PLANNING MODERN MANUFACTURING SYSTEMS

BY

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INTRODUCTION

A manufacturing system consists of production methods or procedures, facilities or equipment, tooling, material moving or handling systems, quality assurance, production control, and people collected together to accomplish specific manufacturing or fabrication sequences resulting in components or end products. (DeGarmo, Black, & Kosher,1997; Seymour, 1995) If the end products which are suggested in the above definition are included, then five groups of related components can easily be identified for planning: a) **equipment and facilities component:** machines, tooling, equipment and facilities; b) **production methods and processes component:** procedures, production methods, quality assurance, and production control; c) **materials and material moving and handling component:** materials and material/tooling handling or moving systems; d) **Labor component:** people or men; and e) **the end products**

Although they share some similarities in some aspects, modern manufacturing systems are very different from traditional systems. For example, modern manufacturing systems are very computer-dependent, operate in highly and complex competitive societies, process newer and harder materials, and operate in an environmentally sensitive world which is getting smaller each day. As a result, modern manufacturing systems are more and more perceived as "closed-loop" systems, which have no room for unnecessary variations in all their components. Thus, instead of the traditional systems in which the components are separated and on their own (as was the case with the 1980s islands of automation), today's systems tend to be more integrated, much like a “whole”. Any plan intended for any one component will most likely affect the rest. See figure 1.

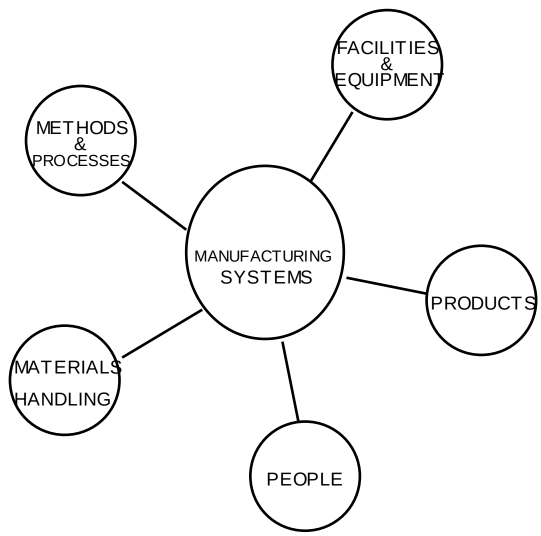

Figure 1. Components of Manufacturing Systems

One of the main goals in operating a modern manufacturing enterprise is efficiency. Manufacturing systems in such an enterprise are made up of important components each of which must be well planned in order to meet the increasing demand in today’s competitive manufacturing industry. The growth in modern technology has rendered the manufacturing environment such a complex place that a more comprehensive planning approach is needed to better compete in today’s manufacturing industry. Manufacturing systems also have been influenced so much by modern technology that systematic planning is a must for every manufacturing enterprise.

This article also suggests that manufacturing systems professionals (professors, students, workers etc.) need to understand the nature of these innovations in order to be more knowledgeable and better represent their programs in the industry. Industrial Technology professionals who are in manufacturing field should align with modern manufacturing industry and its practices. The nature of planning needed in each component area is discussed in the following sections. Although each of the components in figure 1 can be taken out of sequence (for planning) by any manufacturing entity according to their need, effort has been made to follow the sequence suggested in the model developed by Seymour (1995), to highlight the nature of planning required in each component area. In his *Developing Manufacturing Systems* model, Seymour (1995) had sequenced the components in the order that they should be taken when developing or planning a manufacturing system.

Planning for Production Methods and Processes

Planning for production methods and processes actually is dependent upon the type of product or products, which the company is established or has accepted to manufacture. The company depends on that information to generate its so-called *annual operating plan or AOP.* (Pelphery, 1998) The production planner studies the AOP and determines the unit production plan and master production schedule, which is used to create a material procurement and shop floor manufacturing plan. All this information, together with the product's blue print or production drawing, is needed by the process engineers and technologists who will develop a detailed plan for the methods and processes needed to produce the number of products required.

Due to the increasing and complex manufacturing challenges of modern industry, knowledge and presence of several key factors and resources are necessary to properly do a compressive planning for production methods and processes for a modern company. One such resource is the role of the computer in integrating the increasing activities of a modern facility. The concept of computer-integrated manufacturing (CIM) must be established in any facility that is planning production methods and processes. CIM, by means of its powerful sub-systems or modules, makes the sharing of common computer data between manufacturing disciplines and other systems required to produce a product possible. See Figure 2. Since many manufacturing companies have different products and processes, Kelly (1998) recommended that "Each company will need to develop its own CIM philosophy, strategy, and plan for implementation." p. 328

