E-Enabled Operations Management

Jean-Pierre Briffaut







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Contents

PREFACE	xiii
PART 1. MODELING OF BUSINESS STRUCTURES	1
CHAPTER 1. SYSTEM APPROACH TO BUSINESS OPERATIONS AND	2
INFORMATION ENGINEERING	3
1.1. System approach to conduct business operations	3
1.1.1. General considerations	3
1.1.2. System description	4
1.2. Information engineering	6
1.2.1. Information as a resource	6
1.2.2. Explicit and implicit information.	6
1.2.3. Clarification of some terms	7
1.2.4. Characteristics of information systems	7
1.2.5. Information system content for a	
manufacturing company	8
1.3. System approach to describing	
inventory-controlled storage	8
CHADTED 2 RUSINESS MODELING BY PROCESS AND	
MANAGEMENT APPLICATIONS.	13
2.1. Process definition and control	13
2.1.1. Definition	13
2.1.2. Process control mechanisms	14
2.2. Process modeling in perspective	15
2.2.1. General considerations	15

2.2.2. Management applications 17 2.3. Management by process 19 2.3.1. Activity-based costing and budgeting of products/services 20 2.3.2. Activity-based management 28 2.3.3. Information system: relationships between processes, activities and data 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW 33 3.1. Organizational structure as a blueprint for information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business function model 39
2.3. Management by process 19 2.3.1. Activity-based costing and budgeting of 20 products/services 20 2.3.2. Activity-based management. 28 2.3.3. Information system: relationships between 26 processes, activities and data 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
2.3.1. Activity-based costing and budgeting of products/services 20 2.3.2. Activity-based management. 28 2.3.3. Information system: relationships between processes, activities and data 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
products/services202.3.2. Activity-based management.282.3.3. Information system: relationships between processes, activities and data30CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW MODELS, ORGANIZATION MODELS, FUNCTION MODELS333.1. Organizational structure as a blueprint for information systems333.2. Business models363.2.1. Definitions363.2.2. Examples of business models383.2.3. Example of business function model39
2.3.2. Activity-based management. 28 2.3.3. Information system: relationships between processes, activities and data 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
2.3.3. Information system: relationships between 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW 33 MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
processes, activities and data 30 CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW 33 MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for 33 information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
CHAPTER 3. BUSINESS MODELS: CONTROL MODELS, FLOW MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for 33 information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
MODELS, ORGANIZATION MODELS, FUNCTION MODELS 33 3.1. Organizational structure as a blueprint for 33 information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
3.1. Organizational structure as a blueprint for information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
information systems 33 3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
3.2. Business models 36 3.2.1. Definitions 36 3.2.2. Examples of business models 38 3.2.3. Example of business function model 39
3.2.1. Definitions363.2.2. Examples of business models383.2.3. Example of business function model39
3.2.2. Examples of business models. 38 3.2.3. Example of business function model 39
3.2.3. Example of business function model
3.2.4. Examples of business flow model
3.3. Aris-toolset: a software-toolset: a software
package for business modeling
3.3.1. Introduction
3.3.2. Logic connectors in event-driven processes
3.3.3. Exercises
3.4. Supply-chain operations reference modeling
3.4.1. Introduction
3.4.2. What is a process reference model? 50
3.4.3. Model scope and structure. 52
3.4.4. Applying the reference model to configurability 54
PART 2. MANAGERIAL CONCEPTS AND SOFTWARE
PACKAGES IN PERSPECTIVE
CHAPTER 4. FROM MATERIALS REQUIREMENT PLANNING (MRP) TO
ENTERPRISE RESOURCE PLANNING (ERP) CONCEPTS AND
THE ASSOCIATED SOFTWARE PACKAGES
(PICS AND COPICS OF IBM TO ERP-LABELED PACKAGES) 59
4.1. From MRP to ERP concepts 59
4.1.1. Overview of the evolution of management thinking
4.1.2. Correlation between management thinking and DBMS 63
4.1.3. Styles of manufacturing

