Book reviews

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Computer Integrated Manufacturing and Engineering

Addison–Wesley Publishing Company, Wokingham, England, 1993, pp 640, ISBN 0-201-56541-2

A global requirement for any manufacturing system is the fulfilment and permanent maintenance of its economic justification. Any computer control automation of the manufacturing process should by all means contribute to the increase of the manufacturing economy. Flexible manufacturing system which generally represents the heart of modern part production system should beside its machining control functions carry out all necessary manufacturing planning activities. These second type of activities belong to the higher control level. Accordingly, an implementation of hierarchical levels for planning and control activities makes the common approach in system modelling and system control design. The necessary logistics provided to support manufacturing constitutes in some views the environment of the manufacturing system which can be considered as a functional extension of the manufacturing process and subsequently integrated within the enhanced control system at the next hierarchical level.

A successive interchange of planning and control activities is extended throughout the factory incorporating a complete structure of the production organization. In this case, the factory environment can be determined by the facts and forecasts concerning supplies and products market.

With respect to the multidisciplinary approach, the whole complexity and various particularities, CIM can be considered more as a philosophy, rather than technique, in which the computer plays the central role in planning and control of the manufacturing process. According to this, the book contains a number of chapters, each of them highlighting CIM subject from its specific point of view. The first three chapters introduce the manufacturing system, CIM models and concepts and analysis tools for manufacturing.

In this sense the book presents and maintains a unique approach by introducing global hierarchical levels which relate the domains of engineering and bill of materials activities, process planning, material requirement planning, scheduling, order processing, production monitoring and storage control. The activity control structure ensures proliferation of instructions to the dependent activities and feedback of the control variables in a hierarchically organized manufacturing operation.

According to the CIM model several existing CIM concepts are presented and discussed. Specially elaborated, the Amherst-Karlsruhe CIM model describes the technical activities of manufacturing. The concept has several layers representing various manufacturing activities like engineering and design functions, process planning, order scheduling and control of the production floor activities. Using the MAP protocol suite, a computer network enables connections of the engineering, planning and scheduling activities. Manufacturing is controlled by a hierarchically structured real-time computing system. The communication on the factory floor is realized via a field bus. Special consideration is given to the CIM database which must support the entire flow of information through the factory.

Pointing out the importance of planning in establishing complex manufacturing systems the authors present several modern planning tools by emphasizing their applications. Planning methods like simulation, Petri nets and expert

systems are discussed as the structuring tools for the design of complex production systems.

Chapters 4 and 5 present the flexible manufacturing and assembly equipment and control structures for manufacturing systems. Modern manufacturing and assembly equipments are presented by introducing numerical control and design features of NC machines. Because of the increased need for production of product variants, classical mass-production methods are no longer optimal. For this reason flexible production systems are required which usually consist of several individual machines linked together by inclusion of the appropriate transport system and common computer linked control system. In this way the FMS (Flexible Manufacturing Systems) show better response to the demands in part variants production. Increase in flexibility of automation exhibits higher investment cost what has to be compensated by increase of the part production rates. Several typical configuration examples of machining centres, flexible manufacturing cells, flexible manufacturing systems and flexible assembly systems are presented as valuable manufacturing tools used in the flexible part production.

Control structures for manufacturing systems relating the CAM (Computer Aided Manufacturing) area are presented by means of their function-oriented structures, hardware structures and software building blocks and files. Programming of the NC equipment in relation to its computer-aided machining functions belongs to the computer-aided process planning area. It supplies data for process-oriented control devices. Some examples and related methods in manual/machine-oriented and automatic /computer-aided programming are shown.

Chapters 6, 7, 8, 9 and 10 introduce the specific techniques, methods, procedures and standards which play a fundamental role in the support of any CIM project. These are communication nets and protocol standards, computer-aided design, process planning and manufacturing scheduling, robotics and material handling.

One of the most important role in CIM concept belongs to the communication i.e. reliable data transfer via a computer network. Area network topologies, possible access procedures and the ISO OSI reference model are introduced and discussed. Special attention is given to the physical, data link and application layer standards. The important protocols for computer integrated manufacturing are FTAM (File Transfer, Access and Management) and especially MMS (Manufacturing Message Specification) which service and protocol specifications are the base of the appropriate companion standards for the application areas of numeric control, robot control, PLC and process-control technology.

New developments in computer-aided design and their impact on manufacturing are presented and discussed. They relate to the methods used in producing of the manufacturing documents, drawings, bill of materials, process planning, as well as various CAD/CAM interfaces.

Planning and scheduling of manufacturing operations is specially elaborated. When the parts have been appropriately grouped and separated for machining and assembly, the process planning determines the production processes and their sequence. After the selection of tools and fixtures, machining data and programs are generated and orders are released to manufacturing.