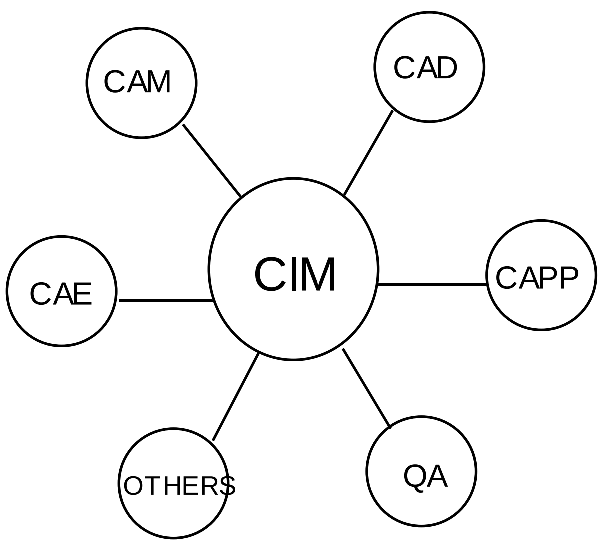

Figure 2. Some CIM Sub-Systems

With the CIM environment established, the planners must consider the use of concurrent engineering philosophy. In the highly competitive manufacturing industry, the concept of concurrent engineering helps companies to rapidly and efficiently design and manufacture a product in a shorter time cycle. Concurrent engineering also helps in using forces of change as tools or resources in organizations and communication, for efficient, fast and economical product development (Wakil, 1998). Concurrent engineering philosophy also helps to involve the customer in all phases of the product's development. A major objective in virtually all manufacturing system development phases today is the involvement of the customer who will eventually decide whether to use the end product or not. The customer's input must be sought in developing any plan on how to make the product, in order to avoid any potential problem that may come up later.

The concept of group technology has been around for a while now, and companies that have implemented it are reaping the rewards. A modern comprehensive plan for a competitive manufacturing must include that technology, to fully equip the organization for the tasks ahead. In the same token many of the recent widely publicized modern manufacturing techniques, such as computer-aided process planning (CAPP), just-in-time (JIT) manufacturing, flexible manufacturing systems (FMS), computer-aided manufacturing (CAM), tool inventory control systems, and the rest must be included. There are also many powerful software available today for use in operating these various systems. With the implemented CIM environment, the company will reap the reward of an efficient flow and control of information.

Schey (2000) also emphasized that formal methods of quality assurance must be established, together with a plan for preventive maintenance of equipment. To these can be added the company's formal process planning, production control, routing and scheduling tasks.

Planning for Equipment and Facilities

Because they are long-term capital investment for the company, facilities and equipment planning for a modern manufacturing enterprise must have its basis on the long-term goals and objectives of the company concerned. These goals and objectives may include the company's business plans and products. " A facilities plan is a well thought out procedure for purchasing either new equipment or rebuilt equipment in order to meet the capability or capacity requirements of the company". (Koenig, 1994, p. 86) What is being suggested here is that a system's planner does not just make a plan for the sake of one, or even to justify an end. A facilities and equipment planner must integrate the long-term goals of the company into the plan in order to meet the future needs of the company. Such often subtle issues as immediate and future capacity of the facility and equipment, cost of their maintenance, ideal vendors and dealers of the equipment, needed training and skills requirement of the operators of the equipment, and their life cycle must be included in that plan.

For a modern manufacturing entity to survive today, the planning for its equipment and facilities must take a comprehensive approach. The days are gone when manufacturing companies had machines and building space sitting idle for days or weeks on end. Today's manufacturing companies cannot afford those luxuries any longer, because they must operate in an efficient manner to make profit for their stockholders, and account for every dollar invested in that business. As a result, an idle piece of machinery or an empty or underused space cannot be tolerated. Added to that is the need to include every facet of the infrastructure in the plan so that the system will be treated as a whole. Such facets as capacity and capability of facilities and equipment, level of automation required, life cycle, maintenance, skill requirement, and return on investment must be included in such a plan for it to be comprehensive. No room should be given for any error of exclusion, omission and such likes, which may become a future problem in the operation of the system. However, the plan is highly dependent on the available capital budgeted for the component.

Assuming that the budgeted capital is not a problem, the facilities and equipment planner can take several steps to aid in developing an efficient facility and equipment plan. It is once again assumed that the planner has taken into consideration all the company's long-term goals and objectives. Koenig (1994) suggested that the planning include: a) consolidating facilities needs list; b) ranking equipment needs; c) placing equipment in year-of-purchase groups; and d) establishing due dates for major action items through implementation of the equipment. Focusing on, and integrating, the needs of the company into these steps will result in a more efficient equipment and facilities plan for the company.

Planning for Materials and Materials Handling

Broadly speaking, manufacturing materials include metals, ceramics, composites, synthetic polymers (plastics), and natural polymers (wood). Other materials such as the different types of coolants or cutting fluids can be added to these. Three key areas need to be planned for in materials and material handling. The first area is to identify the type of materials the company will be employing in manufacturing its various product lines. This is important because it will influence the types of equipment that will be purchased for machining or fabricating those materials. Those materials, their available shapes, prices, ease of processing, manufacturing properties, suppliers, proximity and environmental/disposal issues should be identified and documented. All these pieces of information can constitute one of the CIM sub-systems already discussed. There are also some smart software capable of linking these materials to specific product characteristics, thus helping to make material selection and substitution easy tasks.

