AALBORG UNIVERSITY

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P1 Project
Software

Prediction of Production Processes

A Program that Solves a Problem

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Preface

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1 | Introduction

1.1 Manufacturing Standards and Methods

Manufacturing is the action of producing a product from (mostly) raw materials, adding value in the process. This is done through use of human labour as well as machines and equipment, that carry out a broad range of actions in a predetermined order, to produce the product. In today's world, this leads to the rather broad definition: (Manufacturing is)

"the making of products from raw materials using various processes, equipment, operations and manpower according to a detailed plan that is cost-effective and generates income through sales."(Scallan 1.3) [1]

The manufacturing of a product is often described in a manufacturing system, which is just a series of processes, machines, etc. set together in such a way that they manufacture a product. (Scallan 1.4)

However, these broad definitions do not say a lot about how manufacturing is carried out in the real world. Since there is a broad variety of products being manufactured, there equally is many different systems and (subsystems) used to describe different techniques and approaches to manufacturing. This firstly leads to two basic categories of manufacturing systems, namely:

1. Continuous Process Manufacturing
2. Discrete Parts Manufacturing

1.1.1 Continuous Process Manufacturing

Continuous process manufacturing deals with continuous processes such as those found in the making of petroleum, steel, or sugar, where the product physically flows. This is sometimes confused with 'flow production', another term for mass production, which just refers to the fact that the assembly line always running, and not the state of the product. Production in continuous process manufacturing often involve use of chemicals in various stages of the production, and might also involve mechanical means, all aiding in what is basically mixing the product following a recipe. However, it is important to note that no discrete product is made during processing, seeing as the product is ever chaining until finally being complete, and instead the outcome of this type of manufacturing system is often measured in volume or weight. Continuous process manufacturing often results in specialized equipment operating 24 hours a day to make the exact same product, which makes this type of manufacturing system highly specialized, thus not very flexible. (Scallan 1.9.6)[1]

1.1.2 Discrete Parts Manufacturing

However, discrete parts manufacturing deals with countable objects such as cars, toys, furniture(,) and the likes. These products all have the property of being countable in common. The production of discrete parts, as oppose to continuous flow, also allows for customization of specific products to a certain degree, as well as the ability to order anywhere from 1 to many millions of the product at a time, instead of always having continuous flow.

Discrete parts manufacturing is often further broken down into the following systems, as shown in figure 1.1. This figure also includes Continuous manufacturing, which obviously isn't a type of discrete manufacturing. These different systems mainly describe the relationship between quantity and variety of the product, where larger quantities lead to less variety (and the other way around).

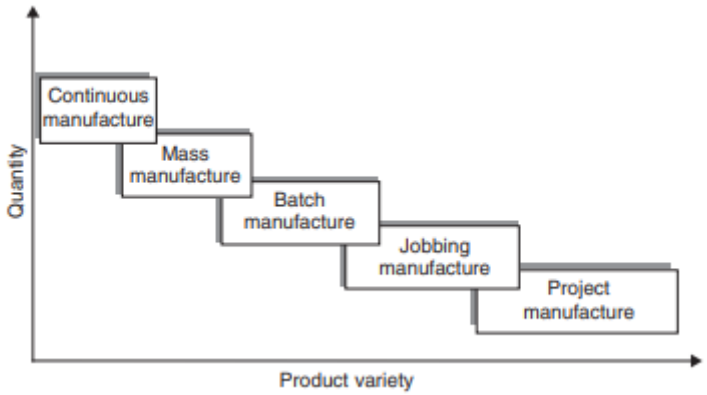

Figure 1.1: Quantity vs Product variety in the different production systems. (Scallan Fig 1.9)[1]

As seen in figure 1.1, some of these different varieties of discrete manufacturing are as follows:

1. Job manufacture
2. Batch manufacture
3. Mass manufacture

1.1.3 Job Manufacture

Job manufacturing is, as seen in figure 1.1, a manufacturing system that focuses on variety and customizability as opposed to quantity. This means that lot-sizes are small, but the finished products often are unique. To manufacture a lot of unique products requires machinery and tools which are non-specific, so they may be used for different purposes when producing different products. However, this require the workforce to be highly skilled since they must fulfill different assignments depending on the specific variety of a product being manufactured. The same person might also be the one to make an entire individual product. (Scallan 1.9.2) [1].