4.2. Inventory control system	65
4.2.1. Basic model: reorder quantity	65
4.2.2. Basic model: lead time and threshold stock	67
4.2.3. Generalization of the basic model	68
4.2.4. Probabilistic situation: service levels and safety stock	69
4.2.5. Delivering into stock over time: economic	
manufacturing quantity (EMQ)	72
4.3. Manufacturing resource planning.	76
4.3.1. Defining planning and scheduling	76
4.3.2. General description of the MRP technique	76
4.3.3. MRP-related concepts in action	80
4.3.4. Implementation of MRP-related concepts in the	
maintenance field.	88
4.4. The just-in-time concept	93
4.4.1. Introduction	93
4.4.2. Core features of the just-in-time concept	94
4.4.3. JIT and inventory management.	96
4.4.4. JIT and resources capacities	97
4.4.5. JIT and kanban	99
4.5. Customer order decoupling point	102
4.5.1. Description	102
4.5.2. Deploying an MPS within a CODP context	103
4.6. Contrasting the various control concepts	104
CHAPTER 5. SPECIFIC FEATURES OF ERP PACKAGES	107
5.1. Featuring ERP philosophy of software packages.	107
5.2. ERP-tagged software packages for managing business	
processes available in the marketplace	108
5.3. Function capabilities of the SAP CRM package	108
5.3.1. Why CRM?	108
5.3.2. Function capabilities of CRM	
software systems	110
5.4. Reference control model of a	
manufacturing firm	111
5.5. Finance reference control model	120

PART 3. BEYOND ERP PACKAGES: THE E-Enabled Enterprise	23
CHAPTER 6. CHANGE IN BUSINESS PROCESSES INDUCED BY E-Commerce and E-Business	125
6.1. General considerations for approaching the digital economy 1	25
6.2. Change in business structures	27
6.3. Microeconomic approach to the digital economy 1	30
6.4. E-commerce	32
6.4.1. Distinction between e-commerce and e-business	32
6.4.2. E-commerce from different perspectives	33
6.4.3. Business models for e-commerce exchanges	35
6.5. Changes in business processes induced by e-enabled business operations.	135
6.5.1. Dell business model and its evolution	36
6.5.2. Bricks-and-mortar model	38
6.5.3. Virtual firm model	39
6.6. Online auction process	40
6.6.1. Introduction	40
6.6.2. Online auction process in a high-tech manufacturing	
company	40
6.6.3. Description of the market place COVISINT	43
6.6.4. Exercise	44
6.7. E-commerce, sales chains and ROI	49
6.7.1. General setting 1	49
6.7.2. ROI of e-commerce in sales chains	52
CHAPTER 7 CONTROL PARAMETERS FOR FF.NARLED	
SUPPLY CHAIN	155
7.1. Collaborative planning, forecasting and replenishment	55
7.2. Control parameters for e-enabled supply chain	157
7.2.1. Master production schedule	58
7.2.2. Projected available balance (PAB) 1	59
7.2.3. Available to promise (ATP) 1	159
7.3. The bullwhip effect	60
7.3.1. The model	61

CHAPTER 8. INTEGRATION OF ERP PROCESSES WITH E-COMMERCE AND E-BUSINESS PATTERNS	163
8.1. Information system architecture and business processes	163
8.1.1. What is a layer architecture?	163
8.1.2. What is a layer architecture describing a business?	164
8.1.3. Developing a layer architecture	165
8.1.4. Relations between different layers	166
8.1.5. Relations between different subsystems inside a layer	167
8.2. Business workflows and information system architecture	168
8.3. Integration of ERP processes with e-commerce	
and e-business	169
CHAPTER 9. ROLES OF INFORMATION TECHNOLOGIES FOR	
MAKING BUSINESS MODELS FLEXIBLE	175
9.1. Information technologies: engine of change	175
9.1.1. CAD/CAM	176
9.1.2. Quality of service and speed of delivery	176
9.1.3. Virtual organizations	176
9.2. Approach to the specific functions of virtual	
collaborative context	177
9.3. Applications of portals	181
9.3.1. How portals impact business organizations	181
9.3.2. Portals and negotiations in business life	181
9.3.3. Scenario of a collaborative e-enabled working environment	
in the fashion-sensitive textile sector	184
9.3.4. Example of a collaborative design environment.	191
9.3.5. Benefits of electronic negotiations.	193
PART 4. CRITICAL BUSINESS FUNCTIONS FOR E-ENABLED OPERATIONS MANAGEMENT	197
CHAPTER 10. LOGISTICS	199
10.1. Logistics in perspective	199
10.1.1. Overview	199
10.1.2. Components of logistics	200
10.1.3. Logistics and the digital economy	201
10.2. Logistics and hierarchical layers of management	
within the framework of supply chain management.	203

