Introduction

Chapter 1
Introduction

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This chapter provides a general introduction to this book. As such, it also describes the context of the CrossWork project that is the main source of information for this book. This project is introduced in the next chapter. We start below with discussing the business conditions for the raise of the virtual enterprise as an organization form in the modern economy. As we focus on process-oriented virtual enterprises in this book, we continue with an overview of developments in business process support technologies. Then, we introduce a framework with four aspects that can be used in a combined demand pull and technology push context – this framework is used later to structure topics discussed. In the last section of this chapter, we explain the structure of the book.

1.1 Business Conditions for the Rise of the Virtual Enterprise

The differences between the business environment at the start of the twentieth and twenty-first centuries are staggering. Take the well-known example of Ford as one of the first mass-producers of automobiles, a company which operated then and is still in business today. The first affordable automobile Ford Model T was produced for 19 years (1908 till 1927), a comfortably long life cycle. In contrast, the best-selling car in the world for 2000 and 2001, Ford Focus Mk 1, was manufactured for 6 years, a three times shorter lifespan. A shorter product lifespan is complemented by an increase in product variability and complexity. Between 1915 and 1925, Ford Model T was only produced in a single colour – black, to speed up the production, whilst throughout its lifespan, Ford Focus Mk 1 had more than a dozen different engines, including a separate set of engines for the US market, 4 body styles with 14 trim levels, and 12 special editions. The level of competition on the marketplace has also changed beyond recognition. By 1918 half of all cars in the United States were Ford Model T, and the commercial success meant Ford was working to full capacity and did not spend any advertising money between 1917 and 1923. Today's

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environment is rather different – Ford Focus Mk1 competed in the same market sector with 25 different cars by other manufacturers. These trends also hold true for other sectors of the economy, for example the average cycle of pharmaceuticals is reduced from 25 years to 7 years [16], again roughly threefold. Market opportunities are also shrinking in duration, for example a specific financial service in the pension industry had a window of opportunity of 3 months to coincide with a quirk in tax laws and interest rates [11].

The ability to reconfigure the enterprise rapidly to meet changing market needs and demands is one of the six grand challenges identified by [6]. Figure 1.1 summarizes these trends in product life cycles and market dynamics and illustrates the tension created by their opposing forces. Indeed, the developments in information and communication technology, together with general advances of science and technology, are causing the appearance of products with ever-increasing complexity, which have shorter and shorter life cycles.

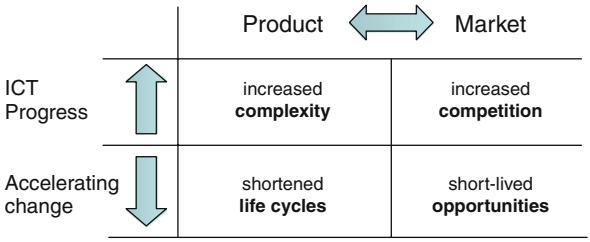

Fig. 1.1 Contemporary forces in product and market development

At the same time, advances in communications and socio-political developments mean organizations have to operate in increasingly competitive global markets which demand greater efficiency, developing complex products to address short-lived market opportunities. These pressures on resources and competences of individual companies have motivated an increased presence of *Virtual Enterprises* (VEs), where companies assemble forces to address a business opportunity. Once the opportunity is gone, so is the VE.

Figure 1.2 shows the life cycle stages of a VE [1] in relation to the lifespan of the business opportunity addressed by the VE. These stages are:

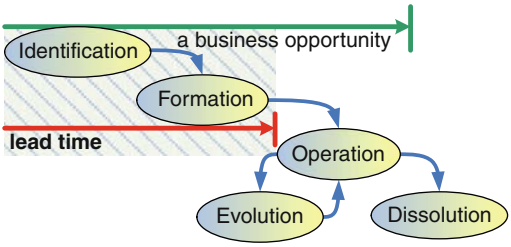

Fig. 1.2 Stages in the life cycle of a virtual enterprise pursuing a business opportunity

- *Identification*: This stage involves the identification, evaluation and selection of business opportunities that may be met by the formation of a VE.
- *Formation*: This stage involves partner identification, partner evaluation and selection and partnership formation, including the binding of the selected candidate partners into the actual VE.
- *Operation and Evolution*: This stage is characterized by the controlled integration of the services and resources offered by the VE partners in VE-wide collaborative processes, leading to the achievement of shared business objectives. Membership and structure of VEs may evolve over time in response to changes of objectives or to adapt to new opportunities in the business environment. Changes of VE context may necessitate contract amendment or adaptation of policy and business process enactment.
- *Dissolution*: This stage is initiated when the market opportunity is fulfilled or has ceased to exist. The major decision processes in the termination stage include operation termination and asset dispersal.