1.1.4 Batch Manufacture

Job and batch manufacturing has quite a few similarities and are therefore often confused. Normally batch manufacture is a production of medium size lots. These lots is approximately 5-1000, and sometimes more. The difference between job and batch is not the number of components, nor the number of lots. But it's how the manufacturing itself is done. With batch manufacturing similar items are produced together and each batch of components goes through one stage of the manufacturing process before going into the next stage [1]. An example of batch manufacturing could be in a bakery where buns are prepared together, baked together and they always stay together throughout the process [2].

1.1.5 Mass manufacture

Mass manufacture is all about producing high rates of a specific product. To do this, specialised equipment and processes are used, which in turn means that the workforce have lower skill level, due to this specialized nature of the machines used in mass manufacture. Machines in mass manufacture are often arranged in a specific sequence to carry out their exact function one after another. To do this, conveyor belts are often used to carry individual devices through the different machines in the predetermined sequence. This results in a sharp contrast to job manufacture, where an individual person can craft the entire product himself. Mass manufacture instead focuses on specialising individual processes in the making of the product and distributing these processes to different machines. This is much alike batch manufacture, only on a larger scale with larger quantities and less variety. Mass manufacture is used to produce products which normally require a more steady output flow than batch manufacture, which is why it is also refereed to as flow manufacture. (Scallan 1.9.4) [1]

1.2 Production Waste

1.2.1 Lean Manufacturing

The term Lean manufacturing refers to the application of lean practices, principles, and tools to the development and manufacture of physical products. For many people, the term Lean manufacturing is synonymous with waste removal. But the ultimate goal of practicing Lean manufacturing is not simply to eliminate waste - It is to sustainably deliver value to the customer. To achieve that goal, Lean manufacturing describes waste as anything that requires an investment of time, money, or talent that does not create value for the customer. [3]

One of the first people credited with introducing Lean practices at the workplace is the founder of Ford Motor Company, Henry Ford. Ford streamlined the process of manufacturing the Model T car by arranging workers, machines, parts, and tools in a continuous system. However, it was not until the 1930's that Toyota came up with the modern concept of Lean Manufacturing, when they invented the Toyota Production System (TPS). Toyota initiated the idea of "manufacturing to order" instead of "manufacturing to fill warehouses", because they realized products piled in warehouses without buyers were no more than just wastage. It made financial sense to base production targets on actual sales. This style of manufacturing eventually became known as Just in time (JIT) manufacturing. [4]

TPS explicitly defines seven types of waste, which continues to be relevant in Lean manufacturing today. They are often referred to as TIMWOOD:

Waste in this context is defined as any action, such as activity, process and cost, which is a part of the production process or implementation of services, which do not add value to the end product and increase the cost of the product.
In a production company, that wants increasing results, it is important to cut out any inefficiency, that might cause waiting, unnecessary movement etc. When Japanese companies talk about waste, they often talk about "3MU" which is an activity of reducing waste. The three MU's are:

- Muri - surpluses, overloading,
- Muda - losses, waste,
- Mura - uniformity, deviations.

These three points are cited from:
https://www.pea-journal.eu/files/Vol.-9,-No.-4—08.-M.Ku-erova,-M.M-kva,-J.Sablik,-M.Gejgus.pdf
In lean manufacturing philosophy is striving to eliminate any waste in any part of the process, this is called Muda in Japanese. Muda is divided into seven sections:

- Transport
  Transportation of a product, does not add any value to the product and is not a part of the production process, but is a crucial part of the delivery of a product, hence it can not be separated from the process.
- Inventory
  Unnecessary stock is a result of over-production. The company has bought too many materials, finished goods etc. These items are piling up in the storage and taking up too much unnecessary space.
- Motion
  Unnecessary movement are movements of human or machine, that is inefficient, e.g. grabbing a heavy object of the floor, instead of doing it from an appropriate height. This puts less strain on the person and makes the activity faster and more effective. Another waste of movement is travel time between work posts.
- Waiting
  If everything in the production process is not working optimally at the same time, e.g. damaged machines, inefficient manufacturing methods, insufficient amount of materials etc. This may result in the workers having to wait. Often workers are spending a lot of time waiting for expert to come fix the machines, waiting on supplies etc. so that are able to go back to work.
- Over-Processing
  This is the usage of unsuitable techniques, unfitting tools, doing processes that are not needed by the customer etc. All the above are very unnecessary and will cost time and money in the end.
- Overproduction
  If a company is manufacturing a number of products that is overly sufficient for the users, it becomes an overuse in materials, energy and human work.

- Defects
  When a defect occurs, actions must be taken, in order to fix the problem. This may result in waste of material, energy, rescheduling, paperwork, losing a customer etc.

http://leanmanufacturingtools.org/77/the-seven-wastes-7-mudas/

1.3 Specific Case

2 | Problem Statement

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