Excogitating a new Category of Computer Users to benefit CAD/CAM Industry

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Abstract

Job categories in computer systems particularly Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) have been classified into: users (operators) and programmers (administrators). In spite of the broad definition of such a classification, it is widely used in industry, consultant and engineering firms to describe the workforce needed to operate CAD/CAM systems.

Giving the industry a broader and deeper look, the need to excogitate a new category of computer systems users is of great importance due to many reasons; of these reasons, the rapid growth of computer systems usage, the increased demand to enhance and improve efficiency and productivity, and the need to develop the existing systems.

In this paper a preliminary investigation is launched to: explore the need for the new intelligent user workforce, recognize and define the main features of this workforce individuals, and finally provide some scientific experimentations to verify that the intelligent user is an independent user category.

1. Introduction

Modern industry has been characterized with the adoption of CAD/CAM systems to automate (or partially automate) company's design and manufacturing activities.

As a historical background, Computer Aided Drafting and Design (CADD) was introduced in the mid 50's by the American Air force to aid the military radar system and was accelerated by the invention of sketchpad systems by Ivan Sutherland at the early 60's [5]. Initially the R&D costs for CAD/CAM systems were very high and requires high investment cost. It also required extensive training and sophisticated hardware and software that were not available for small companies. By the end of the 1970's and beginning of 1980's many companies started to realize the importance of the CAD/CAM systems to the future of their companies. Tremendous effort

was done and still is being done to design, implement, and integrate computer systems specifically CAD/CAM into almost every company's backbone structure.

The Impact of the continuous development of CAD/CAM hardware and software had a great impact on the characteristic of the users. In the early CAD/CAM systems the user was self-trained. Nowadays users have to go through specialized certificate programs that can go as long as 12 months to allow them to be CAD or CAM specialists [1].

The objective of this paper is to provide taxonomy of the CAD/CAM users, and introduce a new category of users named as intelligent users. In addition some academic experimentation was done to prove that the new category of users is indeed an independent category. This research will have another phase where the industry will be contacted for possible participation in questionnaire type of survey to get their feedback and suggestions.

Fig. 1 shows the proposed Job taxonomy for careers in CAD/CAM and particularly in the user section. The programmer section is left as an area of future research. As shown in the figure, the user section is split into three categories: users, super users, and intelligent users

In this paper each user category will be discussed and a special focus will be dedicated to the intelligent user category.
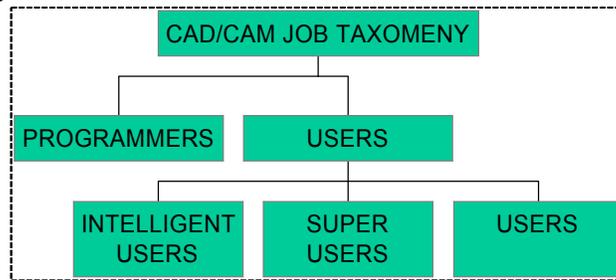

Fig. 1 Job taxonomy of CAD/CAM personnel

2. CAD/CAM Users

CAD/CAM users (sometimes called operators) represent the mainstream of the CAD/CAM job market. The person working in this category could be a re-trained, newly graduate, or even a higher-level professional person. This category of personnel represents the backbone of the CAD/CAM job market and is the companies' most effective employees measured by their impact on the flow of the work daily activities.

2.1 Super User

A Super user is by definition a user +, i.e. they are a special category of individuals from the user category who performs some additional important tasks such as checking the general work, inspecting it, recommending solutions, system customization etc.

The need for this category of personnel stems from the fact that it is always required from the system users to be not only knowledgeable on how to operate the system but also to be experts in the computer system field of application.

