscure the substance of these exchanges: information. Information which was previously passed from one person to another through human interaction is now exchanged via computer protocols, which aim to optimize systems interoperability

without really considering human interaction; these interactions involve the exchange of much more than simple information. Information alone is simply a transcription, in the same way as a prehistoric painting on the wall of a cave, hieroglyphs on a papyrus or the neumes of Gregorian chant in a hymnal. Historians of today are constantly confronted with the challenges involved in interpreting this transcribed information (see Figure 1).

Figure 1. *Information can only become knowledge for you if it has a meaning for you. "King Ptolemy, the ever-living, beloved of Ptah, the god Epiphanes Eucharistos, most gracious lord": extract from the Rosetta Stone [FER 68, p.43]*

(source: National Library of France)

This book aims to be highlight the advantages offered by information and communication technology (ICT) both in terms of information exchange and ensuring that the correct meaning is transmitted, allowing beneficial interpretation and the creation of knowledge. Information systems thus become information and knowledge systems. Although an information system may be based on ICT, it cannot be reduced to these technological aspects: users themselves play a role, acting as system components in their own right. These users process, store and transmit information, bit this data has a meaning for them, something which does not occur in the case of technological artifacts.

Any attempt to limit information exchange to the framework of a digital information system using computer technology, to the exclusion of human contact, would most probably be seen as “totalitarian” within any organization [FEE 04, p.180]. However, the number and availability of technological devices, the ease of use and the social character they may acquire all lead to more direct, frequent and essential interaction between individuals and the digital information system. Moving beyond the information transmitted within an organization, this book introduces the concept of information and knowledge system, which highlights the role of knowledge and the part played by individuals as holders of this knowledge. To do this, a clear distinction should be made between “information” and “knowledge”; moreover, it is crucial to be aware of the fact that information can have different meanings, leading to the creation of different knowledge for different individuals.

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Introduction

An evolution, either in technology or in its use, can have a significant impact on affected organizations. For Tran *et al*. [TRA 13], the ability to differentiate between evolutions which “will take root within organizations, leading to change” and those which “are more ephemeral, or have a much lower potential impact” is a key factor in ensuring the success of any Chief Information Officer (CIO). This monitoring activity aims to direct investment in relation to a situation and a context, but cannot be reduced to technological evolutions, as use and the evolution of use should also be taken into account.

Information and communication technology (ICT) seems to evolve independently of organizational activities. It forms an important part of our daily and private lives, sometimes even to a greater extent than in our professional lives. Any technological innovation may generate new uses; these new uses may raise new legal concerns, although this aspect will not be considered in detail in this book. Over 20 years ago, Chambat [CHA 94], discussing new information and communications technologies (NICT)[1], noted that technical offerings do not necessarily respond to social demands, but can generate new demands and new uses. Even further back, in 1974, discussing the contemporary use of “invented machines”, Le Goff stated that:

> Men use the machines they invent while retaining the mentality they had before the invention of these machines [LEG 74].

Nowadays, in 2015, this remark is no longer truly relevant: the relationship between technological evolutions and changes in use has undergone a fundamental shift. While

the use was formerly presented as a hindrance to technological development, due to inertia [GUI 93], it now continues to evolve faster than organizations are able to adapt to new technologies. Use evolves in the wake of technological evolutions, but in advance of organizational evolutions; it is essential to be aware of this fact when considering the processing, storage and diffusion of information in an organizational information system. Information systems are intrinsically linked to digital technologies, a consideration that will be discussed further in Chapter 2.

Web 2.0 is an example of a technological evolution going hand in hand with evolutions in use. The term “Web 2.0” appeared for the first time in 1999 when Palm Inc. was developing the first personal organizer with integrated web browsing capacity:

> The Web we know now, which loads into a browser window in essentially static screenfuls, is only an embryo of the Web to come. The first glimmerings of Web 2.0 are beginning to appear, and we are just starting to see how that embryo might develop. […] The Web will be understood not as screenfuls of text and graphics but as a transport mechanism, the ether through which interactivity happens. […] The hardware will be different from device to device; compare the interface of the Palm Pilot with that of the Game-Boy, for instance [DIN 99].

