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# Shop of the 90's The Implementation of A CAD/CAM System for Small Machine Shops

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**U.S. DEPARTMENT OF COMMERCE**
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**TECHNOLOGY ADMINISTRATION**
**Robert M. White, Under Secretary for Technology**

**NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY**
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## Acknowledgment

The author would like to thank system engineers and application engineers at Auto-trol Technology, CADKEY, and Calma Company for their input in preparing this document.

Input and information was received through training programs the author attended (1976--1988), training programs conducted (1981--1988), and conversations and discussions with various system and application engineers (1976 - 1990).

## Special Notice

The original implementation procedures were written for those that purchased an engineering workstation or main frame system. I have rewritten the procedures to apply to the personal computer (PC) and small workstation. Although some of the terminology and procedures may seem to apply to larger systems only, they do not. These procedures apply to the installation of any CAD or CAM system. Although some of these procedures will not apply to all businesses that implement CAD and CAM systems they should be used as "food-for-thought" when considering or contemplating system expansion or upgrades.

Appendix A is a suggested set of job descriptions to help with personnel duties and selections. Appendix B contains three suggested form formats for a standards manual. These are not standards that have been set by NIST. They are included to assist the reader in making sound decisions and speed up the system implementation process only.

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# I. INTRODUCTION

## SO, YOU BOUGHT A CAD/CAM SYSTEM. NOW WHAT?

System management planning starts months prior to the actual installation of the system. Some companies make the mistake of neglecting this planning process completely, or moving the planning process ahead until it nearly coincides with the system installation. A comprehensive management strategy begins at least two months prior to system installation, and continues throughout the life of the system installation.

The system manager is the focal point for defining the direction and philosophy of system utilization, and this direction must be planned before the inception of the system. As the system evolves, factors that affect management decisions will make the actual decision making process easier. Early decisions will be more difficult because the manager has less experience on which to base his/her decision; sometimes to the point of relying on support or guidance from the vendor.

There are several distinct phases that system implementation passes through. Of course the time frames are flexible and some management aspects may overlap between phases, but overall, the phases are universal, and every system implementation experiences them.

The phases are:

1. Management definition of goals and objectives.
2. Personnel selection and installation preparation.
3. System installation and operator training.
4. Productivity plan implementation.
5. Continuing growth and implementation.

# II. GOALS AND OBJECTIVES

**Two months prior to system installation** you should establish preliminary system use requirements and define interdepartmental relationships.

**Define system use and objectives.**

Your organization had specific reasons for purchasing a system.

Before the pre-installation planning phase of the system you must specifically define what the intent of the system use is, and what the overall objectives of the system will be. Talk to other individuals who have acquired a system to gain their insights into what the system's uses and objectives should be. Their viewpoints may be different from yours. After gathering a consensus, you'll need to spend time compiling, reviewing, and redefining your company's definition of the system's uses and objectives. Take the time to do this work carefully and completely. This review will serve as a basis for all the direction and development that will take place throughout the entire implementation of the system.

**Define system user groups.**

Your defined system's uses and objectives will serve as a basis for defining what users or departments will be involved with the system. The planning process is a time for narrowing your focus of how the system is going to be used. A major part of this is selecting those necessary parts of the company's organization that will be directly affected by the system.

**Choose a system manager.**

Your system user groups will help in defining those supervisory personnel who could serve as a system manager. You want to choose a system manager with a very critical eye. Select an individual who is a good communicator. Communication is the most important asset that a manager can have.

Other traits that you need to look for are:

1. Prior computer experience.

2. Previously demonstrated management skills.

3. Good attitude and motivation.

4. Employee respect and deference.

The system manager will work closely with company management to develop and review system progress. You need to have individuals who will be able to plan, review, and direct the system's growth.

**Define communication channels and responsibilities.**

The system will probably be placed in the company organizational structure where it will be shared by different areas of the organization. These organizational communication channels need to be examined in regard to management reporting routes, and also to define responsibilities relative to system usage. What needs examining are the communication paths, or where friction may occur between organizations.

**Define interdepartmental decision making mechanisms and responsibilities.**

After examining which departments are involved with the system implementation, you will need to determine what management or supervisory personnel may be necessary for those areas. These individuals should have decision making responsibilities within their departments. Their responsibilities relative to the system would be for providing supervision and direction to those people within their departments who use the system, and for working with and reporting to the system manager.

**Involve the new system manager.**

Soon after selecting the system manager, involve him/her in the planning. You need to go over all the planning that has been done prior to his/her selection. The manager needs to be aware of the goals, objectives, and company direction of the system.

**Define special system requirements.**

Work together to analyze and plan for any special needs that may be part of your system implementation. Topics like special communication needs, special political considerations within your company, or specialized software needs in addition to standard software, should be examined and evaluated.

**Define preliminary production goals.**

Referring to the system's uses and objectives plan as a guideline, develop a preliminary set of production goals. These goals should define the initial accomplishments that will occur immediately after installation and training. Include in these goals the initial types of production drawings planned, the development required to accomplish these drawings, estimated time frames for accomplishing the production goals, and a format for defining when these goals are accomplished.

**Define preliminary site preparation and installation dates.**

Examine in detail what requirements are necessary to prepare the physical facility for the equipment installation. You may need to have electrical work done, cables may need to be routed throughout the building, and walls and rooms built. Plan your physical site and target all work to be completed before the equipment is installed. Plan for all this work to be completed before the system delivery date.

**Four to six weeks prior to installation** you should:

1. Complete personnel selection.

2. Complete site preparations.

3. Define support requirements.

4. Define preliminary usage requirements.

**Receive system management training.**

System management training is important in the early planning stages of the system implementation. Most management planning has to occur months ahead of the actual events on the system. The system management class gives new managers the tools necessary to begin directing the growth and development of the system.

**Review production and system objectives.**

The management team needs to review the planned direction and use of the system throughout the entire implementation process of the system installation. Keeping these goals and objectives in mind helps the managers plan the system growth, and, if necessary, rework the goals and objectives to reflect more realistic expectations of the system. At this point, reviewing this information is important to the management team who will be directing decision making concerning company and system standards.

**Make preliminary personnel choices.**

One of the most important and necessary steps you have to go through is the selection of operators to be the core group of users on the system. This core group is the most critical ingredient in the early implementation of the system because it is their work that will serve as the ground work and basis for all future work performed on the system. It is imperative that this group be chosen with great care. Primary personnel selection is done in two steps.

1. The preliminary step is to select a variety of personnel according to the planned discipline areas that will initially be implemented on the system.

   Refer to Appendix A for a suggested set of job descriptions to help with personnel duties and selections.

2. Evaluate personnel choices against system objectives. The management team will need to take the time to individually evaluate those people who make the initial list of system personnel.

Keep in mind that you are selecting system users based on their knowledge and background, and your defined system objectives. The objectives are the most important. You are basing your personnel selections on who can do the best job of accomplishing the objectives.