2.2 Intelligent Users

The Intelligent user is a job category that exists at an intermediate level between programmers and users. The need for such a category stems from the fact that programmers need users to provide them with directions and feedbacks to develop the existing systems, and users need programmers and system analysts to improve their understanding and utilization of the CAD/CAM systems. So, the intelligent user is a user of CAD/CAM systems who has some training and background in system design. An intelligent user will have the following characteristics:

1. Very knowledgeable in operating the CAD/CAM systems.
2. Has a considerable knowledge accumulated either by education and/or experience at the filed of application.
3. Equipped with general knowledge (can be specific if necessary) on the basis on which CAD/CAM systems operate such as: Geometric modeling, solid modeling, surface modeling, computer graphics, etc.
4. Is capable of customizing the CAD/CAM system.
5. Is capable of discussing his/her needs and communicate effectively with the R&D staff.
6. Performs maintenance and develops short cut solutions to improve system utilization.
7. Be able to develop, direct, and mange projects intended to develop subroutines, sub-programs or work relate material intended to serve the CAD/CAM system.

3.   Building a Curriculum Program for Intelligent Users

The best approach to design these programs is to team the academia, industry and software companies to design the appropriate program. As a start, the following is a list of topics that can be used at the area of design and machining.

-   Solid modeling
-   Surface modeling
-   Benefits of hybrid Modeling
-   Constraints & Limitations
-   Clean modeling practice
-   Modeling parameters control
-   Benefits of macro and customization
-   Intensive study on tool path generation
-   Intensive study on manual programming
-   Intensive study on GUI and software comparison and testing
-   Process Planning for CAD modeling

4.   Scientific Experiments

The following experimentations were done on two groups of students. The first group was semaphore and junior level students who represent non - experienced CAD/CAM users. The second group was senior level students who represent experienced CAD/CAM users.

Both Groups were fed by set of information and knowledge believed to be directed to build an intelligent user [2, 3, 4, 5]. The following results were obtained:

4.1 Beginners Group

The beginners group was asked to machine different parts using manual programming on a CNC machining center (Fig. 2). Initially, all the necessary information including the mathematics required for programming was taught in the class. They realized that using a manual approach would not get them to finish on time. They were granted a permission to use a CAD system to help them. The approach can be called CAM/CAD approach to generate the tool path.

4.1.1 CAM/CAD approach

In order to machine a part on the CNC machine a tool path has to be generated. The tool path is basically the geometrical path that the cutting tool will trace to generate the required shape.(Fig 3a) shows a solid model of the part to be machined, and its working drawing (Fig. 3b). (Fig. 3c) shows the tool path that half-inch end mill-cutting tool will trace to generate the required piece.

 A CAM/CAD approach is basically the CAD system turned into a CAM system to generate the tool path. As shown in (Fig. 3c), offset boundaries were used to generate the tool path along with extensive use of trimming and intersection operations. It is a great tool developed by the students to demonstrate their deep understanding of the process fundamentals.


Fig. 2 A CNC machining center
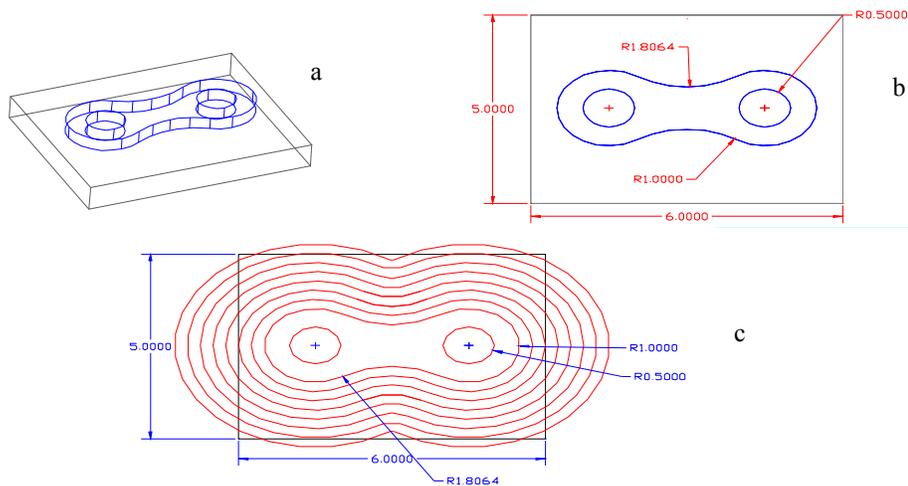
Fig. 3   a. A solid model of the part,   b. a working drawing c. tool path