Web 2.0 is dynamic in nature and designed for use with multiple devices. It is a means of producing interaction, and has been labeled as “the social Web”. This technological evolution led to changes in use; users are no longer content to simply consult Web pages in a browser (Figure I.1), but want to add their own content, whether from home, from their workplace or while traveling. This

content is information, which may be processed, stored and diffused through a digital information system (DIS). It can also be a source of knowledge, when interpreted by individuals who are able to give a meaning to the content. However, this content cannot be considered as knowledge in its own right.

Figure I.1. *Internet home page of the Paris Dauphine University in a) 1997 and b) 2014*

The domain of information systems will be discussed in Chapter 1. Chapter 2 will introduce the domain of knowledge management, while Chapter 3 is devoted to the information and knowledge system, using an example taken from a real company. Finally, the book concludes with a conclusion, offering perspectives for future developments.

1 No distinction will be made between ICT and NICT in this book.

1
Information Systems and Digital Technology

In this chapter, we will introduce the concept of information systems (IS), including a brief history of the domain. We will then define the concept of “digital” technology, and consider the role of IS and digital technology in a business context.

1.1. The concept of information systems

The concept of information systems (IS) includes two main aspects: first, the concrete organization which develops, innovates, communicates and records information, and second, the digital information system (DIS), an artificial, man-made object which makes use of the possibilities offered by information and communication technology (ICT) to acquire, process, store, transmit and render information in order to fulfill its role within the organization.

The key role of the DIS is thus to supply relevant information to each decision center, at all levels of the company hierarchy, for the purposes of monitoring, decision-making and innovation. In this way, the DIS is a crucial element in the decision-making process and in company operating and production processes; the DIS itself also interacts with these processes. The DIS is also a coordination tool. It plays an important role both at individual level, supplying information, i.e. representations used to solve problems in a decision-making process, and at collective level, transmitting shared representations throughout the organization.

According to Ermes-Groupe ESCP [ERM 94], “the information system of a company is the sub-system which contains all components of the company which interact through the provision of information. Its role is to provide information used to assist and monitor the operation of the business to all levels of the organization”. The IS defined in this way is not an exclusively computerized system, as a distinction is made between the organizational IS, covering activity associated with the operation of the IS, and the DIS, which only concerns computerized content [NAN 92]. For Le Moigne [LEM 90], “information systems serve to represent, memorize and allow access to representations (in symbolic form) of the operating system for the decision system”.

Definitions of some of the concepts used in this book will be given below. Systems science, also known as systemics, originated in the late 1970s. “Systemics is defined by a project rather than an object. Its roots lie mainly in systems theory, control theory and cybernetics” [NAN 92]. According to Le Moigne [LEM 77], the aim of systemics is “the modeling of complex perceived or conceived phenomena: the modeling of possible intentional interventions and their interconnected consequences for planning and forecasting purposes”. IS have their origins in the systemic modeling of organizations, of which they form one of the three components. Further details may be found in publications by Le Moigne [LEM 74, LEM 77, LEM 90], Nanci *et al.* [NAN 92] and Mélèse [MÉL 79], among others.

According to Le Moigne [LEM 74], an IS is the system linking the operating and control systems. The operating system is the system in which physical or intellectual transformation takes place, and the control system is that in which decisions are made, in terms of aims and available resources. The IS enables decision makers and operators to access the information they need for, respectively, the purposes of control and action.

For Reix [REI 90], “the information system of an organization is made up of a set of methods and procedures for seeking, inserting, classifying, memorizing, processing and

diffusing information. Its purpose is to supply this information in a directly useable form to different members of the company at the right moment, in order to facilitate correct operation and decision-making at various levels". Note that the processed information should provide assistance in decision-making, and sometimes in coordinating actions. The system needs to respond to requirements in terms of response time, relevance, accessibility, precision, cost and reliability of the information it provides. Information exchange occurs at different levels of command structures, and coordination issues may arise. Two types of coordination exist: "Vertical coordination, to avoid incoherency and conflict, and horizontal coordination, enabling users to work toward a shared objective, despite the division of labor. This coordination can either be carried out by mutual adjustment (direct information exchange) or by direct supervision" [REI 90].

