Computer-Automated Process Planning for World-Class Manufacturing

James Nolen

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Foreword

It took centuries for markets to move from local to national levels. Along with this evolution came the transition from artisan- to mass-produced products. In historical terms, the recent expansion to worldwide markets and the explosion of information processing forced those involved in manufacturing to revise their ways of doing things. A reindustrialization process began—a "do or die" procedure—which was complicated even more by varying exchange and labor rates in different parts of the world.

The initial solution for many was CAA (Computer-Aided Anything). However, the computerization and automation of information that was often made up of inefficient methods cost most manufacturing departments more than it provided.

I believe that we are about to enter a new stage in this reindustrialization: to take a step backwards, look and analyze what is really happening in the product-creation process. It is a combination of analysis and standardization that will establish the best design and manufacturing methods, and these should be used consistently. In taking this step backwards, however, you will probably find yourself in the same dilemma that a family has the week after a wedding when the photographs arrive: many pictures are mediocre, some are bad, and a few are really good. What should be thrown away and what should be kept?

Assume, for example, that there are 21 different process plans for a particular drive shaft in your company. As history has proven, probably only one or two of these plans reflect your company's best manufacturing practices. Furthermore, an analysis of all the drawings related to drive shafts may show that one or two insignificant design changes will reduce your production costs by

10–20%. The question is: What are the benefits of introducing an MRP or production control system to your company if no effort has been made to link the best design with the least expensive work method in that MRP system?

When it comes to the development of designs for high-quality parts (products) with low manufacturing costs, process planning is the focal point. That is the area where production costs are determined because of the manufacturing methods used; these methods are selected as a result of design requirements.

Computerizing process planning and decreasing the time spent on clerical tasks (also known as electronic pencil activities) is a cost-reducing activity. To step back, analyze, and work toward the optimization of process planning data, in cooperation with the design office, prepares a company for integrated design and manufacturing systems and for world-class manufacturing. Unfortunately, there are no shortcuts.

Computer-Automated Process Planning for World-Class Manufacturing addresses the subject of process planning in detail and provides the reader/user with sufficient examples so that management can no longer hide behind that slightly worn-out phrase: "Our company is different from everybody else's." I highly recommend this book to all those who intend to prepare their company for the future.

Alexander Houtzeel
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Preface

This book has a threefold objective:

- To provide a comprehensive survey of the state of the art in computer-automated systems for process planning and work measurement.
- To explain the spectrum of application to which CAPP systems may be applied. Special emphasis is given to the key role they play in the construction of just-in-time foundations, setup reduction, and quality in a batch manufacturing environment.
- To promote the use of CAPP systems as a springboard for capital equipment selection, factory layout, and the construction of a master computer-integrated manufacturing (CIM) plan attuned to company strategy, product design requirements, and the capabilities of the production facility.

The first objective is probably the best understood and the least significant. It has been estimated that by 1990, 30% of the work involved in the area of process planning and work measurement will be eliminated by computer automation. Savings of this magnitude are easily obtainable by delegating the functions of paper, pencil, and file cabinet to the computer. However, the benefits to the organization eclipse clerical savings by orders of magnitude when these systems are more fully utilized. Through graphics interfaces, it is possible to use group technology-based systems for design standardization, value analysis, and improved CAD/CAE utilization. Other systems incorporate intelligent machinability databases for the selection of machine tools and metal removal parameters. Still other systems accurately and rapidly measure human work and

may be employed for ergonomic design of fixtures and work area layouts essential for zero setup. At the highest level are systems capable of capturing knowledge and consistently applying this expertise to assembly and test requirements of our complex products.

The second objective is more difficult, because it requires changing long-established behavior patterns of middle and senior managers in an effort to duplicate the advantages achieved by our foreign trading competitors, particularly Japan. Essentially, it involves enlisting the support of senior management, traditionally removed and often disinterested in manufacturing, to build the foundation required to achieve total quality and zero setup in a batch environment. Technical professionals and department managers, accustomed to expending the efforts of their small staffs on writing manufacturing instructions that explain what is desired—not how to do it—must learn how to efficiently employ CAPP to quickly achieve benefits that have taken the Japanese 30 years to realize. Moreover, we must do so while in batch production within a culture where individualism in the work force is a larger factor than for our Asian competitors.

The third and last objective is intended for senior management responsible for setting company strategy and making investment decisions affecting manufacturing facilities, equipment, quality, and inventory. The master CIM plan for companies introducing new technology to the marketplace is likely to be very different from one constructed for a mature product line. When CAPP systems are installed, the information within them may be tapped to bring investment decisions in step with company strategy. Rational approaches to factory layout, equipment selection, and work force requirements can be easily made, often with surprising results. "Designed-in" costs can be reduced manyfold, and CAD utilization is improved. Machine tools are often far more expensive than required. Cellular manufacturing using specialized fixtures often outproduces the most exotic robots or flexible manufacturing systems at a fraction of the cost. Families of parts under the control of an MRP system may be transformed into efficient JIT flow lines.