**Define a completed site plan.**

Working with your field engineering representative, complete a formal site survey of your facility. The field engineering representative will make recommendations of what you will need to do to bring your facility up to the standards required for installation. This formal site survey will serve as the plan for completing your facility and, if necessary, you can share the information with contractors to estimate when the facility can be completed.

**Define preliminary system use standards.**

You know what the initial direction of system use is going to be. A major task that you need to accomplish prior to installation and training is the development of a preliminary set of system standards. These standards will encompass symbology (or patterns), detail drawings, standard parts, company drawing standards, layering conventions, plotting conventions, data storage and archiving, directory structures, system access, communication paths, and overall system work flow.

**Communicate your completed site plan to management.**

After the facility site survey is complete, you will need to schedule time to communicate the facility requirements to other company management, and if necessary to any contractors necessary to complete the site. Be sure the information is clear and concise so work will not have to be redone at a later date. Also, work towards a definite completion date. You do not want to be at the mercy of a sliding completion date for construction that will affect your installation and implementation plan.

**Define work flow and interdepartmental work flow requirements.**

Up to this point you have considered what work is going to be done on the system. You now need to also consider what requirements are necessary for having work come into, through, and out of the system. These considerations are very important when you have interdepartmental usage requirements. The management task now is to define mechanisms that control the flow of data into the system, and prioritize mechanisms so that accepted work will be completed in a timely, equitable manner.

**Make final personnel choices.**

After giving careful consideration to the preliminary personnel selections, select the people you feel will be the best qualified to use and be productive on the system. Make the personnel selections far enough in advance of the system installation and training so that any necessary human resources paperwork can be completed. Make the personnel selections in a non-threatening environment. If you make your personnel selections based on the criteria given in Appendix A, you should not have any problems getting enthusiastic, proficient system users.

**Begin site preparations.**

Monitor and coordinate the physical site preparations. Try to keep the work on schedule. If any delays occur, be sure to contact your sales representative and make him/her aware of the potential delays.

**Define core group for training, using preliminary production goals.**

You may need to train your system users over a period of time. If you are in this situation, you will have to further evaluate your selected personnel to define a core group to receive training in the first available training class. These people will be directly involved in doing the preliminary development work on the system, so you want to select your very best people for the core group. These people should have the best knowledge of all the different disciplines you are planning on implementing in the preliminary production phase.

**Analyze and prepare support requirements.**

The implementation of your system will require constant support. Work with your regional support group to understand and prepare for the various support services available to you. You will need to know who in your organization should place service calls, where to place the service calls, and what information is necessary to log the service calls. Also, you should know about software support services and vendor education services that go beyond initial training requirements.

**Define the training program and schedule.**

Work with your sales representative to develop an effective and comprehensive training plan for all of your users. Remember there are different levels of system knowledge recommended for different users, and therefore not all users need to attend all classes. Plan on scheduling training on or near the installation of your computer. It is important that your users have the equipment available immediately after their training class. There is too much information to forget if they do not have a chance to practice what

they learned. Your sales representative will assist you in the actual scheduling of your personnel into classes. The course enrollment forms and necessary billing information should be mailed as soon as possible.

## III. SYSTEM OPERATOR SELECTION

Operator selection for a system is a difficult task. The manager's goal is the successful integration of the system; and it is the choice of personnel to use the system that determines the success of implementation.

Although successful user selection may seem like a mystical occurrence, a seasoned, knowledgeable manager already has the ability to target good candidates for the system environment. Many of the attributes managers look for in hiring new personnel apply directly to system users.

There are two separate tasks involved in user selection.

1. The first task is to define what traits and qualifications are necessary for a user to be successful.

2. The second task is the actual selection process.

**What to look for in operators.**

There are four major qualifying areas to examine when selecting users for a system. They are:

1. Specific job aptitudes.

2. Directly related aptitudes.

3. Indirectly related aptitudes.

4. Attitude and motivation.

Specific job aptitudes are quantitative, previously demonstrated factors and measurements that cover a user's knowledge of company practices, his/her design and drafting abilities, and his/her previous job history. Users should be able to demonstrate fundamental and drafting knowledge as it applies to company formats, company standards, and overall end product standards.

Users should also demonstrate the ability to formulate a planned approach to a problem, work within a given time frame, work in the presence of distractions and interruptions, communicate

effectively, and describe how to solve a problem.

Candidates should have a good history of work experience and practical knowledge.

Related aptitudes are those parts of a user's background that apply directly to his/her current job abilities, and would also apply to a system position. Prospective users should have previous system experience, a good math background, and good spatial relationships.

These abilities demonstrate a user's ability to work within a logical developmental framework; and from previous computer experiences users will not be intimidated by the use of the hardware and software.

Indirectly related aptitudes are not pertinent to the actual performance of a system user's job, but have the potential to enhance the candidate's on-the-job capabilities. Some of the indirect aptitudes are:

1. A language facility.
2. A teaching ability.
3. Effective communication of ideas.
4. A musical ability.
5. A hobby that demonstrates the use of logical progression.
6. Typing skills.

A person's attitude is apparent in his/her day to day activities. If the candidate is serious about his/her work and enjoys challenges, then working in a system environment may serve as a growth path for them. A person who volunteers for the job, is confident in his/her personal abilities, and is willing to take on the challenge of the system is a good candidate to pursue.

Motivation is more difficult for a manager to determine. Why does an individual want to be involved with the implementation of a system? Is it a status builder? Does it make the individual part of a special team? Would the system experience serve the individual as a springboard to another job with a different company? What does the candidate intend to accomplish after receiving training?

These are some very important questions to keep in mind while determining the motivations of a prospective employee. The basic question a manager has to resolve is: Will the employee provide a payback on my investment?

The best way to narrow the field of in-house employees is to find the employees who:

1. Have some years of service to the company.

2. May be vested in stock option or retirement plans.

3. Have proven a commitment to the company.

4. Have a stable home environment.

System knowledge is a valuable and marketable commodity. People who have experience with a system may become targets for headhunters and other companies. A manager's best defense is to find loyalty in the existing employee base, and capitalize on the employee's product knowledge.

Some organizational frameworks lend themselves to the assignment of system responsibilities. Smaller groups where one to two individuals are responsible for specific design applications reduces voluntary participation in favor of selection by prior user qualifications. Small organizations may not have the luxury of being able to choose system personnel.

The ideal beginning basis for selecting users is to have a large enough group available so the enthusiasm associated with a system can be linked to a voluntary participation program.

There are three steps involved in a voluntary user selection process. They are:

1. A system orientation seminar.

2. An initial selection procedure.

3. The final selection process.

The system orientation seminar is an important primary step in the selection process. The seminar serves as a public relations vehicle for clearing up rumors and misconceptions brought about by the system acquisition. The seminar also serves as a tool to attract potential user candidates.

A typical agenda for the orientation meeting might be:

1. An introduction to the system.

2. Job role definitions.

3. Program implementation schedule.

Ask your sales representative to assist in the seminar by

addressing the group; using films, slides, and literature to explain what the system is, how it works, and what the end results can and will be.

In addition to a discussion of the benefits of the system, the orientation seminar should also focus on some of what may be considered negative factors.