It is clear that the greater the lead time between the appearance of the business opportunity and the start of the operation of the VE, the greater the losses to earlier entrants on the marketplace or earlier bidders for the opportunity.

One industry where VEs have existed since the middle of the twentieth century is the film industry (or "Hollywood") [5] where actors and special-effect small and medium enterprises (SMEs) are joining forces to create a movie under the management of the producer and director. This project-based virtual organization model succeeded the vertically integrated large studios and is one of the earliest examples of VEs. A number of temporary formed organizations of individuals and enterprises, can of course also be found throughout Europe. The reasons for their existence range from investigating a challenging research topic to setting up a supply chain for producing the latest car. They are intrinsically linked with more permanent groupings, formal or informal, where members share interest in a specialist topic. These organizations can be either informal communities of practice or formally constituted organizations, like chambers of commerce. In relation to the virtual enterprises they play the role of Virtual Breeding Environments (VBEs), providing social and informational prerequisites for the formation of VEs.

To illustrate the difference between a VBE and a VE, let us take the example of the Automotive Clusters, or Networks of Automotive Excellence. Such organizations exist in many European countries, including Austria, Slovenia, Belgium, Hungary, etc. Their role is to support local communities of automotive suppliers, helping them bring their complementary skills and create VEs that successfully bid to develop major automotive subsystems such as engines or car doors for an automotive manufacturer such as Ford. The Automotive Clusters are playing the role of VBEs in relation to the VEs created within them.

Other examples of VBE as regional clusters seeking to facilitate project collaboration among their members are Swiss Microtech (SMT), ISOIN/Helice and Supply Network Shannon (SNS). SNS[1], for example, is an open network of

[1] http://www.snshannon.com

companies in the Shannon region of Ireland. It is established as a limited liability company. SNS has developed a framework for indigenous companies to collaborate in joint marketing, training development and quotation activities. SNS is a regional VBE with individual members currently creating subnetworks on a global scale. Federazione Regionale Ordini Ingegneri Pugliesi is a VBE focused on individuals rather than companies, and thus called a Professional Virtual Community (PVC). Its membership comprises the Apulian engineers, and it is established to facilitate collaboration among professionals and between professionals and SMEs in the concurrent engineering domain, again leading to project-based collaborations or virtual enterprises.

Moving to examples of VEs, one well-known example of a virtual enterprise in the high-tech industry is Airbus. Airbus consists of a number of autonomous parties that produce and assemble parts of airliners. Airbus was formed to counterbalance American forces in the airline industry. Note that Airbus is a rather stable VE; it has been in existence for a number of decades now, with a few different consortium configurations which evolved over time. An example of a VE with a much shorter lifespan (3 years) is the CrossWork project. CrossWork was organized in 2002 and 2003 in order to officially start in January 2004 as a European IST research project. It was running for 3 years and evolved over this time; individual persons came and left, as did enterprises. Dissolution was also a process that started in January 2007 and lasted for several months (till all reports and financial statements were delivered to the European Commission). Another example for such a temporary organization is ECOLEAD (European Collaborative networked Organizations LEADership initiative; for more information see http://www.ve-forum.org). ECOLEAD and CrossWork are both VEs which study the support and emergence of other VEs, used as examples in this book.

Today VEs exist in many industry and research sectors. An example in the *insurance industry* is the alliance[2] between the specialist online broker for health insurance, eHealthInsurance, and the general customer-facing financial services provider Countrywide Credit Industries, allowing Countrywide customers to shop for health insurance from a number of third-party providers via eHealthInsurance. In the *financial sector*, Special Purpose Vehicles[3] are tax-exempt companies formed for the specific purpose of buying off (or securitizing) a large pool of mortgage rights from a bank, which link together the bank, the mortgagees and its own investors in a complex financial instrument to ensure stability of the credit system.

A common feature linking the variety of VEs is that their work is often technology-mediated and geographically distributed. In a widely cited example, the Digital Media technology enables the distributed development of a new video clip for a chart-topping single. The recording session is located in London, where the singer lives, the design is done in San Francisco, the writers work from their homes (Paris and Barcelona) and the animation of the characters is outsourced to China.

[2] http://www.ehealthinsurance.com/content/pressNew/CountryWide.shtml

[3] http://en.wikipedia.org/wiki/Securitization_transaction

The global network and the interactive cycle of recording, writing and animation "around the clock" allow the recording of the clip to take place in a very short time, including repeated takes and rewrites.

An interesting interplay exists between VEs and supply chain arrangements. In the domain of the automotive manufacturing, for example, the large manufacturers are seeking to reduce the number of component suppliers they have to interact with. This has caused smaller companies to form VEs, which can deliver larger subsystems to the producer. This trend is reflected in several of the case studies covered by this book. The trends in product and market developments are highlighted in Fig. 1.1.

