PRODUCIBILITY:
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Introduction

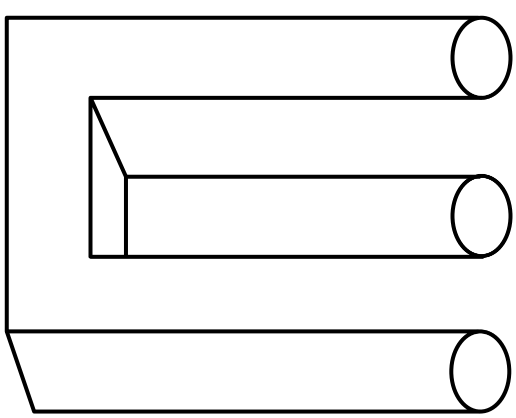
Producibility can be defined as "the measure of the relative ease of manufacturing." That is, you can manufacture a part out of inexpensive material, using unskilled workers, simple tools, and manufacture it in a very short time.

Integration of and Design/Production

Producibility is a design accomplishment resulting from a coordinated effort by design engineering and all the functional engineering specialties to create a functional hardware design that optimizes the ease and economy of fabrication, assembly, inspection, test, and acceptance of the hardware without sacrificing desired function, performance, or quality. Producibility is considered one of the most important determinants of product cost as producibility or lack thereof impacts both the product and the sustainment or life cycle cost.

Figure 1 shows an item that the designer wishes to produce, but the factory cannot produce. The problem is not that the item is an optical illusion, which it is, but that there are people who think that if you can draw an item

Figure 1 - Impossible Figure



in two dimensions, then manufacturing can create it in three dimensions. And that is not always the case.

Concurrent engineering is a good approach for accomplishing the systems engineering process. In particular, the use of Integrated Product and Process Development (IPPD) teams will help to ensure that the numerous functional disciplines have a voice in the design. Manufacturing concerns begin as soon as the design begins to emerge and materials are selected (Material Solution Analysis Phase). Those decisions, along with rate and quantity requirements, and parameter/tolerance settings on key characteristics drive factory floor requirements. Thus if you are building ten aircraft using composite materials you would most likely opt to fabricate those by hand, with quality being driven by the capabilities of the people performing the task. However, if you are going to build over 300 aircraft then you will probably invest in a new manufacturing technology to automate the tape lay-up process. Once the material and rate/quantity considerations become known then the engineering team must de-conflict any deficiencies between the design requirements and the factory floor capabilities. It would help if manufacturing already knew their capabilities so that that information could be fed into the design process so that the material selection was driven in part by the ability of the factory floor to make the item consistently and economically.

Basic Producibi1ity Principles

There are some basic design or producibility principles that will aide engineers in achieving a design that is producible. While they usually make sense, there are times when violating the rules is the right thing to do. There are things you should try to Maximize like:

- Simplicity of design: Henry Ford used simplicity of design to aide the ease and economy of assembly, which tends to improve reliability. One of the newer approaches to simplicity of design was developed by Boothroyd & Dewhurst and is called "Design-for-Manufacture and Assembly" or DFMA. DFMA is a structured approach for analyzing a design's efficiency and for identifying parts that can be combined or eliminated.

There are also some design objectives you should try to maximize like:

- Use economical materials: If you have a choice of materials that provide the same performance, then choose the least expensive material.
- Use economical manufacturing techniques: If you have a choice on which machine or method to use to fabricate or assemble a product choose the least expensive approach.
- Standardize materials and components: Often components or materials used in one product can be used in other products.
- Process repeatability: Use quality control tools to make your processes more repeatable. Processes that are capable and in control reduce cost and improve reliability.
- Product inspectability: Consider how you are going to inspect or verify that the product will meet its objectives. If you are inventing a new material you need to ask yourself how you are going to determine its acceptability.
- Use acceptable materials and processes: You should be aware that some materials like methylene chloride (an ozone-depleting compound) is not an unacceptable material for use. So do not embed it in the product or use it in the manufacturing processes you employ.

There are also some design objectives you should try to minimize like:

- Procurement Lead Times: Do not use materials, processes, machines or any other element of the factory floor that requires a long lead-times or is a foreign or sole source.
- Generation of scrap, chips, and waste: Some processes generate more waste an others. This waste must be dealt with and constitutes an added cost, which should be avoided.
- Energy consumption: Some processes require more energy in order to get the same output or characteristic. If you have a choice, choose the process that uses the least energy.
- Total part count: The number of parts drives a design's efficiency, reliability, and maintainability. It is usually wise to study the design and work to reduce part count.
- Skill levels required to manufacture: Henry Ford used simplicity to enable workers to focus on only one task and thus improve efficiency. By doing this Ford was then able to give the world its first moving assembly line.
- Special test systems: This is usually one of the plants bottlenecks. So design around them.
- Use appropriate tolerances. Studies have shown that tolerances are often set without rigorous study.

Most dimensional characteristics are robust, that is they can accommodate a lot a variation and not impact fit, function, or service life. Thus save your limited amount of available management attention for the vital few characteristics that require restrictive tolerances, and then work hard to improve process repeatability for those processes or machines that control that dimension.

Producibility Engineering Planning (PEP)

A design is not automatically producible. It becomes producible through structured activities as planned for and executed during the design/development process. That planning process is called Producibility Engineering Planning (PEP). PEP includes all the measures taken to ensure a timely transition from Engineering and Manufacturing Development (EMD) to low rate initial production (LRIP). The purpose of PEP is to ensure that material designs reflect good producibility considerations prior to release to manufacturing. PEP requires funding upfront to cover the cost associated with implementing the producibility engineering plan.