ASSEMBLING A PRODUCT

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Abstract: The article deals with assembling a product. Assemblies are the product of the assembly process. But assemblies are also the product of a complex design process. This process involves defining the functions that the item must perform and then defining physical objects that will work together to deliver those functions. The structure of the item must be defined, including all the interrelationships between the parts. Then each of the parts must be defined and given materials, dimensions, tolerances, surface finishes and so on. Assembly, which actually creates the product, is by comparison much less studied and is by far one of the least understood processes in manufacturing. The topics in this article are basic steps in designing an assembly system and main processes of assembly.

Key words: assembly, design, product, system

1. INTRODUCTION

This article deals with assembling a product. It lays out the basic issues, the choices that system designers must make, and some approaches to making these choices systematically. Manufacturing system design is not a science, even though several of it is supported by well-developed computer aids. There is still a great deal that is subject to expert judgment, arbitrary decisions, and lack of information about future conditions that the system may face. No design can cope with all future events and still retain adequate efficiency. No single technology can do all jobs, much less all jobs well. For these reasons, our approach to system design emphasizes careful specification of the information needed for good design decisions. It also encourages the development of hybrid systems made up of suitable mixes of specialized or fixed automation, flexible automation, and people. Even though we present the topics in a particular sequence, it should be kept in mind that the actual process is highly iterative. A very simple model of the project is shown in Figure 1.

Fig. 1. A Simple Version of a Project Model
2. BASIC FACTORS IN SYSTEM DESIGN

Manufacturing system design can begin when a candidate product design is available along with the requirements for each process step and a candidate assembly sequence. The process is illustrated schematically in Figure 2. It comprises these steps:

1. Analyze the product and the necessary fabrication and assembly operations. Determine alternate fabrication methods, fabrication and assembly sequences, and candidate subassemblies. Determine fabrication and assembly process requirements. Assess the maturity of these processes and estimate process yield. Identify flexibility requirements such as batch sizes and model mix. Identify problematic assembly steps and suggest product modifications.
2. Select an assembly sequence for use in assembly system design.
3. Determine the production capacity required of the system, taking into account factors like downtime, time to switch models, employee breaks, process yield and other factors that effectively reduce capacity.
4. Tabulate feasible fabrication and assembly techniques (equipment or people) for each operation and estimate the time for each.
5. Using either intuitive techniques or the computerized method described, select a set of equipment or people that can make the product at the required rate for a reasonable cost.
6. Either makes preliminary economic analyses or proceeds to detailed workstation designs and then performs economic analyses.

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**Fig. 2. Basic Steps in Designing an Assembly System**

The system and the products both provide constraints to the design process. Some modifications to the product are design may be desirable or necessary (Fig.2.). At any stage in this process, economic or technical evidence may appear that forces a reconsideration of product design, selection of subassemblies or assembly sequence, timing requirements, and so on. If all of the required information is not available, or if system design reveals knowledge gaps, then additional product or process design effort, engineering, or experiments may be necessary. The alternative is a system design with less robustness and predictability than desirable. Product quality, delivery, or cost may suffer, or the time to reach full production may be prolonged, as a result.
3. ASSEMBLING A PRODUCT

The day-to-day process of assembling mechanical products typically involves a long chain or network of activities and actors. A sketch of this process appears in Figure 3. The main activities of assembly are:

- Marshaling parts in the correct quantity and sequence
- Transporting parts and partially assembled items
- Presenting parts or subassemblies to the assembly workstations
- Mating parts or subassemblies to other assemblies
- Inspecting to confirm correct assembly
- Testing to confirm correct function
- Documentation of the process is operation

Marshaling is a logistic function which may be performed according to one of many strategies. These strategies are based on estimates of work schedules, the planned production of various product types, and lists of the parts needed for each type of assembly.

Transport is short-term logistic implementation of marshaling. That is, transport accomplishes the actual carrying of parts or assemblies between station or work areas.

Part presentation takes parts from the transporter and places and orients them so that assembly can occur with only minor adjustments. A person, assembly griper, tool, or robot may acquire the part either directly from the transporter.

Part mating is the actual process of fitting parts together. Mechanical mates include peg-hole insertions, interference or force fits (for example, peg larger than hole), insertion of electronic components into sockets or circuit boards, mating of gears, insertion of threaded fasteners, compliant mates like snap fits, and other similar mechanical mates.
Joining accompanies mating and usually involves fastening in some way. Screws, rivets, adhesive bonding, welding, soldering, crimping, staking, and ultrasonic bonding are examples. Each of these has important implications for assembly, repair, and upgrading, especially decisions regarding use of reversible versus irreversible joining methods.

Inspecting usually involves determining that an assembly operation has been completed correctly. One may check the tightness of a screw or freedom of motion of a shaft in its bearings. This is different from testing, where the issue is to determine that a subassembly functions correctly. The distinction between inspecting and testing is that latter may be directly related to a functional specification on the assembly or product. Often special test equipment is need. In addition to the above direct operations, an important indirect operation is documentation.

4. CONCLUSION

Manufacturing and assembly processes must be prepared. These must not only be able to generate parts that meet the specifications and assemble them properly, but must also be capable of producing at the rate required to meet demand.

Different fabrication and assembly processes are appropriate for different production rates. For example, low-volume fabrication might be done by machining while high-volume fabrication could be done by molding or casting. Similarly, low-volume assembly is typically done by people while high-volume assembly is done by machines, but only if the parts and the final assembly are smaller.

Assembly is more than putting parts together. It brings together all the upstream processes of design, engineering, manufacturing, and logistics to create an object that performs a function. CAD systems can support a top-down design process for assemblies. Before CAD existed, design followed a top-down process in which the most skilled person, a layout man, put down the basic boundaries and centerlines of a concept on black paper. Gradually a layout emerged. Detail men, the least experienced in the profession, were assigned to design each part, providing detailed geometry, dimensions, and tolerances. A more experienced person took these detail designs and built up an assembly drawing, while a checker looked for errors and interferences by adding up all the dimensions and tolerances. Present-day CAD systems are just beginning to support representation of assemblies. The layout process is hardly supported at all.

Assembly is the capstone process in manufacturing.

5. REFERENCES