4.1.2 Signs of an intelligent user on the beginners group

The following is a list of how the intelligent user is developed in the beginners group
1-   Some new ideas were developed for tool path generation that could be implemented in future CAM systems. As an example. (Fig. 4) Shows a screen capture where the numbered circles were used to mark the imported points necessary for tool path generation.
2-   Students have a deeper understanding of the fundamentals of tool path generation Techniques. As an example: offsetting, offsetting problems, intersection and pocketing routines).
3-   Students have a deeper understanding of some techniques that are used in current CAM systems such as a coloring schema (normally is very confusing for the normal users).
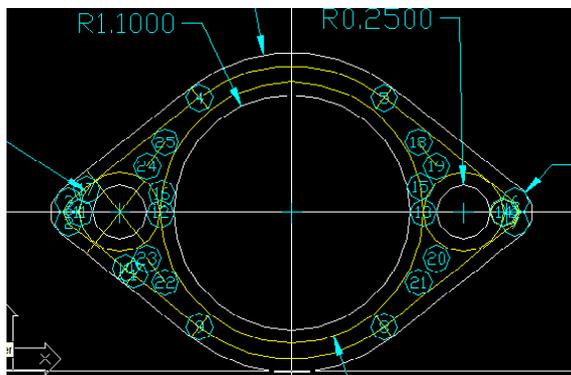

Fig. 4 a New idea in tool path generation
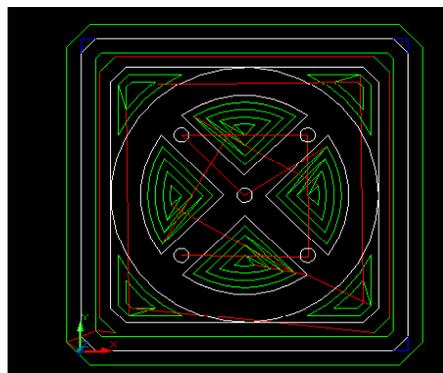
Fig. 5 An intelligent usages of
a coloring schema

4.2 Advanced Group

The advanced group was basically a group of students who were selected from senior level students. These students were CAD/CAM users for an extended period of time. The results of the experimentations showed very important and interesting outcomes. Starting from a normal user, a supper user would be the next development stage rather than an intelligent user. To implement an intelligent user from a general user more effort and more targeted programs have to be carefully designed to accomplish this task.

4.2.1 Super Users Vs. Intelligent users

It was noticed that most of the students in the advanced group were interested in performing the following activities.
-   Learning more about the system that they are using,
-   Learning the art of short cuts during product modeling.
-   Learning more about organizing the software for faster product modeling and developing good modeling habits.
-   Mastering multiple CAD/CAM systems to accomplish their objectives faster compared to the traditional way of using one system.
-   Comparing among systems and techniques and developing a set of recommendations for their favorite systems.

