

# Enterprise Modeling and Integration: Principles and Applications

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Several factors such as globalisation of markets and production, shifts in competition criteria (from "cost" to "quality" and "time"), evolution of human factors (operators and clients), new manufacturing technologies, advances and integration of the enabling technologies of computers and communications, have shaped the modern enterprise during the last decades. One of the most significant evolutions is the trend for "intra enterprise" (and more recently) "inter enterprise" integration. A lot of efforts have lately been made by academia, industry people, professional associations and standardisation bodies to produce conceptual frameworks, methodologies, commercial support tools and standards for enterprise integration. In this context, the author makes important strands towards a new discipline, namely "enterprise engineering". This is defined in the book (on page 30) as "the art of understanding, defining, specifying, analysing and implementing business processes for the enterprise entire life cycle, so that the enterprise can achieve its objectives, be cost-effective, and be more competitive in its market environment". It is placed by the author "at the crossroad of many disciplines concerned with the design, re-engineering and continuous improvement of business processes of manufacturing enterprises (logistics, system engineering, information system engineering, software engineering, computer communication engineering)".

The main themes of the enterprise engineering this book analyses are a) the "enterprise modeling" and b) the "enterprise integration" support offered by information and communication technologies.

The main body of this book is composed of three Parts and a conclusion Section.

**Part one** titled "Basic principles" is actually an introduction to enterprise modelling and integration and consists of two chapters.

**Chapter 1** describes the business context, introduces basic ideas and terminology, reviews previous works, and states the purpose of the book and the method used in producing it.

**Chapter 2** reviews and compares several well-known particular reference architectures for enterprise representation and integration such as PERA, produced at Purdue University, GIM, developed at Université de Bordeaux, ARIS, developed at Saarbrücken Universität. The international co-operation results such as the Reference model of ISO Technical Committee 184, Sub-committee 5, Working Group 1, CIMOSA of the European consortium AMICE, the European pre-standard ENV 40 003 "Framework for Enterprise Modelling" of the European Committee for Normalisation (CEN), which has apparently been influenced by CIMOSA, and the new generalisation produced by the IFAC/IFIP Task Force on Enterprise Integration, called GERAM, are presented too.

**Part two** is titled "Enterprise Modeling". It includes a general presentation of enterprise modelling aspects (**Chapter 4 through Chapter 7**), addressing the "views" of ENV 40 003 ("function, information, resource and organization"), and an extremely useful comparative analysis of enterprise modelling approaches and the existing (commercial and prototype) tools (**Chapter 8**).

**Chapter 3** presents the purpose, scope, basic principles of enterprise modelling. It also reviews several modelling approaches such as "Structural Analysis and Design Technique" (SADT), IDEF suite of the US AF Integrated Computer Aided Manufacturing Programme, GRAI/GIM, CIMOSA, IEM ("Integrated Enterprise Modeling") of Fraunhofer IPK, other modelling approaches to information systems (SSAD, object oriented approaches and Petri nets) and gives some evaluation criteria and workbenches. The author recommends that, beside the approaches described in this Chapter,

which are mainly technical, the reader also considers other techniques addressing management, organisation and human factors.

**Chapter 4** deals with the modelling of "enterprise functionality" (things to be done) and "enterprise behaviour" (the way things are done). It starts with formal definitions of functional modelling and graphical representation of activities. Several techniques such as IDEF (0,1,2 and 3), GRAI nets, real time structural analysis (SA/RT), CIMOSA function view, the Integrated Enterprise Modeling (IEM) and Petri nets (including timed, stochastic and coloured nets) are fully described and illustrated.

Modelling of data and information, the most mature part of the enterprise modelling, is addressed in **Chapter 5**. The specific part of this Chapter formally describes and illustrates such approaches as entity relationship, object orientation together with M methodology, IDEF 1x and CIMOSA information view.

**Chapter 6** reviews some well-known and recent results concerning the modelling and management of the resources found in the manufacturing enterprise. IEM and CIMOSA resource view are specifically described in this chapter.

A discussion on the organization aspects modelling is there in **Chapter 7** together with a presentation of the GRAI Grid tool and CIMOSA organization view.

**Part three** of the book has four chapters (**Chapters 9 through 11**) and is basically a presentation of the enterprise integration from the information technology perspective. **Chapter 9** is a survey of several general and special architectures and technologies such as the celebrated seven-layer reference model of ISO-OSI, the client-server architectures, TCP/IP of Internet, the "Manufacturing Automation Protocol" (MAP) of General Motors and CNMA the European implementation of MAP, the Fieldbus, the asynchronous transfer mode (ATM) network protocol and the data exchange formats (EDI, STEP, SGLM, HTML, KQML and KIF). New issues of "agent-based architectures" together with the new paradigm of "holonic manufacturing system" (HMS) and the "ontologies", are reviewed as well.

