

COMPUTER INTEGRATED MANUFACTURE

Computers are now used in many ways in the design and manufacture of products. With sophisticated hardware and software, manufacturers are now able to:

- minimise manufacturing costs
- improve product quality
- reduce product development time
- make better use of materials, machinery and people
- maintain a competitive edge in the domestic and international marketplace

Where all the phases of design and manufacturing operations are brought together through the use of information technology, this is known as **computer integrated manufacturing**. It is not just the use of computers that is important, it is the way that a company's operations are planned and integrated that brings success.

The following elements are essential ingredients of a computer integrated manufacturing (CIM) system:

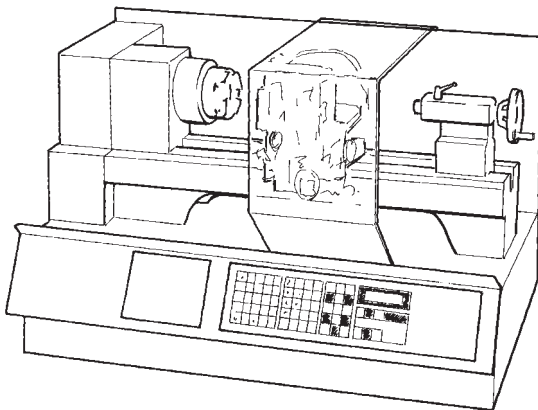
Computer-aided design and draughting (CADD) allows the designer to conceptualise new products more easily without having to make costly illustrations, models, or prototypes. Modern CAD systems are capable of analysing designs from simple brackets to complex structures such as the wings of aircraft. The performance of structures when placed under different loads or temperatures can now be represented on the computer screen - analysed and tested efficiently and quickly. The information developed can be stored, retrieved, displayed, printed and transferred anywhere in the company. Designs can be modified and improved directly and easily at any stage in the life of a product.

The benefits of CADD are:

- the time between having initial ideas for a design, and the manufacture of a product, known as **the lead time, is reduced**
- a designer can have **more ideas in less time**, hence an improvement in **productivity**
- the **quality of the final design** is likely to be better as the designer can try out many ideas on the computer, including **simulating** how the product may behave when being used
- designs created by the CAD software may be fed to other parts of the company such as the purchasing department. It means that **everybody in the factory is working with the same drawing** - any modifications to the design are then made available immediately to everybody who needs them.

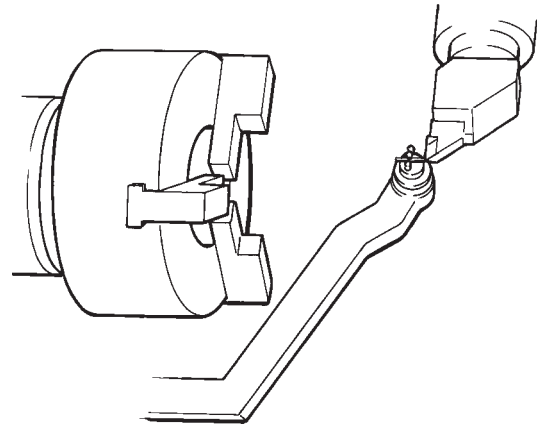
Computer aided manufacture (CAM) involves monitoring and controlling the manufacturing operations. Computers now assist engineers, technologists and others in:

- organising tasks such as the programming of CNC (computer numerically controlled) machines
- programming robots for the handling of materials and component parts
- designing tools, tools and fixtures
- quality control and inspection.



When used to replace people, CAM offers the following advantages:

- **continuous working** is possible - 24 hours a day and 7 days a week. The only interruptions will be when maintenance is necessary, or the machine breaks down. Robots do not need holidays or lunch breaks
- using CAM, **more consistent quality** is possible, with less wastage of materials likely. Once programmed to perform a task, a machine will carry that out until a fault occurs of because of a progressive deterioration, such as the tool wearing away. Most machines are now fitted with automated inspection systems that monitor quality and will send out warning signals as appropriate.