(Figures 6) shows an example of a student who is demonstrating her organization by using layering at the different modeling steps necessary to machine build a one pieced die-cast body mold for a sampling valve.
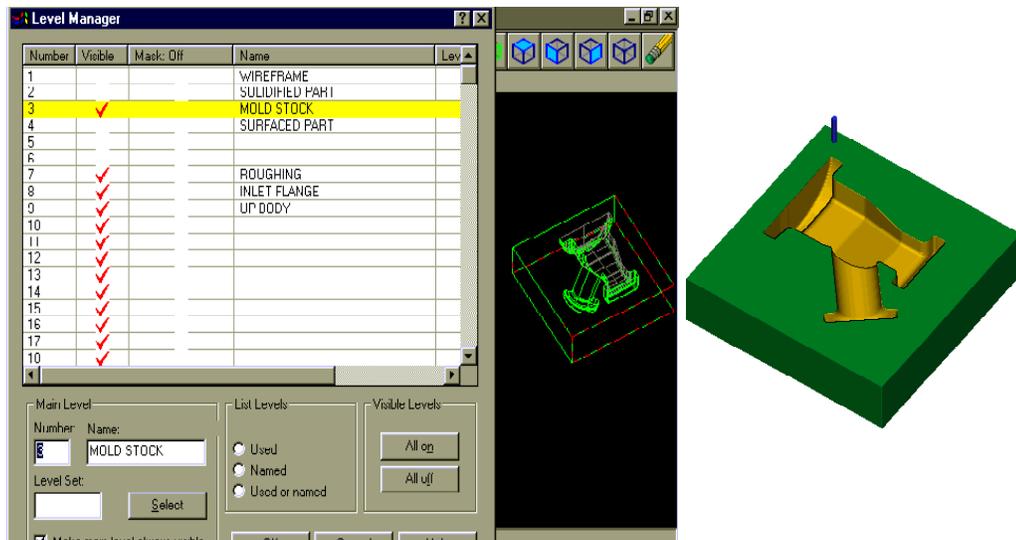
Fig. 6 A CAD/CAM a of die-cast half body mold for a sampling valve.

Another experiment shows two students who chose to explore surface & solid model technology to generate tool path for an automobile radio bezel found on the dashboard as their final course project. As shown in (Fig. 7) their focal point was to explore the best technique to transfer the CAD information to the CAM system, and reducing the modeling steps necessary to generate the tool path, shows their Conclusion.

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7) Comparison of surface model to Solid model creation and Conclusion summary for complete project:

In general Master Cam can do both surface and solid model as input file to create the desired CNC program to operate the work centers in manufacturing. What we found is the method of using the Surface Model could require addition steps than when using the Solid Model.

The Surface model required that the top surface be modified as a spline. The spline was an exact match of the curve surface form the CAD file. This was accomplished by creating the points along the entity and defining the resolution (# of points). Once the splines were created on each end of the part the surface-coons was made to establish the top curved surface. This whole process can be reviewed in detail in the enclosed report form the CAD CAM class Tech 3430 report. In comparison with a properly created Solid Model (such as the Solid Works – Parasolid model) that was noted in this report the surface was immediately recognized by MasterCam without any additional steps such as the spline and coons creation process needed for the surface model.

The key is that the Solid Model must be done correctly or the feature that are imported form the CAD file may not fit for use by the CAM software such as Master Cam. This was demonstrated in this report when making the first design with ACAD and Master Cam and Solid works and Master Cam Solid Models. Surface modeling and Master Cam is a bit more mature as far as the industry usage based on our class lectures. Therefore many users can achieve making parts with Surface Models.

Conclusion:
Since the Solid Modeling approach seems to be more efficient than Surface Modeling and is the way of the future, an expert user if properly educated in the Solid Model creation could deign and create the manufacture the part more efficiently.

The key is knowing how to create the solid model and transfer it into the CAM package, such as Master Cam so that all the features and topology are the true shape representation.

The proper part (Solid model) can create the toolpaths program and allows for the powerful parameter, setup and tool selection capabilities that a Cam package can produce. Just as machine time is critical in today's industry for profits so is the ability to make design and post process them for manufacturing, in an automated way for maximum time to market and customer satisfaction.

Fig. 7 Sign of super users at the advanced group

5. Conclusion

Intelligent users could be of great benefit to modern industry. These benefits could be summarized as: providing the job market with highly skilled personnel who possess targeted knowledge of how the system works in addition to their knowledge of how to operate the system. Such knowledge serves two main objectives, bridging the gap between regular users and programmers and helping users to develop a deeper understanding of how the system works hence it could lead to better trouble shooting skills and higher productivity.

Intelligent user is a category of users that stands by itself. It can be created either from the existing user or from fresh beginner users. The latter approach is preferred. Special educational programs have to be built and designed specifically to create this category of users. It is believed that intelligent users will have a huge impact once introduced to the CAD/CAM job market.

6. Acknowledgement

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