The second key area that needs to be planned is material movement or handling. Schey (2000) noted that material movement is the most auxiliary function in production process. Raw materials, partly finished parts and other tooling must be made available to every workstation at the right time. The material-handling system that should be planned for a modern manufacturing enterprise must involve programmable automation, such as, robots, automated guided vehicles (AGVs), conveyors, shuttle carts, pallets and/or other programmable systems that can efficiently move tools or parts to their intended destinations in a timely manner. These systems are part of, and are also sub-systems, of the CIM network system already implemented in the facility.

The third area of materials to be planned is the inventory of materials and tooling. For the materials, this is one area where just-in-time philosophy should be seriously considered. Modern competitive manufacturing tries to avoid carrying any inventory of materials. For the material- and tooling-handling systems, all required robots, AGVs, conveyors, shuttle carts, and pallets must be economically justified and documented. There are simple equations employed in determining their return on investment (ROI). This analysis should be conducted and dealer prices and service commitments compared before purchasing such expensive systems.

Planning for Labor

Labor, workers, or people are the most important component in a manufacturing system. They are the ones who will use their initiative and other system components to produce the product to the required specifications and quality. These employees must be sought, hired, and trained. In most cases, the jobs are advertised in various forms. But one of the biggest problems facing employers today is how to tell a bad employee from a good one. A recent study of 81,000 people on integrity, work attitude and drug use by Orion PE System (1999) found that 24.9% of them admitted to stealing from previous employers, 28.5% admitted to some drug use, 24.0% admitted they had problems with absences in previous jobs, while 30.0% admitted tardiness in previous jobs. Clearly, no employer who intends to be on a competitive edge would want to hire such employees.

A company may have the best components, but if it does not employ and train the best workers it may not produce quality products, which are the only things that can save it from today's stiff competition. There is always a positive relationship between productivity and the ethics of a company's employees. Industrial responsibility is directly related to industrial productivity. Both go hand in hand. When there is a low industrial responsibility, industrial productivity tends to be low and vice versa.

Industrial responsibility usually precedes industrial productivity. This is especially true of new and start-up companies where profits may not be realized for some years until the company has been firmly established. For such companies, it is very important that corporate and employee responsibilities are strengthened the same time other areas of the companies are being established. Otherwise, the companies may later find out that they have to go back to deal with training and responsibility problem, a potential factor in the collapse of many new manufacturing companies.

The more productive manufacturing companies will be those that hire more responsible workers. Thus, it is very important for manufacturing organizations to take the pain to seek and hire highly responsible individuals if their businesses are to progress. Similarly, workers should strive to be employed by companies that have high responsibility. When responsible workers work for responsible companies, success usually results and everyone tends to benefit.

Competent, responsible, and knowledgeable employees with manufacturing background should be sought and hired. Kelley (1998) recommended that such employees must be flexible so as to perform multiple functions, and will need to be trained to perform other manufacturing disciplines. Some good sources of such workers are in Manufacturing Systems and Technology programs that are found in many colleges and universities all over the United States. Administrators and professors of each of those programs will be willing to help any employer who needs these professionals.

Planning for the End Product

Planning for the end product actually involves most or all CIM sub-systems, because every one of them has something to do with the product. However, areas such as CAD, QA, Marketing, Customer Support and Research and Development (R&D) should be emphasized because of their unique relationships with the finished product.

Most people think that manufacturing a product begins with the product designer who puts an idea into a drawing known as the blueprint. But modern manufacturing actually goes deeper than that. The current practice is for the Marketing Department to gather product data through its contacts and surveys of the customers, who must be made a partner in product development. The product design team retrieves that information (customer feedback) from the company's CIM database, and with that forms the original product concept or conceptual design. (Kalpakjian, 2001; Schey, 2000) From here, product specifications, design and analysis can proceed, leading to the development of part and assembly drawings, and associated bill of materials used to manufacture the end product. In all this, the design team must integrate all the product's critical quality requirements into their design. Techniques like rapid prototyping should be employed to hasten the speed of the product development.

At the same time, the marketing personnel team continues their market research, forecast and advertising efforts to ensure that the product is effectively marketed. Using documented information on product life cycle, the team can make more accurate forecasts regarding sales quantities during the product's so-called *introduction, growth, maturity, and decline* stages. (Wakil, 1998) Wakil (1998) noted that "A clever management would start developing and marketing a new product during the maturity stage of the previous one so as to keep sales continuously high". p. 8

It is also important to plan on how to support the customers who would use the product. This can be in the nature of product manuals describing how to use and care for the product. Or it can be through service contracts or commitments to the customer of some sort. Also the process of how to dispose, reuse, or recycle the product at the end of its service life must be planned.

Conclusion

This paper is a rather brief overview of how to effectively plan modern Manufacturing Systems in a complex and demanding industry. It reveals and recommends what Industrial Technology professionals who are in manufacturing fields should do to align with modern manufacturing industry and its practices. The growth in modern technology has rendered the manufacturing environment such a complex place that a more comprehensive, CIM-oriented, modern planning approach is needed to better compete in today’s manufacturing industry. This paper examined manufacturing systems as being made up of components, each of which must be carefully and comprehensively planned for, to stay competitive. Emphasis was placed on implications for Manufacturing and Industrial Technology programs in the new millennium.

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