

Computer aided manufacturing and measuring technologies

[Business](#), [Manufacturing](#)



Introduction

Automated manufacturing refers to a mode of manufacturing that relies significantly on computerised control systems for running production equipment. In automated manufacturing, there is no need to employ human operators on the manufacturing floor and the assembly line since the automated system has the capability of managing both mechanical procedures and scheduling manufacturing tasks. According to Beno (2003), the development and use of automated manufacturing systems can be traced back to the latter half of the 20th century. Since its inception, automated manufacturing has been used in various scales across the globe. Traditionally, manufacturing tasks were done exclusively by hand, which posed the need to employ huge labour force that drove production costs and increased risk exposure to workers. The Industrial Revolution saw the introduction of mechanised manufacturing, which replaced direct use of human labour (Braz 2006). This was instrumental in cutting costs, improving consistency and increasing the safety of workers. Automated manufacturing followed mechanised manufacturing and was instrumental in modernising and refining the manufacturing methods. In a facility that is fully automated, no humans are required. Ganesha & Raju (2007) point out that the automated equipment uses control systems to do the manufacturing tasks. According to Mikell (2010), automated manufacturing makes use of complex software having the capability of scheduling manufacturing tasks and undertaking diagnostics on the manufacturing equipment during instances of malfunction. Cameras can be linked to the software to monitor the quality of the final product and the assembly line's speed. The only role that humans

play in automated manufacturing is to maintain the equipment and program the control systems (Yves, Alwin & Frits 2011). This report discusses the advantages and limitations of automated machine tools when used for the manufacture of components in both large batches and very small batches. The report also provides a discussion of the recent advancements in Computer Aided Manufacturing (CAM) technology and the areas in which the technology is likely to be improved in the future.

Advantages and Limitations of Automated Machines Tools When Used in the Manufacture of Components in Large Batches

Automated manufacturing has both its advantages and limitations when employed in the manufacture of components in large batches of about 500 components on a monthly basis. The first advantage is accuracy (Braz 2006). Because of clear-cut manufacturing specifications, automated manufacturing results in enhanced quality control since products are manufactured in repetitive cycles. Ganesha & Raju (2007) points out that automated manufacturing lessens the production downtime in large-batch production since there are fewer breakdowns when compared to manual production line. Automated systems are often programmed to perform several tasks in an assembly line, and change the task in accordance with what is needed at the moment.

The second advantage of automated manufacturing in large-batch production is lean manufacturing. Ganesha & Raju (2007) points out that automated production makes the manufacturing process more efficient

through the use of robots. In addition, it reduced the production lead times. Rather than having a relatively large materials' inventory, the firm has a just-in-time inventory system. According to Ganesha & Raju (2007), saving inventory and time plays an integral role in reducing the cost of components produced and can facilitate flexibility with regard to changes in the production line. Reliability is also enhanced because robots are programmed to execute manufacturing tasks efficiently and save materials and time. The ability to change tools and reprogram the machine makes a substantial contribution in regards to the flexibility of the production process. The measures of flexibility in relation to the automated manufacturing includes: design change; volume; the ability to deal with mixed parts; machine; process; product; routing; expansion; and production. Overall, all these savings mount to increased profits (Ganesha & Raju 2007).

The third advantage of automated manufacturing in large-batch production is that the production volume is very high; this is because automated manufacturing facilitates a faster work piece machining. Because CNC machine tools are guarded in a much better manner when compared to the traditional machine tools, users in an automated environment can deploy the most efficient and effective cutting conditions in order to achieve the best cycle times (Ganesha & Raju 2007). When manufacturing components in large batches, a high volume of production is significant, and Computer and Numerical Control (CNC) machines come in handy when achieving this target. Overall, CNC machines increase the throughput. This results in improved quality and increases the predictability of product quality. Additionally, it

leads to improved robustness of the product and production processes (consistency). CNC machines use a number of methods to improve robustness, quality and productivity, they include reduced cycle time; high degree of accuracy; performing tasks that are beyond human capabilities in terms of endurance, speed, weight and size; and lessens operation time (Yves, Alwin & Frits 2011).

Another notable advantage of automating the production process is the increased safety in the working environment. Automated manufacturing improves work flow and reduced handling by human operators, which creates a safer environment since human operators are only involved in controlling the CNCs rather than handling the manufacturing processes.

Regardless of the advantages of CNC machines in manufacturing, there are a number of limitations of automating the manufacturing process. The first disadvantage is the cost of automated manufacturing. Ganesha & Raju (2007) points out that investing in a single CNC machine requires at least ? 300, 000. Besides initial development costs, automated manufacturing can also result in unpredictable and excessive development costs. Braz (2006) points out that the research and development costs of automated manufacturing can go beyond the cost savings resulting from the automation process itself. In addition, automated manufacturing needs relatively large initial investment when compared to the unit cost of production. In addition, Yves, Alwin & Frits (2011) state that the initial cost of transforming from human production to automated production is relatively high. Increased investment costs are needed in research and development prior to bringing

in robots. A number of financial analysts have pointed out that the money spent on acquiring CNC machines could be used more effectively through training workers. In order to sustain the production process, the firm has to continue using the old production methodology while at the same time introducing automation. To this end, workers need specialised training to operate the CNC machines, which escalates the costs. Nevertheless, Mikell (2010) asserts that the main objectives of automated manufacturing have leaned towards time, cost and productivity. Moreover, Ganesha & Raju (2007) argue that investment in CNC machines may pay off since the firm will not require huge numbers of workers after acquiring the needed CNC machines. In addition, Yves, Alwin & Frits (2011) consider CNCs a good investment in large batch production because they result in substantial savings on materials.