Industrial robots take also an important part in production automation. Their application may concern the material transfer, assembly and processing operations. Robot classification is made with respect to the geometrical and control characteristics. The subject review contains a mathematical approach to the manipulator kinematics and basic principles of the dynamics of the robot arm motion. The topic on robot programming introduces the explicit and task level oriented programming.

Material handling is presented through the respective material handling concept and control of material flow which includes identification of parts and their tracking through production. A computer controlled storage system is also described.

The final chapter 11 is devoted to the quality assurance. A computer-aided quality control relates quality planning, testing and evaluation. An integrated quality assurance concept is presented and discussed. Special attention is given to the operation of the coordinate measuring machines and programming languages for test applications.

With the completion of the book review it should be emphasized that the authors have fully succeeded in the presentation of the general ap-

proach to the entire CIM philosophy. This approach can be treated as a valuable and useful leading concept in modelling and design of CIM projects. A comprehensive and illustrative presentation of different related techniques, methods and procedures which compose or significantly contribute to the project development, offers an excellent field introduction, as well as a valuable survey of the recent achievements and future field development. A supplement consisting of numerous references and comprehensive lists of further readings supports anyone's possible deeper interest in any of the relevant field specific subjects.

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Introduction to Computer Graphics

Addison-Wesley Publishing Company, Reading, Massachusetts, 1993, pp. xxvii, 557, ISBN 0-201-60921-5

Introduction to Computer Graphics is an adaptation of the book *Computer Graphics: Principles and Practice, Second Edition* written by James D. Foley, Andries van Dam, Steven K. Feiner, and John F. Hughes in 1990 as the most comprehensive and authoritative teaching and reference work in the field of computer graphics issued whenever up to nowadays. Its parent book comprises almost 1200 pages and is really the first encyclopaedia of computer graphics. While *Introduction to Computer Graphics* is half the size of its parent, it is not only a shorter version of it. It features, in some cases, a different approach to exposition, older material was dropped, and hardware performance and cost figures were updated.

This book is designed to be used in a one- to two-semester course in computer graphics in any four-year college or university. It can be used without prior background in computer graphics and only some background in C programming, basic data structures and algorithms, computer architecture, and simple linear algebra. *Introduction to Computer Graphics* can be also a convenient book for professionals who want learning the fundamentals of this dynamic and exciting field.

The computer language used throughout the book, both in pseudo coded program segments and complete programs, is modern ANSI C. The use of C, rather than Pascal, is consistent with current teaching and professional practice, especially in graphics.

Book topics cover basic graphics programming, hardware, and applications. The mathematics needed for them has been explained carefully. Important algorithms are included to facilitate implementation of both 2D and 3D graphics. SRGP, an integer raster graphics package, and SPHIGS, a simplified dialect of PHIGS 3D standard, reflects two major schools of interactive graphics programming. As a direct benefit of the use of C in the book, there is a one-to-one correspondence between the data types and functions of the code used in this book with those of the SRGP and SPHIGS packages that are free available to book buyers only if shipping and handling is paid. The book presents also a concise overview of interaction issues and techniques. It contains 44 full-color images. I like examples added at the end of each chapter. The book consists of fourteen chapters and is supplemented by a comprehensive bibliography with roughly 340 reference items and an index.

Chapter 1 provides an overview of the use of computer graphics, a brief history of computer graphics, separated in output technology, input technology, and software portability and graphics standards. It is followed by a section where its advantages are explained. At the end of the chapter the conceptual framework for interactive graphics is presented. I miss a definition of computer graphics and its relation to image processing what can lead a beginner to incorrect imagination about computer graphics.

In Chapter 2 the use of SRGP (Simple Raster Graphics Package) is described. It is device-

independent and exploits raster capabilities. SRGP primitives (lines, rectangles, circles and ellipses, and text strings) are similar to that of the popular Macintosh Quick Draw raster package and that of the Xlib package of the X Window System, while SRGP interaction-handling features are a subset of those of SPHIGS, covered in Chapter 7. Although SRGP and SPHIGS were written specifically for this text, most of what one will learn here is immediately applicable to commercial packages. For a more complete description, one should consult the reference manuals distributed with the software packages.

The purpose of Chapter 3 is to look at SRGP from a package implementor's point of view — that is, in terms of the fundamental algorithms for scan converting primitives to pixels, subject to their attributes, and for clipping them against an upright clip rectangle. The algorithms are discussed in terms of the 2D integer Cartesian grid, but most of the scan-conversion algorithms can be extended to floating point, and the clipping algorithms can be extended both to floating point and to 3D. The final section introduces the concept of antialiasing minimizing jaggies by changing a pixel intensity.