- *Developments on the product side*: Rapidly increasing product complexity is addressed by combining knowledge and skills of individual organizations in a VE. A tension is created between the increased difficulty in forming the right combinations of knowledge and skills, and the requirement to shorten the formation stage of a VE. The latter is motivated by shortening the overall product life cycles and business opportunity lifespans. Overall, a greater efficiency in forming and dismantling of VEs is needed.
- *Developments on the market side*: Market dynamics requires effectiveness in the selection of members in VEs. Currently, partners are selected from static "acquaintance" networks. Effectiveness, however, demands a more open and dynamic manner of finding the right organizations with the right skills at the point of need. Increasing competition, on the other hand, requires high speed in setup and deployment of VEs, and their efficient management.

In an environment of increased competition and reduced life cycles for increasingly complex products, we need to find ways to effectively and efficiently compose a VE and to coordinate its operations and processes. Manufacturing is an excellent example sector but not the only one where such developments are badly needed.

1.2 Developments in Business Process Support Technologies

Management of business processes is currently supported by a number of technological developments. Below, we briefly discuss three important areas of development – workflow management (which we use as a synonym for business process management in this book), agent technology and service-oriented computing. In the following chapters of this book, we revisit these areas.

Workflow Management (WFM) technology has been around since the early nineties of the previous century and has been receiving ample attention in both industry and research. A number of general purpose WFM systems are on the market and WFM technology has been integrated into enterprise information

systems, such as Enterprise Resource Planning (ERP) systems. Much of the existing WFM technology, however, focuses on intra-organizational workflows, assuming a possibly distributed, but homogeneous WFM system in a trusted environment, i.e. in the context of a single organization. When WFM is extended across organizational boundaries, the complexity is heavily increased. Early developments in the area of inter-organizational WFM have targeted the cooperation between organizations specified at process definition time. An example is the WISE project [3], which aimed at providing a software platform for process-based business-to-business electronic commerce, focusing on support for networks of SMEs. WISE relies on a central workflow engine to control inter-organizational processes (called virtual business processes). In the approach presented by WISE, a virtual business process consists of a number of black-box services linked in a workflow process. Slightly more recent, there are developments towards the dynamic integration of business processes in a workflow-based service outsourcing paradigm. An advanced approach has been developed in the CrossFlow project [7]. The CrossFlow approach uses a proprietary contract specification language to specify business relationships in two-party, dynamic virtual enterprises. A dedicated Java-based collaboration layer is used for support of dynamic business process outsourcing on top of standard workflow management software.

Agent Technology is a comparatively recent and very active field of research which has roots in general artificial intelligence research. The key idea behind agent-based technology is to form systems from communities of independently reasoning, goal-driven agents who communicate using natural language like constructs. Crucially, an agent will only take a particular action when it judges it to be in its best interests to do so. This basic structure makes multi-agent technology well suited to building systems containing multiple self-interested components. A further feature of multi-agent system is the extensive use of negotiation to enable the agents to reach mutually agreeable outcomes. This combination of features means that multi-agent systems are able to represent the interests of every company through individual agents. This is highly suitable for supporting the formation of virtual organizations [4, 15], for coordinating the work of business partners in a supply chain [12] and for controlling the scheduling and execution of detailed workflow processes [13, 14]. Agent standards are fairly mature and FIPA (http://www.fipa.org) has recently been adopted as an official standards committee of the IEEE.

Service-Oriented Computing (SOC) is a relatively new computing paradigm that promises flexible, dynamic, component-oriented interoperability between encapsulated business functionalities of autonomous organizations, called services. The functionality of a service can be quite diverse, depending on the application domain, from very simple (e.g. the functionality to convert an amount of money from one currency to another), to very complex (e.g. the functionality to invoke complex business applications). SOC as a concept is usually closely linked to Web Services as a technology. The Web Service paradigm allows the dynamic composition of application functionality using the Web as a medium [2]. A Web Service is an encapsulated piece of software functionality with a well-defined interface that is made available on the Web. Web Service technology is based on a stack of standards. The basis of

the stack is typically formed by HTTP as a basic communication protocol, XML as a basic language and Simple Object Access Protocol (SOAP) as an interaction protocol on top of these two. On top of SOAP, we see languages for service interface definition (Web Service Description Language (WSDL)) and service composition (Business Process Execution Language (BPEL)). Again on top of that, there are protocols for collaboration and transaction management. Further, there are standards for various aspects of collaboration, examples of which are brokering, service level (agreement) management, and security. Recently, there are developments to integrate SOC and explicit inter-organizational process management (e.g. [8, 10]).

Current technology developments make it possible to provide software support for near-automatic formation and coordination of virtual enterprises.