1. Discuss the human/machine interface that may produce a semi-sociable atmosphere. There is a potential for a temporarily elevated level of frustration.

2. The user may work in low-level lighting conditions.

3. The user's pride associated with art work and lettering may be diminished by having a computer perform the functions.

A discussion of the trade-offs may prevent a user becoming involved in a stressful, frustrating position that is not beneficial to the overall system implementation.

Define the job roles delineated by the implementation plan. Explain what the company's expectations are concerning the positions, and also what may be necessary qualifications for candidates interested in the positions.

Present an overview of the system implementation. Discuss the milestones and time frames that are projected for system installation, training, primary development, and initial project goals. Be certain everyone understands that the system implementation is a team effort, and those involved will be valuable members of the team.

Obtain a list of interested candidates at the end of the orientation seminar. From the list, an initial selection procedure can take place. Examine the work histories of all interested candidates according to appropriate company guidelines. Talk to involved managers and supervisors, if appropriate, to gather information concerning the candidates' knowledge, and their possible ability to use a system.

From the candidates' work history, supervisory recommendations, and the user requirements defined by the implementation plan, choose proper candidates to participate in the final selection procedure.

The final selection procedure is where a system manager can focus on specific candidates to find the best possible users of the system.

Have all prospective candidates fill out a short questionnaire (ten

questions or less) on why they are interested in operating the system. Target the questions towards employee attitudes and motivations.

Have a personal interview with each candidate. Use the information gathered from the questionnaire as focal points to probe the candidates' attitudes and motivations. Gear portions of the interview to cover the candidate's aptitudes and related skills. Have each candidate sell you on automated design and drafting. They should explain to you what a system is, and what they may do with it, given the opportunity.

A one-on-one interview with a candidate is the best possible tool for determining attitude, motivation, and individual skills. After the interview process, take some time to compare individual abilities and motivations. Then, make your final decisions.

Select personnel to fit the specifications defined by your company's job descriptions. Select personnel who represent the required disciplines called for in the system implementation plan. Plan for the future. Select personnel who can develop the expertise to become supervisors. Find those people who have prior experience, demonstrated knowledge, and the personality to achieve success through hard work.

After the final selection process is complete, notify all candidates and their management of your decisions. If necessary, arrange for the transfer of personnel. Continue with the implementation plan and proceed to the next major milestone, basic education of the new users.

## IV. WORK FLOW

Your system utilization will be clearly defined when you analyze the communication/feedback channels and internal organization of your facility. This system utilization will, in turn, define necessary guidelines that lead to a standardized work flow scheme for the system organization.

There are three major definitions of system organization types. They are:

1. Centralized organization.

2. Centralized/decentralized organization.

3. Decentralized organization.

If the system is a network of a computer system, the work stations

can be situated over a large area. The Local Area Network allows for inter-system communication and transmission of information. The density or distribution of work stations in your facility will classify your organization as one of the three definitions listed.

The centralized organization is a collection of systems in a geographically enclosed area and it will provide you with the most control possible over system resources.

A combined centralized/decentralized organization is a group of systems in a geographical location, with some remotely located work stations in other offices or buildings. The majority of work stations are in one place, so you still have close control over those resources. The remote work stations are outside of your sphere of influence, so your control of those resources is reduced considerably.

A decentralized organization is where all the systems in the network are distributed throughout a facility. There may be small concentrations of two or three work stations, but they are typified as being widely separated geographically. This system type is usually a shared resource between different organizations within the company and these groups will assume responsibility for the data that pertains to their applications. Your influence over this type of organization is minimal. You have little direct control of system usage, and will not have a need to know what projects are being developed in the other organizations.

Your internal organization and organization type defines the flow of work into the facility. From this entry point, projects will need to be put through an estimation and priority mechanism to determine relative importance. This prioritization then requires appropriate scheduling methods to achieve project completion in a timely fashion. The foundation of your work flow strategy should be the accomplishment of a balanced project throughput, system and user accountability, and overall efficiency of operations.

Because you are now dealing with a data base of information stored on disks throughout your network, it becomes very difficult for you to be aware, at a management level, of the progress and status of projects being developed on the system. Your work flow procedures should provide you with the tools to be able to track projects, and know where they stand in terms of completion.

After a project is completed and released, you will have to decide where the project data is to be maintained. The first choice is whether to keep the data accessible on the system, or to move the information to an archival medium and remove it from the disk. Developing an archival record of system projects is a task that all system users have to face. After all, disk space is not an infinite commodity. When you approach this task, you are going to need to examine how you currently access projects in a manual environment,

looking at frequency of access, revision management, and recording of archival data. This information will better help you to understand how the data created on the system will need to be accessed. The result of this research is the development of an efficient, easily maintainable archive structure that will give quick and accurate access to the information your organization has created.

System installation and operator training starts **two to four weeks prior to installation** and continues for **two months after installation**.

**Complete your preliminary standards.**

By this time you should have compiled all the necessary information needed to define a preliminary set of system standards. You will need to put the information together in a format that will serve as a basis for a system standards manual. The graphic symbology and detail drawings will be the first drawings your operators create when they return from training. Be sure to have everyone who supplied you with information review the documentation. You want to verify the correctness of the standards.

**Review system goals and objectives.**

As installation and training approaches, review the system goals and objectives again. This will refresh what the immediate goals of your installation really are. You may find that your initial assessment of the system implementation may need to be modified now. Review and amend, as necessary, your goals and objectives. This review process is important to the system manager because one of his/her major tasks is to communicate the implementation plan to the recently selected system users.

**Establish your initial production plan.**

You have set milestones as to what you want to accomplish on the system. You should now start putting timetables into place to accomplish those milestones. Choices have been made concerning what areas are the initial thrust of system usage. Target dates for when development tasks should be complete, when production should start, and what the initial goals and levels of productivity should be. Be certain that you select production tasks that are appropriate to your users' level of system expertise.

**Coordinate the installation.**

You are getting close to the arrival of the equipment now. Work with your sales representative to coordinate the shipping, arrival, and delivery of your system. Refer to the facility site plan you developed with the field engineer to plan a strategy for equipment that may need to be placed in different areas of the building. It

now becomes very important to begin pulling together site completion dates, system arrival dates, and planned system installation dates.

In general, be aware of what is happening, and any bottlenecks that may have a negative effect on the installation.

**Complete the site preparation.**

Complete the physical facility. Your area should now be ready for the equipment installation. All power, lighting, furniture, and fixtures should be in place.

**Supervise and complete installation.**

The installation of equipment will require your assistance to see that boxes are routed to the correct areas, and that curious onlookers are kept out of the way. Your field engineer is a trained professional who is installing your system according to well defined procedures. Your responsibility at this point is to help the field engineer do his/her job with as few disruptions as possible.

**Train your core group of users.**

While the system is being installed in your facility, you should have the core group of users being trained. There are two benefits to target training during the installation:

1. First, you get the users out of the office, reducing traffic during installation.

2. Second, when your users return from training, they will have equipment immediately available to them so they can pick up their system practice on their first day back on the job. Immediate practice is extremely important for retention of information.