For the purposes of this book, the following definition will be used, adapted from a definition given by the French *Commission Centrale des Marchés* (Central Contracts Commission, CCM [COM 90]):

> *An information system is a set of human, material and software resources, used by a user to carry out an activity within a given environment, which must be taken into account.*

An IS, as described above, is not necessarily computerized. The computerization of IS within organizations has led to a distinction being made between the organizational and technical aspects of these systems; the latter is referred to as the DIS. The difficulties encountered when designing a DIS lie in the separation of the two systems. The DIS forms part of the IS as a whole, and strong interactions exist between the two aspects. Churchman [CHU 71] established nine conditions used to define a system, which will be discussed below in the context of IS:

1) *An information system always has an aim,* that of providing necessary information to all levels in the management structure. How is this objective to be defined? How can necessary information be supplied to all levels? What is necessary information? These points are rarely specified in an IS, as analysts tend to focus on the solution to the problem rather than on the problem itself. In this book, we will attempt to follow the advice of Morin [MOR 77]), cited by Le Moigne [LEM 91], who stated that "we need to consider the system as a problem, rather than the system as a solution".

2) *The performance of an information system can be measured*. What is system performance, and how is this performance to be measured?

3) *An information system always needs to respond to the preferences of a user*. How are user preferences to be defined? What do these preferences mean? Which user is being considered? When identifying actors involved in an IS, the term "stakeholders" is generally used instead of considering individual users.

4) *An information system contains components which have their own objectives*. The objectives of information subsystems (components) are no easier to define than those of the IS itself.

5) *An information system operates in an environment*. The environment is rarely mentioned, and not often taken into account. Organizational aspects should be taken into account during system design.

6) *A digital information system must be paid for*. The buyers are rarely considered as stakeholders in the DIS design process, unless they also play a part in this process. It is important to give due consideration to the available resources when considering the functions to be fulfilled by a DIS.

7) *A Digital Information System has a designer*. The stakeholders involved in designing a DIS generally include an analyst (the designer) and a programmer. The way in which

these parties relate to the final users of the system is rarely specified.

8) *The aim in designing a Digital Information System is to achieve user satisfaction*. How is user satisfaction to be evaluated?

9) *A Digital Information System provides a way of verifying the feasibility of the designer's intentions*. How are the intentions of the DIS designer to be verified, and at what stage in the design process does verification occur? What verification procedures are to be used?

A certain number of key questions need to be answered: Who are the stakeholders? How do they interact with each other? What is being done (i.e. what problem is being tackled)? How is this to be carried out (how is the problem to be solved)? Where (in what organization)? What influence will this place or context have on the system? What part does this context play in the user/machine relationship?

In all the cases, decisions are made based on the information. "The true role of the information system is in providing the simplest and most appropriate form of support to users when reconsidering raw data, redefining useful and relevant information, and rebuilding decision models in order to make them more effective" [COU 93]. Information is as important in diagnosing problems as in choosing appropriate solutions. All information is intimately linked to the subject of study, and is contextual. "An object should always be designed with an eye on the larger context: a chair in a room, a room in a house, a house in a neighborhood, and a neighborhood in a town plan" (Eero Saarinen, cited in [INM 93]). Information treated in this way needs to be represented. In designing a DIS, the representation of all relevant information is one of the main issues at play. A solid structure is, therefore, needed for the DIS design process, including defined stages, from information acquisition to transformation, representation, treatment and interpretation.

The rapid changes which have taken place in ICT in recent times have led to reconsideration of the way in which DIS are designed. This evolution can be described through four major steps, from the appearance of the first computers in the 1950s up to the explosion of ICT at the start of the new millennium.

1.2. History of the concept of information systems

Following a brief summary of the role and functions of a DIS, we will consider the main turning points in DIS design, triggered by technological developments.

1.2.1. *The centralized processing stage (1950s–1960s)*

This stage was characterized by constant, relatively stable linear development. The information technology (IT) developed during this period enabled tools to be designed to improve productivity in scientific and administrative tasks. Applications were implemented by large calculation centers. This method, known as batch treatment, was functional, specific and non-real time. The period was characterized by the use of mainframes, centralized architectures and work stations. DIS were centralized, and corresponded to "process-oriented" design methods, such as the Warnier method and the structured programming method. These methods were influenced by the technological resources available at the time, which were based on the use of files. They took a functional approach to organization and used a top-down methodology, consisting of a hierarchical breakdown of problems into subproblems, mirroring the image of the organization. The development cycle for systems of this type followed a strictly sequential cascade model.

1.2.2. *The data decentralization stage (1970s–1990s)*