10.2.1. General context	203
10.2.2. Promotion of logistics strategy by Toshiba of Japan	205
10.3. Information system for e-logistics.	206
10.3.1. Introduction	206
10.3.2. Goods movement control system and its	
components from the customer side	208
10.3.3. Goods movement control system and its components	
from the provisioning side	211
10.3.4. Electronic data interchange	214
10.4. Logistics flow process management:	
logistics performance indicators	224
10.4.1. Definition	224
10.4.2. Logistics key indicators	224
10.4.3. Definitions of logistics key indicators	226
10.5. Location analysis of warehouses and transportation	227
10.5.1. Transportation method	228
10.5.2. Procedure of the transportation method	229
10.5.3. Stepping-stone method	229
10.5.4. VAM method	230
10.5.5. Problem setting	231
10.5.6. Solution with the northwest corner rule and the	
stepping-stone method.	232
10.6. Reverse logistics: cash from trash and	
environmental issues	235
CHAPTER 11. SOURCING AND PHYSICAL DISTRIBUTION	237
11.1. Sourcing policy	237
11.1.1 Dure market ontion	237
11.1.2 Controlled competition ontion	237
11.1.2. Controlled competition option	230
11.1.5. Vertical integration option.	238
in relation to husiness strategy and types of products	230
11.2 Physical distribution policy	239
11.2.1 Application policy	243
11.2.1. Objectives and constraints	243
11.2.2. Various patients of physical distribution	244
11.2.5. Choice of a physical distribution option.	240

CHAPTER 12. QUANTITATIVE QUALITY MANAGEMENT	247
12.1. ISO 9000 standards: impact upon business operations	247
12.2. Acceptance testing	248
12.3. Operating characteristic curve	248
12.4. Average outgoing quality	252
12.5. Terms used in an acceptance plan for attributes	255
PART 5. CASE STUDIES.	257
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY	259
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY	259 259
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY 13.1. Hellas Corporation case study 13.2. The e-enabled car industry	259 259 263
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY 13.1. Hellas Corporation case study 13.2. The e-enabled car industry 13.2.1. Introduction	259 259 263 263
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY 13.1. Hellas Corporation case study 13.2. The e-enabled car industry 13.2.1. Introduction 13.2.2. Assignment.	259 259 263 263 264
CHAPTER 13. CASE STUDIES: HELLAS CORPORATION AND THE E-ENABLED CAR INDUSTRY 13.1. Hellas Corporation case study 13.2. The e-enabled car industry 13.2.1. Introduction 13.2.2. Assignment. 13.2.3. Car manufacturing	259 259 263 263 264 264

Preface

Although the theory of operations management has been presented in many textbooks published over the last two decades, the subject of e-enabled operations management is rather short on literature which is easily accessible to students. When they want to gain some understanding of what it is all about, students are obliged to search journals and select papers from a large number of books. Even then they will find it difficult to arrive at a uniform view of the matter.

The objective of this book is to expound the subject at an "intermediate" level. By "intermediate", it is not assumed that students are specialists in mathematics and statistics, but it is supposed they have a working knowledge of calculus, algebra, probability and statistics.

The approach to operations management described in this book is unusual with respect to what is found in standard textbooks. Information and communication technologies (ICTs) impact the ways firms are organized and managed, and, as a result, change the practical means used to conduct business operations.

The features of this book are threefold.

- system approach to business modeling

Business activities, controlling functions and associated information systems are described within a coherent analytical system framework enabling a clear understanding of the various current control and costing concepts. Operations costing is not usually included in textbooks as part of operations management, but it should be. Cost targeting has become an integral part of good practice of business management.

- validity of models

Apparently simple models are analyzed in detail. Students must be completely aware of the assumptions made when models are formulated and of their conditions of validity. Applying a model automatically implies that assumptions of a particular type are taken for granted.

- logistics, procurement and quality management

These three business functions are critical key success factors for managing e-enabled supply chains from suppliers to customers. That is why their main tools are introduced in this book.

> Jean-Pierre BRIFFAUT May 2015

Part 1

Modeling of Business Structures

System Approach to Business Operations and Information Engineering

1.1. System approach to conduct business operations

1.1.1. General considerations

The system approach is instrumental in tackling complexity in the managerial as well as technical worlds. The system concept is a modeling tool based on interacting entities. Its purpose is to understand complex structures by (de)composing them into entities having specific functions and interacting with each other.