**Receive basic training.**

Your users will be taking their basic training during installation. Basic training is just as the title says. Basic! Do not expect your users to be proficient or to have a comprehensive understanding of the system when they return. They will learn how to activate the software, use the software to make and save drawings, and plot completed drawings. The training class is very intense, but instructors try to keep the class fun and interesting. You should find your users to be enthusiastic and ready to continue developing their abilities when they return.

**Train all users.**

If you have a large number of people who you want to train on the system, you will probably arrange for different groups to go to basic training. After the core group receives training, you will need to plan some time before the next group of trainees receives training. Your strategy should be that as a group receives training they should have some priority on receiving hands-on time when they get back to the office. You can not bounce your first group off the system completely because they are in the middle of doing the development of your standard pattern and drawing libraries. But, you can balance their development time with the new trainees' learning time.

After all of your users have received training, quickly get them all involved to some degree with the initial development process. You should be able to give everyone a sense of purpose and direction in working on the system.

**Make preliminary production plan task assignments.**

As your users gain more direct system expertise, and the standard libraries near completion, you can start initial production. Start by selecting appropriate projects, and then assigning them to individuals or discipline groups who are ready to start working in a production environment. Do not expect too much immediately. There is a substantial difference between creating patterns and details, and using these tools to create an entire drawing. The first projects will probably be time consuming. Your users may not even be working as fast as they could on the drawing boards. Do not panic, they're learning again. You should very quickly see major improvements in productivity as they start to better understand the tricks and techniques for making drawings.

**Receive advanced training.**

After your users received basic training, and have accomplished a certain level of expertise on the computer, they still need more knowledge. Advanced training is designed to show them the remainder of the software and also how to begin using the available software tools to start customizing the system to your specific requirements. Advanced training will give your users the tools that they are probably realizing they need to make the system work better. These tools will improve the overall productivity of your system.

**Construct production and system use evaluation tools.**

As you move the system into a production mode, you will want to track system utilization and productivity. Most measurement tools have inherent problems, so you may consider using multiple methods to gain a better comparative understanding of how productivity is

improving. Try to implement these measurement tools as soon as you begin doing productive work. You want to do this immediately because you want your users to become accustomed to the concept of having their output measured, and also so you can see how rapidly your system productivity will grow.

Another suggestion is to begin a measurement process before the system installation, rating the productivity levels of manual design and drafting activities. These results can then be used as a baseline for comparison with productivity on the system.

**Define system development tasks and personnel.**

The system implementation should be approaching a production mode now. Nevertheless, constant system development is still extremely important to the overall goals and objectives of the system implementation. You have had time to observe how your users have developed on the system, so you should have a reasonably good idea who is quite successful at doing system development tasks. Continuing development is not a task for your entire user group. Assign development tasks to your best developers, and give them guidance in the directions you want to see the system evolve. Then, give them the necessary training, freedom, and time to accomplish these development directions.

**Complete initial production tasks.**

Production should now be a fact of life in the organization. The system should be integrated into the normal office environment and you should be getting reasonable production results from all of your users. You are now a functioning system environment.

**Evaluate the initial production plan.**

Allow production to continue for a length of time and monitor your productivity measuring instruments. You should be seeing an improving growth curve throughout this time. You need to evaluate your initial production versus your implementation goals and objectives. Did you achieve your goals? Surpass them? Fall short? Were your goals realistic? Do you need to reevaluate the next phase of the implementation plan? Do you need to rework your overall goals and objectives?

These are questions you have to ask and resolve. Your initial success in the implementation sequence will help you to answer these questions.

# V. STANDARDS

System standards are the specific guidelines that define exactly what work is accomplished on the system and how that work occurs.

The development of system standards is a continuing process throughout the evolution of the system and initial work on standards is extremely important. The accurate definition and implementation of standards will allow you to begin the production phase of the system earlier and with a higher degree of success. Your system standards are the key for arriving at an early achievement of your production goals.

After your system facility is in a production environment, the system standard guidelines will serve as a reference manual for new or casual system users.

You should start the initial planning of standards before the installation of your system. Your production goals and objectives dictate which applications are to be examined. Your immediate goals will be to select the graphic symbology that is required. Then, examine the company's manual design and drafting policies so you can apply directly transferable information to the system operation. Communication paths and responsible individuals should be listed, along with project submittal procedures for the system.

After you've acquired more information concerning software and operating system functions, you will want to start developing standards for graphics creation, output, backing up, and archival of data, and performing other system-wide operations.

As your organization develops, you will find the necessity for specialized software language programs to enhance your system operation. You will need to develop standards that define how these programs are written, and also to assist your users in the application of these programs.

Included in Appendix B are three formats for standards manual pages. The first is a pattern information sheet, the second is a user program documentation sheet, and the third is a numerical control setup sheet.

## A. PATTERN INFORMATION SHEET

The first line of the sheet is labelled PATTERN NAME. This is the name used when looking up or placing the pattern. The next line is labelled DIRECTORY. This is the system directory where the patterns

are stored. It can also be the path name where the directory is stored in the network. The PERTINENT INFORMATION line is for any information needed to place the pattern (origin point, defining view, etc.). The symbols are then placed (drawn or plotted) in the box with their insertion origin points and exit positions indicated. Any other pertinent information (scaling, rotation, etc.) should also be indicated in the NOTES area.

## B. USER PROGRAM INFORMATION SHEET

The user program information sheet is similar. The PROGRAM NAME line holds the name of the program. DIRECTORY LOCATION is the path name for where the program is stored on the system or on the network. The PROGRAM DESCRIPTION is an abstract describing the program. The next section is PROGRAM INPUT AND RESPONSES. This is for the exact program prompts in the order they are output, and indicates what types of responses the prompts expect. You can also indicate minimum and maximum valid responses. The PROGRAM OUTPUT section holds an example of what will be generated by the program. The KNOWN ERRORS section is the possible errors the program itself may generate. The CONTACTS section is for the name(s) and phone number(s) of the person(s) responsible for maintaining the program.

## C. NUMERICAL CONTROL SETUP SHEET

The numerical control setup sheet is for the numerical control programmer to record all necessary information while he/she is doing graphical part programming. The PART NO. is for the number of the part as it appears on the blueprint. The PART NAME is the part file path name and where it is located on the system or on the network. The WORK ORDER NO. is the order number to charge to for accounting purposes. TOOL PATH NO. is the number of the tool path as it exists on the system. TOOL NO. is the number of the tool as it exists on the numerical control machine. TOOL SIZE is the radius or diameter of the tool with other necessary information (corner radius, taper angle, etc.). RPM and IPM are the feed and speed of the tool. LEVEL NO. is the level or layer within the part file where the tool path can be found. DESCRIPTION is for a comment as to what the tool path is going to accomplish.