Chapter 4 introduces graphics hardware: hardcopy technologies, display technologies, raster-scan display systems, video controller, input devices for operator interaction, and image scanners. The basic technological concepts behind each type of device are described briefly. I like the discussion of the pros and cons of the various hardcopy and display technologies, but, in the same time, I miss it with the input devices. Further, I miss also the data of disseminations or shares in the market for each individual technology.

The basic 2D and 3D geometrical transformations used in computer graphics are introduced in Chapter 5. The first section is a mathematical preliminaries' section providing sufficient information for the reader to understand and use all subsequent mathematically oriented material in the book. From my point of view this chapter represents a didactic jewel. In the computer graphics community the use of column vectors for points is not yet widely spread as it is a usually practice in the mathematics community, therefore I like that the authors have started to use it.

The 3D viewing process is described in Chapter 6. The complexity of 3D viewing is caused in part by the added dimension and in part by the fact that display devices are only 2D. It is overcome by a series of easily understood steps, many of which have been prepared for in earlier chapters. Chapter 7 gives a general introduction to geometric models, emphasizing hierarchical models that represent parts assemblies. SPHIGS (Simple PHIGS), a package based on the graphics standard PHIGS, is designed to provide efficient and natural representations of geometric objects stored essentially as hierarchies of polygons and polyhedra. It preserves most of PHIGS capabilities and power, but simplifies or modifies various features to suit straightforward applications. SPHIGS also includes several enhancements adapted from PHIGS+. The aim in designing SPHIGS has been to introduce concepts in the simplest possible way, not to provide a package that is strictly upward-compatible with PHIGS.

Input devices, interaction techniques, and interaction tasks are described with Chapter 8. These are the basic building blocks from which user interfaces are constructed. Input devices are the pieces of hardware by which a user enters information into a computer system. Many such devices have been already discussed in Chapter 4. In this chapter, additional devices are introduced and reasons for preferring one device over another are discussed. Interaction techniques are ways to use input devices to enter information into the computer, whereas interaction tasks classify the fundamental types of information entered with the interaction techniques.

The general area of surface modeling is introduced with Chapter 9. The area is broad and only some representations for curves and surfaces are presented. The first section describes polygon meshes. The second one introduces parametric cubic curves (Hermite, Bézier, uniform nonrational B-splines, nonuniform nonrational B-splines). Then, parametric bicubic surfaces (Hermite, Bézier, B-spline) are discussed. The last section describes fractal models. I miss an interpolation approach with B-spline method, resulting very important in practice. Further, a reader does not learn about the relation between Bézier an B-spline method and too little about NURBS.

Chapter 10 introduces solid modeling. A brief introduction to various solid representations is made, such as primitive instances (group technology), boundary representations, spatial-partitioning representations (including cell decomposition, spatial-occupancy enumeration, octrees, and binary space-partitioning trees), and constructive solid geometry. At the end, a comparison of discussed representations is made.

It is crucial that the student of modern computer graphics understands the theory and application of light and color the basics of which are discussed in Chapter 11. The discussion starts with achromatic sensations and halftone approximation. It continues with chromatic color (human visual system, CIE chromaticity diagram). Then, color models for raster graphics are presented. The chapter ends with the section on the use of color in computer graphics. Chapter 12 presents a high-level introduction to the techniques used to produce realistic images. First, some of the applications in which realistic images have been used are considered. Then, in roughly historical progression, a series of techniques that make it possible to create successively more realistic pictures is examined. Each technique is illustrated by a picture of standard scene, with the new technique applied to it.

In Chapter 13, a variety of issues relating to the efficiency of general visible-surface algorithms (hidden-surface elimination algorithms) are introduced. Then, the major approaches to determining visible surfaces are presented, such as the z-buffer algorithm, scan line algorithms, visible-surface ray tracing, list-priority algorithms, area-subdivision algorithms, and algorithms for curved surfaces).

Chapter 14 begins with a discussion of simple illumination models that take into account an individual point on surface and the light sources directly illuminating it. Then, the most common shading models that are used with these illumination models are described and later expanded to simulate textured surfaces. A consideration of modeling shadows and transparency is followed. Last sections present global illumination models that attempt to take into account the interchange of light between all surfaces: recursive ray tracing and radiosity methods.

Each chapter provides an introduction about considered items at the beginning and, at the end, a short summary and a list of exercises. Only chapters 4, 5, and 6 are without a summary. Chapter 2 proposes also programming projects. All this gives the book a great didactic value, therefore I recommend it strongly as a textbook for each university or college course of computer graphics. At the same time, it will be worthwhile to the remaining computer graphics community as a standard reference book.

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