The "composition" approach is implemented when designing a real or virtual object. The "decomposition" approach is implemented when analyzing some existing part of the world.

In both approaches, systems are constructed with a view to identifying certain function capabilities perceived by the users to be desirable. Examples of function-based systems include: defending the country, transmitting messages, transporting people and goods, manufacturing goods, exchanging products and services, etc.

In general, users are known not to be able to articulate all their requirements and expectations. Therefore, at the planning stage, there always exists a considerable uncertainty about many aspects of the system to be built, or, in other words, the system behavior. That explains why prototypes have to be built for checking whether the users' requirements are adequately fulfilled.

Systems do not exist in isolation. Each operates within a definite environment. But the ways a system interacts with its environment may prove to be of a wide variety. In other words, how and when some types of interaction take place have to be ascribed to uncertain or random events. As a result in certain circumstances, the system behavior can run out of control. These circumstances refer to events or sequences of events which have not been taken into account at the design stage of the system.

1.1.2. System description

Describing a system implies:

- describing its constituent entities as attributes;
- describing the inter-entity relationships;
- describing the relationships between entities and the environment.

Each entity can be a system in itself.

When a business unit is described as a system, the purpose is to control its business operations. Three entities have to be identified, i.e. the controlled system, the controlling system and the information system (IS). The controlled system, often called the transformation system, because it converts inputs into outputs, is modeled generally as a process. The relationships between these three entities are shown in Figure 1.1.

It is noteworthy to elaborate on Figure 1.1 for understanding the features of the system approach to business description. What is meant by direct and indirect control? Direct control refers to the direct action on the controlled process to maintain or change its state. Indirect control resorts to some entity external to the system for influencing the state of the controlled process by means of inputs.

Let us take an example to explain how the messages exchanged between the entities involved are articulated and how their contents trigger decisions. The controlled process is assumed to be a manufacturing process made of storage and production activities. A message coming from the market place (environment data) is captured and processed by the IS. The message content says that a market slump is forecast. It is directed to the production scheduler in an appropriate format (control data). As a consequence, the scheduler decides to reduce the production level by releasing orders to the manufacturing shops (direct control) on the basis of inventory levels (process data) and to send orders to suppliers to decrease the number of deliveries (indirect control).



CS = Controlling System

Figure 1.1. Relationships between the various entities of a business unit within the framework of a system approach

Describing any business organization as a system means: – identifying and modeling the system to be controlled (WHAT); - identifying decision-making functions (WHO) and defining management rules (HOW);

- producing the IS requirement.

1.2. Information engineering

1.2.1. Information as a resource

Central to any human activity is the process of *decision-making*, i.e.:

defining a goal;

- identifying a number of alternative *actions* which may lead to the goal;
- evaluating the consequences of each action;
- selecting the action which is most likely to lead to the desired goal.

The decision maker, in general, faces uncertainty mainly about the results of the envisaged action. Decisions vary in uncertainty associated with their outcomes. The greater the uncertainty, the greater the risk of a negative outcome. This uncertainty can be reduced or even completely removed by obtaining the relevant information about the courses of action in progress. It follows that information is defined as a resource by means of which uncertainty is reduced.

For large systems, as a rule, a part of the required information on the behavior of system environment becomes available only after the system has been put in operation. For this reason, there is a need for incorporating a control function of a sort into the very system. The role of control is to make decisions on the system behavior effective. When some deviation from the set goals is detected corrective control action is engineered to reach the set goals.

1.2.2. Explicit and implicit information

Information may be explicit or implicit. Implicit information or knowhow is that piece of information which is an integral part of skill and can be gained only by apprenticeship from an expert. The term "expert" is used here to denote a person who knows how to perform an activity without necessarily understanding why his/her methods work. In contrast, explicit information or know-how exists independently from any skill. It can be readily represented, stored and made available for general use.

1.2.3. Clarification of some terms

The body of knowledge, methods and established practices related to the handling of information as well as the associated devices will be called *information technology*. Systems of artifacts, the purpose of which is to handle information will be called here *information systems*. The engineering discipline concerned with the design, production, installation, operation and maintenance of ISs will be called *information engineering*.

1.2.4. Characteristics of information systems

It is quite clear that no organization could operate without some type of IS. The main functional capabilities an IS must fulfill are:

- capturing data;
- processing data;
- memorizing data.

These are followed in order to support the decision makers to conduct business operations.