1.3 Demand Pull and Technology Push

In the domain of automated support for VEs, we see a combination of demand pull and technology push forces, which when combined enable fast developments. To analyze this domain and design a system for it in a well-structured manner, we distinguish four aspects to describe a VE e-business scenario. These aspects together form the BOAT framework [9]:

- *Business (B):* the business aspect describes the business goals of e-business, or the economic model behind its existence. As such, it answers the question of why a specific e-business scenario exists or should exist or what should be reached. Topics can include leverage of efficiency levels, access to new markets, reorientation of interaction with customers, etc. How things are conducted is not of interest in this aspect.
- *Organization (O):* the organization aspect describes how organizations are structured to achieve the goals defined in the B aspect. Organizational structures and business processes are the main ingredients here. Automated systems are not yet in scope at this aspect.
- *Architecture (A):* the architecture aspect covers the conceptual structure (architecture) of automated information systems required to make the organizations defined in the O aspect work. As such, it describes how automated systems support the involved organizations.
- *Technology (T):* the technology aspect describes the technological realization of the systems of which the architecture is specified in the A aspect. The T aspect covers the concrete ingredients from information and communication technology, including languages and protocols, software and (if relevant) hardware.

In traditional information system design practice, analysis and development of systems proceeds in a linear manner from the business to the technology side (also

referred to as the waterfall model of system design). In the BOAT framework, this would mean starting from the B aspect and working stepwise to the T aspect, where each preceding aspect defines the requirements that must be fulfilled at the succeeding aspect. This leads to a design process as depicted in the left hand side of Fig. 1.3 which we call the stack model for BOAT.

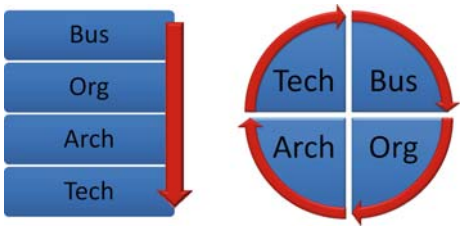

Fig. 1.3 Stack and wheel models of BOAT

In the e-business field, the relation between business and technology is not so linear; business "pulls" technology development by stating new requirements, whilst technology "pushes" business by offering new opportunities. To model this, we need to organize the BOAT aspects such that we get a more cyclical dependency between the aspects.

This results in the picture shown in the right hand side of Fig. 1.3, which we call the "wheel model" for BOAT. With the wheel model, we can make two important observations. Firstly, a development process can, in principle, start at each aspect of the model (although B and T aspects may be most common). A new organization structure in the O aspect, for example, may be the trigger for a new e-business scenario. Secondly, the wheel model suggests a cyclical process: An e-business development process does not end after one cycle around the wheel, but is rather a continuous process of adjustment to new business and technology contexts.

The complexity of automated VE support requires a framework to distinguish the various aspects. The BOAT framework provides the Business, Organization, Architecture and Technology aspects for this purpose.

1.4 Structure of this Book

To provide an easy overview for the reader, this book in organized in five parts, of which you are currently reading the first. Each part contains a number of chapters.

Part I provides the introduction to the book and the European research project on which its contents are mainly based. The current chapter covers the introduction. The next chapter in this part introduces the notion of an "Instant" VE as a target for the research in automated support for VEs, and introduces several influential efforts in this dimension, including details of the CrossWork project. The chapter explains the goals of this project and places it against the background of related work. Parts

II and III of the book present the ingredients of the CrossWork approach, following the BOAT framework outlined in the previous subsection.

Part II discusses the conceptual side of the approach described in this book. It covers the business, organization and architecture aspects of the BOAT framework – each aspect in one chapter. As such, it goes in three chapters from the business goals to the structural blueprint of the means, which will be made concrete in the next part.

Part III discusses the technical side of the approach, covering the technology aspect of the BOAT framework. The chapter structure of Part III is based on the main architectural clusters of the architecture described in Part II. Five chapters describe the information technology used for the realization of the five main clusters in the architecture.

Part IV presents the real-world case studies that have been conducted in the CrossWork project. These case studies show how the concepts and technology described in Parts II and III are actually deployed in the context of the automotive industry. To embed the CrossWork approach in a broader context, we also briefly present approaches and results of related research efforts here.

Part V concludes the book. Its first chapter gives an overview of the main observations with respect to the concepts and technology covered in this book. Its second chapter provides a look into future developments. Finally, a bibliography detailing the references found throughout the book is presented.

This introductory chapter has shown that

- We need to find ways to effectively and efficiently compose a VE and to coordinate its operations and processes.
- Manufacturing is an excellent example of a business sector for VEs, but not the only possible one.
- Current technology developments make it possible to provide software support for near-automatic formation and coordination of VEs.
- The BOAT framework illustrates the interplay between business and technology considerations underpinning this book.

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