## D. OVERALL STRUCTURE FOR A SYSTEM STANDARDS MANUAL.

I. Introduction

II. System goals and objectives

III. Company system policy

IV. Organization chart

V. Contacts

VI. Project submittal procedures

A. Graphic projects

B. Development projects

C. Suggested enhancements

VII. Company design/drafting standards and conventions

VII. Graphic language standards and conventions

VIII. Symbol/part directories

IX. Program directories

X. Output standards

XI. Data tracking conventions

XII. Archiving standards

XII. System-wide operations

This outline includes information needed for most areas of system operations. The Standards Manual will serve as a uniquely specific operations guide to new or casual users, and the use and adherence of standards will avoid duplication of effort due to not knowing symbols or programs that exist.

The Standards Manual is a major undertaking. Nevertheless, it is also important to maintain the standards and keep updating the manual when changes occur. The most common failure inherent in the development of a standards manual is letting the manual get out of date. The manual starts as a good idea, because it is, but production and system familiarity become over-riding factors that erode the ability to keep it up to date. The best way to counter

this is to plan for and schedule a system user meeting on a regular basis for reviewing additions to the manual, and also for soliciting suggestions for additions or improvements from the users. The users may submit files for consideration for addition to the manual. The benefits derived from this meeting are a consistently examined and updated standards manual, and having a regular team building session that gives the users a sense of responsibility and solidarity.

A system effectively enforces standardization in the entire engineering, designing, and drafting cycle. Having a published, clearly stated, standards manual will help everyone do their job more effectively, leading you to the accomplishment of your productivity targets.

## VI. PRODUCTIVITY EVALUATION

Evaluating system productivity is essential to gain a good understanding of the amount of improvement that has occurred during the implementation of the system. It is especially important to have productivity measurement tools in place early in the implementation to see the initial growth.

Why measure productivity? There are many responses to this question. Some of the major reasons are:

1. To measure return on investment.

2. To estimate the time required to complete a task.

3. To justify the acquisition of additional hardware or software.

4. To appraise and reward system users and managers.

5. To appraise the efficiency of the operation.

No matter what you are trying to discover, prove, or justify, you can not accurately measure productivity levels without first measuring, or defining, base levels of performance. This base line can be measured directly from monitoring manual production methods; or by using intuitive methods that center around estimating manual production times. Once a base line has been determined, you can start developing comparisons based on system activity.

There are a number of different methods of measuring productivity levels. They are:

1. Hour ratios (manual estimate/actual system time).
2. Output ratios (system/manual).
3. Judgement and experience.
4. Cost ratios (manual/actual system time).
5. Improvement over time.
6. Monitoring quality
7. Benchmarks.
8. Monitor production rates.

As you can see, most methods for measuring the productivity of a system are based on a comparison of the work done on the system to work done with manual methods. Let's look at the different methods.

1. Hours ratio: This measurement is the ratio of the labor hours estimated to complete the design work manually over the actual labor hours required to complete the work using the system.
2. Output ratio: This is the ratio of the system output generated, (e.g., number of drawings plotted over a week's period) over the estimated or actual output without using a system.
3. Judgement and experience: Your productivity is estimated by a responsible individual based on the individual's judgement and experience.
4. Cost ratio: The ratio of the labor and material costs estimated or actually incurred to complete the design work manually over the actual labor and equipment costs using a system.
5. Improvement over time: The ratio of the design output currently experienced using the system over the output previously experienced without using a system, or with the use of a system at an earlier time or at a different installation.

6. Monitoring quality: The measurement of some quantitative value of quality (e.g., number of revisions required to properly create a drawing) to complete the work manually over the quantitative value of quality experienced using a system.

7. Benchmark: The ratio of the actual hours or cost to manually complete predefined design work over the actual hours or cost to produce the equivalent work using a system.

8. Monitoring production rate: The ratio of the output generated (e.g., number of drawings plotted) with the system during the current time period over the output generated with the system during a previous time period.

Each of these methods of recording productivity has some inherent problems. For example, several methods calculate ratios using actual versus calculated estimates. Estimates are usually not very reliable. For instance, the system manager may have a tendency to overestimate the time it takes to do a project manually, while the manual production supervisor may have a tendency to underestimate those same times. The elements included in making the estimates may also vary, making such comparisons difficult. Other methods may include, in the actual system time, such times as downtime, plot time, or backup/archiving time.

If cost is used instead of man hours, the question is how to calculate charges for the system. Should costs of hardware and software be distributed to general overhead, or only to the specific task of using the system? The charges for system time are heavily dependent on how the system is depreciated, and they also depend on what costs are charged against the system facility.

Productivity measurements based on actual comparisons are the most reliable. However, the majority of tasks done on the system are seldom equivalent to manual work. This method is seldom used and not practical.

Monitoring the overall productivity improvements of system operation by recording the system output over time is effective and can be readily performed.

Avoid judgmental measurements. It should be very obvious that productivity numbers based on judgement are questionable.

Productivity measurements recorded using benchmark techniques are quite reliable. The problem with benchmarks is that they are costly and are usually performed when the tasks are small and manpower is available.

Whatever methodology you employ to evaluate productivity should provide measurements that accurately show distinct improvements. Typical evaluated system benefits are higher drawing quality, higher drafting productivity, higher quality end products, decreased turnaround times, higher design productivity, better employee satisfaction, better customer satisfaction, higher engineering productivity, lower product costs, better management controls, better scheduling, and fewer revisions.

Charting the impact of the system by such factors will help you in monitoring the productivity of your organization.

You should remember that increased productivity does not simply mean more work done in fewer hours. The ultimate purpose of a system is to more quickly produce a higher quality product at a lower cost.

## VII. PRODUCTION PLAN IMPLEMENTATION

<u>Two to four months after installation</u> you should be ready to:

1. Complete personnel applications training.
2. Move into the production mode.
3. Define long range planning requirements.
4. Evaluate system progress.
5. Evaluate personnel progress.

**Schedule your development tasks and training requirements.**

As production becomes more of a priority, you are going to have everyone working on projects. You will find it necessary to formally schedule development time for those people assigned to do development tasks. A certain percentage of these users' day should be set aside for working on problem solving tasks. Also, now that everyone is working on production, this is a good time to break your development personnel away to attend development related classes. These classes are designed to give development personnel a better understanding of problem solving techniques that they can use in their daily routine.

**Complete user training.**

If you were sending groups of users to class, be sure everyone completes all training in a timely manner. This gives everyone a

feeling of equal knowledge, and sense of being part of the system user team.

**Refine your standards and work flow.**

Your initial set of standards and work flow paths are now being used in a production environment. Review these plans and determine if they are functional. You may find bottlenecks in the work flow that were not initially apparent, or disparities in your standards that need correcting. Correct these problems now while they are still flexible. Later these problems may become standardized into your operations.

**Implement a full production program.**

By now your developers should have customized your production to include the use of graphic menus, and many user defined programs. The completion of these tools, along with users who are gaining a real familiarity with the system, should allow you to move into a full production mode of operation. The majority of work on the system should be the completion of projects. Work flow should be smooth, and plotting, backups, and archiving of data should be happening daily.

**Define your long range goals and objectives.**

Initial production plans should be in full swing, and you should be seeing a payback on your implementation. Now you need to re-examine your overall implementation goals and objectives to determine what your long range planning is going to require. You need to re-evaluate your initial plans and redefine what may be unrealistic or out-of-line goals and objectives. Once you've defined these directions you can better target the milestones to accomplish these activities.