- Contents of an information system

Even if users are not aware of this fact, IS designers posit that ISs are a modeled vision of the business universe. Whatever the assumptions made about the chosen representation of the business universe, IS constructs reflect how the enterprise is organized and operates. It implies that business information systems contain, in a way or another, a description of the enterprise's organizational structures, functioning mechanisms and deliverables. The contents of business information system include:

- static properties of operations and controls;
- description of deliverables (products or services);
- dynamic behavior of operations.

Several types of ISs are considered in businesses.

- Transaction processing systems

A transaction is a business operation modifying the state of the enterprise. Whenever a transaction occurs, data describing the transaction is created. Capturing, storing, processing, distributing and reporting of transaction data is the objective of transaction processing systems.

Let us consider an example. When a client places an order, an order form is created where the order content is described in terms of items, quantities and delivery dates and payment conditions. This order triggers updating of the inventory, sending an invoice, launching the manufacturing of new items, recording provisional income in the balance sheet, etc.

Somehow transaction processing systems are the front office of management information systems (MISs)

- Management information systems

MISs must give a relevant, accurate, significant and updated image of business activities and incoming and outcoming goods flows. Today, this is achieved by means of artifacts (software programs and databases) modeling the activities and goods flows involved.

1.2.5. Information system content for a manufacturing company

The IS content comprises the models representing the business from different points of view (processes/functions/organization). As an example, the products/services delivered, the control pattern and the infrastructure can be modeled for a manufacturing company as shown in Figure 1.2.

1.3. System approach to describing inventory-controlled storage

Storage is a buffer activity decoupling inflows of materials from outflows. Materials consist of raw materials, finished products, goods in progress and any type of supplies held by business firms. Inflows and outflows are usually controlled by different business functions.



Figure 1.2. Content of an information system for a manufacturing company

Despite costs incurred when holding stocks, multiple motives to carry inventories justify their presence in businesses.

- Cover of stockout situations

If suppliers are not reliable, buffer stocks facilitate clients to be provided with the materials they require on time. In other words, it ensures a chosen service level of deliveries to clients. At the same time, if demand is stochastic it gives the possibility of sustained deliveries to clients over a period of time within limits derived from the chosen service level.

– Economies of scale in supply

When orders of large quantity are placed, reduced prices are obtained (quantity discount) and some fixed costs (transportation, ordering costs) are portioned out to a larger quantity reducing the unit cost as a consequence.

Consider a storage activity receiving raw materials from suppliers and dispatching them to manufacturing shops when called off.

– Identify the sequence of activities from suppliers to the manufacturing shops.

- Identify the controlling functions.

- Describe the requirements of the associated information system.

The safest procedure to identify the sequence of activities involved is to follow the goods flow from suppliers to clients (here the manufacturing shops). In this case under consideration, three sequenced activities are identified, i.e. receiving, storage and distribution to manufacturing shops.

The controlling functions are found by answering this question: who triggers the activities? The receiving unit becomes active because the procurement function has released delivery orders to suppliers. The distribution unit becomes active when the manufacturing scheduler releases requisition lists of materials to be picked up from storage and delivered to the manufacturing shops.

It is worth noticing that inflows of materials are controlled by the procurement function whereas outflows are controlled by the production scheduling function. This feature stresses the decoupling role of storage.

Inflow and outflow transactions have to be recorded by the IS so that the on-hand inventory for each material is known at every moment. It is assumed that inflows are controlled with the inventory control system (ICS) concept. When the on-hand inventory level comes to a threshold, a replenishment order is released. The reorder level depends on the replenishment lead time and the depletion rate. In fact, it is the demand size during lead time.

The whole system is described in Figure 1.3.



Figure 1.3. System description of an inventory-controlled storage

Business Modeling by Process and Management Applications

2.1. Process definition and control

2.1.1. Definition

Process has a Latin origin "processus" meaning "having progressed". It strongly connotes the dynamics of tasks. It was widely used to describe non-stop manufacturing industries such as steel mills, glass mills, oil refineries, etc.

The use of this wording in the management arena is now widespread. In order to avoid any misunderstanding, definitions have been given by standardization bodies or other institutions and will be commented on hereafter.

A process is a set of means and activities converting input into output (ISO 8402 and 9004).

A definition was given by IBM in an in-house journal of IBM research center at La Gaude/France in 1987 and provides a telling insight. It can be summarized as follows.