The software aspects of the IT infrastructure for intra and inter enterprise integration are approached in **Chapter 10**. The basic principles, architectures and services for

integrating infrastructures are defined. The "Open Distributed Processing" (ODP) standardisation initiative, the "Distributed Computing Environment" (DCE) middleware and the "Common Object Request Broker Architecture" (CORBA) of the Object Management Group (OMG) are reviewed. Several important examples of integrating infrastructure systems (IIS) prototypes and projects such as CIMOSA IIS, CIM-BIOSYS of Loughborough University, the European "CIME Computing Environment Integrating a Communication Network for Manufacturing Applications" (CEE-CNMA), AMBAS of FAW Ulm together with industry initiatives and CEN activities, are presented in **Chapter 11**.

**Chapter 12** of the main body of the book contains final remarks and the author's recommendations and views on the role of IT and further research, development and standardisation works to be done.

The book has four Appendices which describe a fictitious manufacturing enterprise CODEC Ltd (this was an example running all through the book), the CIMOSA modelling framework and the PERA methodology, and a glossary of terms.

This book offers the reader a huge amount of knowledge about the enterprise modelling and the corresponding IT integrating infrastructures. The author's endeavours for selecting, systematizing and comparing the newest results together with other largely accepted and utilised methods and tools, are quite remarkable and rewarding. The material is well-balanced, clearly and homogeneously presented, in spite of the diversity of styles and notations used by various schools and organisations which launched the methods and tools this book surveys. This holds even though this reviewer's feeling, when reading the book for the first time, was that some parts of it had been produced at different time moments with slightly different purposes and even evolving perspectives.

There are several groups/categories of readers who will certainly benefit from studying the book. Academia people will find it informative and stimulating for their own activities dedicated to improving the existing methodologies and to developing new ones in a new and possibly fast growing field of research and development.

Students in industrial engineering and computer science are encouraged to study the book for



getting acquainted to some of the "paceing" and "key" technologies of the present day and of the nearest future.

Consultants in industrial engineering and in business process re-engineering are recommended to consider the book for modernizing and shaping their approaches. Perhaps, for this category of potential readers, the presentation of more real life application cases would have made the book even more attractive.

Special thanks should go to the Publishers, Chapman & Hall in London, who do a superb publishing activity, and an excellent selection of titles.

To conclude with, this reviewer welcomes this timely and valuable work which is to be, in his opinion, a significant contribution to the development of a new discipline, namely the "enterprise engineering".

#### **Florin-Gheorghe Filip**

Dr. **Florin-Gheorghe Filip** was born in Bucharest, Romania, in 1947. He graduated in Control Engineering and took his Dr.Engng. Sci. for his contributions to hierarchical control from the Polytechnical Institute of Bucharest in 1970 and 1981 respectively. In 1970 Dr. Filip joined the Research Institute for Informatics, Bucharest. He was the head of Advanced Decision Support Systems Research Laboratory. From May 1991 to June 1997 Dr. Filip was general director of the institute.

In 1974 he was an invited research fellow at Swedish universities (Chalmers TH Goteborg, Uppsala Universit t, TH i Lund, KTH Stockholm). In 1995 he was trained in research management at FhG IITB Karlsruhe, Germany.

In December 1991, Dr. Filip was elected as a corresponding member of the Romanian Academy. He is a member of the IT Section of the Romanian Academy.

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Dr. Filip is the author/co-author of over one hundred sixty technical papers published in contribution books and international scientific journals such as IFAC J. Automatica, Contr. Engng. Practice, Large Scale Systems, Computers in Industry, Modelling & Simulation, Syst. Anal. Model. and Simul. etc. He co-authored the books: "Cybernetics, Automation and Informatics in the Chemical Industry" (1979), "Hierarchical Real-time Systems" (1986), and "Industrial Informatics" (1997), all written in Romanian.

His main current scientific interests include: modelling and simulation, hierarchical optimisation and control of large scale systems, decision support systems, integrated plant control in process industries and discrete part manufacturing, information systems in cultural institutions and IT technology transfer.

Dr. Filip is a corresponding member of the IFAC/IFIP Task Force on Architectures for Enterprise Integration.