The second disadvantage of automated manufacturing systems in large batch-production is that maintenance is relatively difficult and requires computers, programming knowledge, and skilled operators, which increases the cost of sustaining an automated manufacturing system. Overall, in larger scale production, the benefits of automated manufacturing outweigh the limitations posed by the same (Mikell 2010). The cost savings resulting from the use of CNC machines can be used to cater for the initial development costs of automating the production process, especially in large scale manufacturing. Another downside of using an automated system is increased vulnerability, which stems from the fact that CNCs have limited intelligence levels; therefore, it is vulnerable to making errors that are not within its

knowledge scope. According to Braz (2006), automated systems lack the ability to apply the rules of simple logic in situations requiring general propositions.

Advantages and Limitations of Automated Machine Tools When used in the Manufacture of Components in Very Low Batch Quantities

Assessing the advantages and downsides of automated machine tools when used in the manufacture of very low batches can be challenging, since it revolves around the benefits ensuing from economies of scale and efficiency of the production process. Nevertheless, automated manufacturing has a number of advantages with regard to small scale manufacturing. The first advantage of automated manufacturing in small-batch production is the consistency of the components produced. According to Braz (2006), small-batch production should not have room for inaccuracies, and CNC machining comes as an ideal solution. Because CNC machining relies on program execution, the process is repeated exactly in the same manner in subsequent production. This process results in improved consistency of the components manufactured when compared to components manufactured using conventional machine tools.

The second advantage of automated manufacturing is the lower skill level required from the operator. Contrary to misconceptions that CNC machining requires professional skills set, the knowledge needed to operate the CNC machines is relatively low. However, the program for the Numerical Code is complex. Lower skills set needed are an advantage for small manufactures,

since it eliminates the costs associated with training. Another noteworthy advantage of automated manufacturing in small-scale production plays an integral role in addressing the challenges associated with the complexity of the components being manufactured. Small-batch productions are often typified by complex work pieces, which can only be facilitated by the use of CNC machines. The self-diagnostics feature of CNC machines is also an advantage for small scale manufactures. Several automated machine tools have a self-checking setup used to regularly monitor the system and generate an alarm in case a malfunction is found. Ganesha & Raju (2007) point out that cycle time, volume flexibility and down time are not significant issues of concern for small scale production; however, automated manufacturing comes as an added advantage because of the substantial contributions regarding accuracy and productivity. Other significant advantages of automated machine tools in small-batch production include increased manufacturing flexibility, reduced non-productive time, and enhanced quality control (Braz 2006).

The main downside of automated machine tools for small scale manufacturing producing very low batches is the high costs. Ganesha & Raju (2007) point out that large scale manufacturers benefit from economies of scale, which is not the case when producing relatively low batches. The higher investment and maintenance costs are not favourable for small scale component manufacturing. Another disadvantage is the vulnerability of CNCs to allow errors that are not within its knowledge scope. Overall, for small scale-batch manufacturing, CNC machining can be extremely costly since

manufacturers do not accrue the benefits resulting from large scale operation (economies of scale).

Recent Advancements in Computer Aided Manufacturing (CAM) Technology and the Areas in Technology that is Likely to be Developed

There is an increasing demand for precision, reduced production time and product quality in regards to manufacturing. This implies that computer aided manufacturing is going to play a pivotal role in production processes in future. According to Ganesha & Raju (2007), advances in CAM technologies will play an integral role driving the future of industrial automation. In the present day fast-paced world, computer aided manufacturing systems are increasingly becoming essential for manufacturing industries across the globe. Communication and technology are advancing rapidly, which poses the need for firms to enhance their productivity using efficient manufacturing technologies such as Computer Aided Design and CAM systems. In the last two decades, CAM systems have focused on enhancing system usability, which has been instrumental in ensuring that smaller skills set is needed to manage and operate CAM systems. Since its inception, CAM software has been typified by a number of shortcomings that has resulted in extensive skills requirements for CNC operators. In the course of its use, CAM systems have been integrated with CAD systems, Computer Aided Engineering (CAE) and Product Life Cycle Management (Ganesha & Raju 2007). Integrated manufacturing makes use of computers to link the various physically separated processes, wherein users can share information and initiate appropriate action. At present, CAM packages do not have the capability to

reason in the same manner that the machinist can; as a result, they do not have the capability to optimize the tool paths, which is a core requirement for mass production. Challenges associated with the ease of use, integration with PLM, and manufacturing complexity has posed the need for the development of integrated automation systems (Braz 2006). The common areas of concern regarding the future of CAM systems include high speed machining as well as tool paths' streamlining; 5 axis machining; usability; automating the machining processes; multi-function machining; and feature recognition (Braz 2006).

Conclusion

This report has discussed the advantages and limitations of automated machine tools and provided an analysis of the future of CAM technologies. Overall, the advantages include increased productivity and predictability of quality, as well as enhanced robustness (consistency) of the process and product. The main downside of automated machine tools, for small scale manufacturing producing very low batches, is the high costs. Other notable advantages include high production volume and increased safety in the working environment. The higher investment and maintenance costs are not favourable for small-scale component manufacturing.