**Evaluate system usage.**

Your productivity monitors should also be refined as the system continues to expand. Review these measurements over time to see how your system growth is continuing. Take into consideration other measures that affect the usage results of the system. Items like workstation downtime, user training time, and equipment installation delays due to backlogs are examples.

**Make implementation evaluation.**

After reviewing system usage measurements, evaluate the system based on your original goals and objectives. Your comparison of system usage against your goals and objectives will show you what your progress has been throughout the implementation process.

**Evaluate and communicate to management and users the development and production needs.**

The people working on the system will soon have a very good knowledge of what other software tools they need to do their jobs better. Listen to their needs, and also communicate to them what is going to be done to assist them in their work. This is a place where your developers will make an important difference. Since the developers also work as production personnel, your users will soon understand that they can explain their concerns to the developers and receive a sympathetic hearing.

The developers will have credentials. They understand the system. Management should recognize and encourage this relationship. You should even explore the possibility of sending the developers to local seminars to improve their interpersonal communication skills.

**Establish long range production, training, and development needs.**

You will need to put together a schedule that will accomplish your long range goals and objectives in a logical and achievable order.

Plan for different disciplines within your organization to expand into using the system. You may find new sets of system standards may be needed to accomplish this growth. You also need to plan for any necessary training and special development needs that are required to meet these long range goals.

**Evaluate system personnel progress.**

Your system personnel have been a very important part of your system implementation. In fact, they have made the system whatever it is at this point. Evaluate your personnel's performance. Give them candid feedback of their performance on the system. If so inclined, reward them. Whatever you do, be positive; even with people who are performing at a below average level. People do not all learn at the same rate, or they may not be confident or interested in really excelling on the system. Encourage these people. They need encouragement the most. A little praise will do wonders with their attitude.

**Complete applications and other developmental training.**

After attending other advanced classes, your users should start to use the tools they learned. Give them time to experiment and learn how the software packages work. Then have the new software incorporated into the production work flow.

**Define customized training and production needs.**

As a part of your long range planning, you need to plan for special training of certain personnel in your organization. Customized

training may involve working with regional system engineers or getting training by the vendor.

Keep in mind that your production needs define what types of training you may need. Closely examine what your goals and objectives define as your long range production needs.

## VIII. CONTINUING GROWTH AND IMPLEMENTATION

Four months after installation establish continuing programs for development and system growth. Implement long range production plans. Monitor and evaluate production and development. Evaluate personnel progress and growth.

**Complete your production goals.**

By now your users should have a good grasp of system operations. Their knowledge should be evident in their productivity. When you began production on the system you had goals defined for maximum productivity levels. This is where your group should be now. Compare your planned goals with your actual accomplishments.

**Monitor and evaluate your system usage.**

Your productivity monitors have been in place for some time and you should be able to see the productivity curve improvement over time. Evaluate your system usage from these tools. Remember that no one productivity measurement device is accurate. An average of different measurements should be considered when evaluating overall system performance.

**Communicate the problems and your concerns to the users and management.**

Over the course of your implementation, problems or concerns over different aspects of the system and how your users are reacting to the system, may become evident. Begin a communication and feedback process to better understand the encountered problems and the possible resolutions of those problems.

**Evaluate and resolve the problems.**

Now that you have a clear picture of what organizational or system problems may be occurring, talk with appropriate individuals within your organization and the vendor to resolve the difficulties. Organizational corrections, improved dealer communications, and closely working with your system engineers will help solve most encountered problems.

**Implement advance production innovations.**

Your users will begin to notice where room for improvement exists in your system. Encourage their participation in making suggestions for improvements to your system developers. Your users' production innovations are a part of the fine tuning of your system operations. Your management task will be to see that the developers understand that the users' suggestions are for improving overall system performance, and not an attack on how the developers did their work. You want to build communication bridges so that there is a free flow of information between all levels of your system organization.

**Evaluate system personnel.**

By now you have an extremely good idea as to what your users have accomplished on the system. The different levels of expertise should be clearly defined. You can probably be assured that their learning curves are reaching a plateau. Evaluate the individual users accordingly. You must understand, prior to evaluating everyone, that there are different levels of performance and these levels have little to do with how these people should be evaluated. You must evaluate each user on an individual basis. Be open and honest with the users; talk to them about their success and have them talk to you about ways they think they can improve on the system. Get their feelings on how successful the implementation has been, and what working on the system means to them. Then, make suggestions for where you perceive the users need to improve, and give them the direction and encouragement to accomplish those improvements.

**Evaluate the system users' growth.**

Review the overall performance of the system personnel. This should include the information that was communicated during the system personnel evaluations. Review the personal successes, comments, recommended improvements, and action plan to accomplish the improvements. This activity will give management an awareness of the individuals involved with the system, and what is perceived as growth paths for the individuals.

**Continue to assist in development of standards and procedures.**

Even though the system has become production oriented, it will continue to be necessary to add to the company standards in place on the system, and also any procedural operations that become important as the system continues to evolve. Have the users continue to work on the addition of standards and procedures. This activity will give everyone a knowledge of where the system is directed and what standards are defined. Working on these standards will give the users a feeling of contributing to the overall development of the system.

**Review your system goals and objectives.**

It is time for that periodic review and re-evaluation of the system goals and objectives. Examine your actual progress against your planned progress. Consider all the mitigating factors that have occurred that may have impeded your implementation. Did you succeed? To what degree? Are you ahead of your plan? Where do you go from here? Be systematic and candid with yourself when you examine the system's progress. Finally, examine what you have planned as future directions on the system. Look at your original goals and objectives, re-evaluate them, and then start planning how to accomplish the tasks not yet completed.

**Implement continuing system development goals and objectives.**

Using your long-range goals and objectives as a guideline for future growth, begin taking steps to accomplish the tasks. Communicate the plans to everyone involved. Be open to your system users' and developers' suggestions for accomplishing the growth.

**Define development and system growth requirements.**

At this stage of implementation your users know better than you do what is required to be successful. Their input will help you determine what information may be needed to accomplish the system growth, and also the time frame in which the implementation milestones can be accomplished.

**Define your system use growth plan.**

Put together an overall plan that will move the system to the next level of implementation from your goal and objective definitions. This plan should make provisions for hardware expansion, additional users, new software applications, and the addition of other disciplines within your company.

**Define future support and training needs.**

After the next level of system expansion and growth has been agreed upon and put into place, focus your actions on putting together a timeline that defines the support and training requirements necessary to effectively accomplish this growth. Include training for new users and any necessary advanced training for users who have been working on the system.

**Schedule the additional and continuing training.**

Utilizing the vendors' corporate education schedules, put into place a plan for the effective additional training of any new users brought in through system expansion or by user attrition. You will probably find a continuing need for training users. This is a natural occurrence.