The scope of the book includes current automated process planning and work measurement systems, their capabilities, and their application in a batch manufacturing environment. Also covered is potential for design and process standardization, setup reduction, and quality improvement, a topic of interest to producers regardless of volume.

Interested leaders will include the following: those contemplating the purchase of an automated process planning or work measurement system, technical professionals, department managers responsible for improving quality while reducing setup and work in process inventory (especially those with a boss who

recently returned from Tokyo), and enlightened senior managers who wish to participate actively in improving their company's competitive position.

James Nolen

Demonstration Disk Instructions

CUTDATA™ DEMO INSTRUCTIONS

Overview

The disk in this book contains a sample of the program and data actually stored in the complete CUTDATA™ Machining Data System. Informative windows appear the first time through each demo session to help explain the functions of the system. These windows do not appear the second time through the data retrieval menus, and the system functions in its normal mode. The complete CUTDATA™ contains over 84,000 machining recommendations (40 machining operations and 1,500 workpiece materials). A small sample data set for three operations on alloy steel 4012 is provided on the demo disk. The following choices can be made from the various function menus:

Menu	Operative demo choices
Selected desired option	Data retrieval
Machining operation	Turning (turning, single-point), milling (face milling), or holemaking (drilling) ONLY
Material family	Alloy steels, wrought ONLY Low carbon ONLY 4012 designation ONLY

Menu (Continued)

Menu	Operative demo choices
Material hardness and condition	All choices operative
Tool material	All choices operative
Workpiece dimensions	All reasonable choices operative, applicable to machine operation

NOTE: Press "?" key for help at any time
Press <esc> to back up one menu

Starting the Demonstration Program

To run the CUTDATA™ demonstration disk, you need an IBM personal computer or a PC compatible with 256K memory, a double-sided disk drive (DOS 2.0 or higher), and a monitor, preferably with color display. A printer is a suggested option, as it allows the illustration of CUTDATA™'s capability to print out any of the program's screen displays.

1. At the DOS prompt, insert CUTDATA™ demo disk in Drive A. Type A: and press the return key.
2. Type CUTDATA and press the return key—this will load the information needed from the disk in order to start the demonstration—please wait until the program's "initialization" is completed, as indicated on the display screen, before proceeding to step 3.
3. Select a function with the cursor keys and press enter.

Ending the Demonstration Program

End the demonstration at any time by depressing the (Ctrl) and (Q) keys at the same time. This will exit the CUTDATA program and return you to DOS. At this point, the program diskette can be withdrawn from the drive.

Metcut has also developed a more sophisticated CAPP system, MetCAPP. This system combines the features of CUTDATA with the detailed operation planning functions of CUTTECH. For more information on Metcut software, call (513) 489-6688.

PRIME COMPUTERVISION INSTRUCTIONS

To run the demonstration disk (for IBM PC/AT and XT): Insert disk in the A drive and answer the following prompts:

```
> A:
A> OIR
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After the first two menus hit the return key to view all the features of Multi-Capp II and MultiCats II.

Contents

troduction

he three decades since computers were first employed for business applications
h as accounting, materials management, and numerical control of machine
ls, they have become indispensable not only to manufacturing in general, but
very department within manufacturing companies. This widespread accept-
e and focus on specific applications has resulted in many "islands of automa-
n" about which we hear so much. While localized productivity improvements
le possible by these islands of computer automation are often impressive, true
nputer-integrated manufacturing still eludes most manufacturers and may con-
ue to do so, but only for a short time to come.

In the meantime, techniques exist through which geographically dispersed com-
er systems within an organization can work more harmoniously with one
ther. These techniques, which include group technology, computer-aided de-
, and computer-aided process planning, can be used not only to automate the
ious aspects of design and process planning, but also to help keep the company
a direct course toward its strategic objectives through the establishment of
ducible, functionally toleranced designs, efficient manufacturing methods, and
ible, responsive production facilities.

In the chapters that follow we will see that computer automation in an un-
trolled environment can achieve localized successes at the expense of overall
pany objectives. For example, it can be shown that computer-aided design
ems are not only two to four times faster than manual drafting practices, but
shorten the design cycle through elimination of many of the steps involved
raditional product development. In an uncontrolled environment, however,
ign proliferation (unnecessary variations that do not improve performance)
ngs products to the manufacturing floor which contain inconsistent tolerances,