**Implement your long range production plans.**

After performing system expansion, either through hardware additions or acquiring additional software packages, put in to effect the production plans as outlined in your continuing development goals and objectives. You will find that a natural growth curve will exist as implementation continues. Be sure to take the time to re-examine and fine tune your productivity measurement tools at this time. You will definitely want to keep productivity measurements in place, but you will want to examine your productivity gains in different ways to see where different activities on the system may cause improvements or impacts to the accomplishment of your overall goals and objectives.

## IX. SYSTEM EXPANSION

As you accomplish your productivity goals and objectives, you will find your company has totally integrated the system into your workplace. You will find that to continue the development of your system you will need to explore alternate methods of system expansion.

The distributed processing capability of the system provides you with the benefit of being able to expand the hardware capabilities of the network in incremental steps. You can enlarge the network by adding either a single system or by adding multiple systems. Other peripherals may be added to your network to satisfy growing needs for data storage or archiving data.

Another way of expanding the hardware capabilities of your system is by connecting the network into a mainframe computer, yours or a time share mainframe. You will gain the computational power and data base abilities of your mainframe, and you can carry these capabilities through to the system for the analysis and the manipulation of data.

In addition to expanding your hardware capabilities, you should also examine software application packages that will assist you in expanding into other system application areas. When you are determining the feasibility of adding new application software packages, you will need to give consideration to

1. Personnel.

2. Additional training requirements.

3. Current system utilization.

4. Applicability of the discipline.

5. What possible productivity growth may result from the software.

If your analysis finds that the application software is functional and can provide implementation growth, then implement the use of the application.

There is another method of accomplishing system expansion that is not a capital cost to your company. This expansion comes from using multiple shifts of users on the system. There are a number of benefits derived from multiple shifts. They are:

1. Efficient user input rates.

2. Reduced job throughput times.

3. Increased productivity ratios.

You will see immediate gains in your output production. Multiple shift operations give a greater payback because the systems are being used for more hours per day.

Along with their benefits, multiple shifts have some drawbacks. These drawbacks are:

1. Reduced levels of communications.

2. Problems in resolving design questions.

3. Difficulty managing and monitoring user performance.

These problems can be resolved by putting into place a flex-time shift structure or an overlapping shift schedule. What you want to achieve is having all of your users in the office during some part of the normal working day. This provides everyone with the ability to gather needed information and resolve design questions. Seeing everyone will also allow you to better monitor the work performance of your users. If you do go to multiple shifts you will need to select supervisory personnel to monitor and direct work outside of normal business hours.

The benefits derived from expanding to multiple shifts greatly offset the drawbacks. The drawbacks can be minimized by thoughtful schedule planning around your office environment.

# APPENDIX A

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## JOB DESCRIPTION

**JOB:** SUPERVISOR, CAD/CAM SYSTEM

**OBJECTIVE OF POSITION**

Direct the activities of all assigned personnel. Coordinate CAD/CAM activities within the engineering department and plan the efficient use of people and systems to meet schedule and job cost goals. Maintain and distribute affective management reports.

**ORGANIZATION**

**Report To:** Manager/Engineering Services

**Supervise:** CAD/CAM System Designers
CAD/CAM System Users

**RELATIONSHIPS**

**Manager/Engineering Services:**

Refer policy and administration matters to Manager, Engineering Services. Keep the manager fully informed on status of group assignments.

**Other Personnel:**

Work with other personnel where coordination and cooperation are required.

**INDIVIDUAL RESPONSIBILITIES**

**Supervision:**

Be responsible for the proper and timely supervision, appraisal, assignment, and follow-up of workloads. Make recommendations concerning compensation adjustments and promotions of all assigned personnel. Coordinate activities within the engineering department to plan the efficient use of people and systems to meet schedules and job cost goals. Promote the use of CAD/CAM within the total department.

**Systems:**

Initiate and be responsible for system standards, methods, and procedures. Define standards for the production of output drawings, and also the archiving of data. Maintain and distribute effective management reports.

**Policy:**

Give continuous consideration to engineering and division policies; particularly those which affect new products, product development, product problems, design for manufacturing economies, and production schedules to measure their effectiveness. Recommend new or revised policies to the manager of the engineering department when necessary.

**Planning:**

Collaborate with the manager of the engineering department in developing and administering the annual plan, quarterly programs, and five-year plan of the division with respect to the engineering department.

**Personnel Administration and Organization Planning:**

Maintain an appropriate group to meet the responsibilities of the position, recommending modification of that group as necessary due to changing conditions or new objectives.

Supervise subordinates in performing the work of their respective positions. Plan and delegate to them regular and special assignments, and maintain aggressive follow-through to insure proper performance of their respective responsibilities. Recommend selections, transfers, promotions, and adjustments of compensation. Train, measure effectiveness of effort, maintain discipline and control, and take appropriate corrective action according to established corporate policies and procedures. Participate in or conduct periodic group appraisals and individual progress reviews as required.

Cooperate with the personnel department in securing available assistance in administering these responsibilities.

**EXTERNAL RELATIONS**

Establish and maintain contact with other divisions, industries, organizations, and schools.

**PERSONAL DEVELOPMENT**

Through participation in graphic arts, engineering, management association activities, and technical publications, keep informed on current practices and developments in the areas of the position responsibilities. Follow the general development of the company in order to be prepared to contribute effectively in carrying out long range programs. Display excellent leadership ability and the ability to support company decisions.

## JOB DESCRIPTION

**JOB:** Senior Designer

**DEPARTMENT:** Engineering

**SUMMARY OF JOB:**

Conceive new designs, prepare complex graphic layouts, and do associated complex calculations with little technical leadership from an engineer, utilizing a CAD/CAM system.

**JOB DUTIES AND RESPONSIBILITIES:**

Operate a graphic workstation, and utilize the system's hardware and software.

Display the ability to conceive or design machines and related components with little technical supervision from an engineer.

Prepare complex graphic engineering layouts, utilizing complex related calculations.

Prepare complex engineering quotations as required.

Work with or direct other engineering personnel on design projects.

Gather data from systems, catalogs, or reference files.

Maintain a high degree of attention and concentration.

Handle confidential information in the form of engineering drawings, quotations, and new design concepts.

Provide personal contact with other departments, vendors, and customers as required.

Display good leadership abilities and support company decisions.

**EDUCATION:**

High school, two years of college or equivalent.

**EXPERIENCE:**

Ten years minimum.

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## JOB DESCRIPTION

**JOB:** Designer "A"

**DEPARTMENT:** Engineering

**SUMMARY OF JOB:**

Prepare complex mechanical engineering layouts incorporating new designs, or modifications of existing designs, and the necessary moderately complex related calculations, utilizing the CAD/CAM system.

**JOB DUTIES AND RESPONSIBILITIES:**

Operate a graphics workstation, and utilize the system's hardware and software.

Design and prepare complex mechanical engineering layouts utilizing moderately complex calculations.

Conceive and design machines and related components.

Gather required data from the system, catalogs, and reference files.

Show creative ability.

Instruct and direct other engineering personnel as required.

Maintain a high level of concentration and attention.

Handle confidential information in the form of engineering drawings, quotations, and new design concepts.

Job requires initiative, ingenuity, and a high level of responsibility.

**EDUCATION:**

High school, plus two years of college or equivalent work experience.

**EXPERIENCE:**

Ten years.

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## JOB DESCRIPTION

**JOB:** Designer "B"

**DEPARTMENT:** Engineering

**SUMMARY OF JOB:**

Prepare simple mechanical engineering layouts incorporating new designs or modifications of existing designs, and perform the necessary moderately complex related calculations, utilizing the CAD/CAM system.

**JOB DUTIES AND RESPONSIBILITIES:**

Operate a graphics workstation, utilizing the system's hardware and software.

Design and prepare simple mechanical engineering layouts utilizing moderately complex calculations.

Conceive or design machines and related components.

Gather data from the system, catalogs, and reference files.

Show creative ability.

Instruct and direct other engineering personnel as required.

Maintain a high level of concentration and attention.

Handle confidential information in the form of engineering drawings, quotations, and new design concepts.

Job requires initiative, ingenuity, and a high level of responsibility.

**EDUCATION:**

High school, plus two years of college or equivalent work experience.

**EXPERIENCE:**

Five years.

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## JOB DESCRIPTION

**JOB:** System Technician "A"

**IMMEDIATE SUPERVISOR:** Supervisor, CAD/CAM System

**DEPARTMENT:** Engineering

**SUMMARY OF JOB:**

Operate a graphics workstation and associated peripheral devices.

Understand complex mechanical and electrical drawings.

Compose and revise complex detail drawings, assembly drawings, and bills of materials. Obtain information from sketches, market prints, verbal instructions, actual parts, and by abstracting designers' data from the system data base.

Prepare simple layouts under supervision.

Understand company drafting and CAD/CAM system procedures and standards.

Gather data from catalogs and reference books.

Maintain high level of attention and concentration.

Handle confidential information in the form of engineering drawings.

Follow standardized procedures with minimum supervision in normal routine or work.

**EDUCATION:**

High school or technical. Graphics courses and trigonometry.

**EXPERIENCE:**

One year on a CAD/CAM system, one year manual drafting minimum.

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## JOB DESCRIPTION

**JOB:** System Technician "B"

**IMMEDIATE SUPERVISOR:** Supervisor, CAD/CAM System

**DEPARTMENT:** Engineering

**SUMMARY OF JOB:**

Compose reasonably complex engineering drawings and bills of materials under supervision, utilizing a CAD/CAM system.

**JOB DUTIES AND RESPONSIBILITIES:**

Operate a graphics workstation and associated peripherals.

Understand reasonably complex mechanical and electrical drawings.

Compose and revise reasonably complex detail drawings, assembly drawings, and bills of materials from sketches, market prints, verbal instructions, and actual parts.

Learn company drafting and CAD/CAM system procedures and standards.

Gather data from catalogs and reference books.

Maintain considerable attention and concentration.

Handle confidential information in the form of engineering drawings.

Follow standardized procedures with little immediate supervision in normal routine or work.

**EDUCATION:**

High school graduate, or technical school. Basic graphics course and trigonometry.

**EXPERIENCE:**

One year minimum manual drafting.

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## JOB DESCRIPTIONS

**JOB:** CAD Department Manager

**SUPERVISOR:** Vice President of Engineering

**DEPARTMENT:** Engineering

**BASIC FUNCTION:**

To direct, supervise, and schedule the work for the CAD group. Promote and sell the benefits and services of the automated design and drafting group to the various engineering groups within and outside the department.

**DUTIES AND RESPONSIBILITIES**

Promote the use of CAD to other groups within the company.

Schedule and coordinate the transition of non-CAD disciplines to automated design/drafting.

Establish company standards for work produced by the CAD group.

Establish procedures for controlling work flow between CAD users and the CAD group.

Manage the cost-effectiveness and productivity of the CAD group.

Monitor the support and service supplied by the CAD vendor to ensure that it meets company requirements and contractual commitments.

Represent the company at user association meetings and functions.

Develop effective communications between the CAD group and engineering groups.

Perform company determined managerial functions in the department.

**PERFORMANCE CRITERIA:**

Quality, timeliness, and cost effectiveness of final drawing and documentation output.

Implementation of continuous two or three shift operations where dictated by workload.

**EDUCATION AND EXPERIENCE:**

Minimum of five years experience in line supervision in design or other engineering support service environments.

Should be an outgoing, people oriented person, willing and able to sell the benefits of automated design and drafting.

Have the ability to supervise and direct the work of others.

## JOB DESCRIPTION

**JOB:** CAD Supervisor

**SUPERVISION:**

Receives administrative directions on work which is assigned in terms of broad objectives; reports to engineering management.

**DEPARTMENT:** Engineering

**BASIC FUNCTION:**

Responsible for the administration and supervision of the CAD group.

**DUTIES AND RESPONSIBILITIES:**

Controls and approves work performed by personnel assigned to the CAD group to ensure quality is maintained.

Makes decisions concerning long-range planning, scheduling, budgeting, and priorities.

Develops and maintains a file of solutions to unusual CAD oriented technical problems, and maintains current knowledge of new developments in system improvements to keep the groups' expertise current.

Develops new methods of CAD design or drawing presentation to assure optimum utilization of personnel and equipment.

Collects and evaluates statistical and technical information for the CAD group.

Develops and maintains estimating guidelines for CAD work, and assists in the preparation of estimates for new projects.

**CHARACTERISTICS AND CAPABILITIES:**

Must have a proven ability to plan and organize work and supervise engineering personnel.

Must be knowledgeable of and receptive to new techniques applicable to the group.

Must demonstrate the ability to exercise a high degree of technical judgement in providing solid solutions to technical and state-of-the-art problems.

Must exhibit supervisory and administrative talent and be able to accept broad responsibilities within the group.

**EDUCATION AND EXPERIENCE:**

A minimum of a high school diploma supplemented by one of the following:

An associate degree or certificate of completion of a two-year technology course in engineering, and eight years of experience in the engineering disciplines.

At least ten years of experience in design and drafting.

Partial credit should be given for design and drafting experience not related to the disciplines being served by the system.

# APPENDIX B

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# PATTERN INFORMATION SHEET

**PATTERN NAME:** _____

**DIRECTORY LOCATION:** _____

**PERTINENT INFORMATION:** _____

_____

_____

NOTES: _____

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# USER PROGRAM INFORMATION SHEET

PROGRAM NAME:

DIRECTORY LOCATION:

PROGRAM DESCRIPTION:

PROGRAM INPUT AND RESPONSES:

PROGRAM OUTPUT:

KNOWN ERRORS:

CONTACTS:

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# NUMERICAL CONTROL SETUP SHEET

**PART NO.:** _____ **DATE :** _____

**PART NAME :** _____

**WORK ORDER NO. :** _____

| TOOL PATH NO. | TOOL NO. | TOOL SIZE | RPM | IPM | LEVEL NO. | DISCRETION |
|---|---|---|---|---|---|---|
| | | | | | | |

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Logical implementation steps and procedures that should be followed after a small machine shop has purchased a CAD/CAM system.

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