Tool data is automatically registered in CNC memory simply by bringing the tool tip into contact with the tool eye sensor. The same system can be used to measure for tool wear and automatically compensate the tool offset and also to inspect for tool breakage to ensure unmanned operation with high accuracy.

- CAM systems, such as robots can work in places which are **hazardous or unpleasant for humans**. This should remove the problems of absenteeism from work through boredom or dissatisfaction, and it allows regulations for health and safety to be met more easily. For example, a paint-spraying robot can operate in a room isolated from the rest of the factory. There is no need therefore for specialist protective clothing, adequate ventilation or rest breaks that the human worker would need.

Other Aspects of Computer Integrated Manufacturing

An important new development in the area of manufacturing technology is **rapid prototyping** which relies upon CAD and CAM, and various other manufacturing techniques (using metal powders and polymers) to produce prototypes in the form of solid models rapidly and at low cost. For example, prototyping new components for motor cars By traditional methods of shaping, forming and machining may cost many thousand of pounds and take up to a year to produce. Rapid prototyping can cut these costs as well as development times significantly.

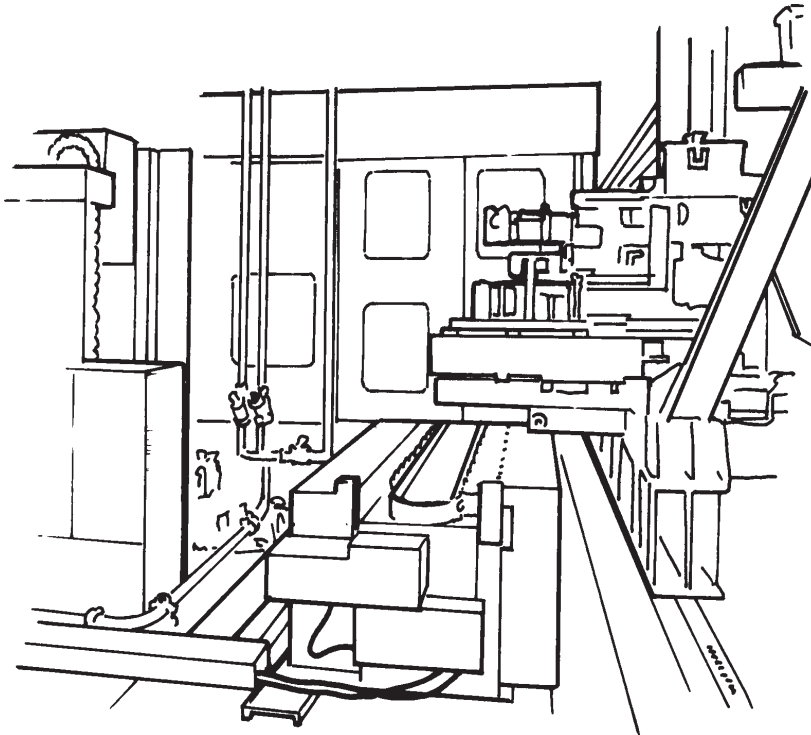
Computers can also be used to help with the planning of processes that take place in the company such as estimating costs or the time taken to perform a certain manufacturing operation. **Computer-aided process planning (CAPP)** helps to improve the productivity of a factory, and the reduce costs.

The high level of automation and flexibility achieved with numerically controlled machines has led to the development of **group technology** or **cellular manufacturing**. The concept of group technology is that parts to be made can be grouped according to similarities in design and manufacturing processes. In this way families of parts can be produced efficiently and economically.

Flexible manufacturing systems (FMS) integrate manufacturing cells into a larger unit, containing industrial robots serving several machines, all linked to a central computer. Flexible manufacturing systems have the highest level of efficiency, sophistication, and productivity in manufacturing. They are able to meet rapid changes in the market demand for various types of products.

CASE STUDY: YAMAZAKI MACHINERY UK LTD

The manufacturing plant based at Worcester began operations in 1987. Today some twelve different models of CNC lathe and machining centres are built at the factory using CNC technologies. Using flexible manufacturing systems (FMS) for machining and computer integration for production control, the factory is able to operate at a capacity of producing 100 different machines a month.

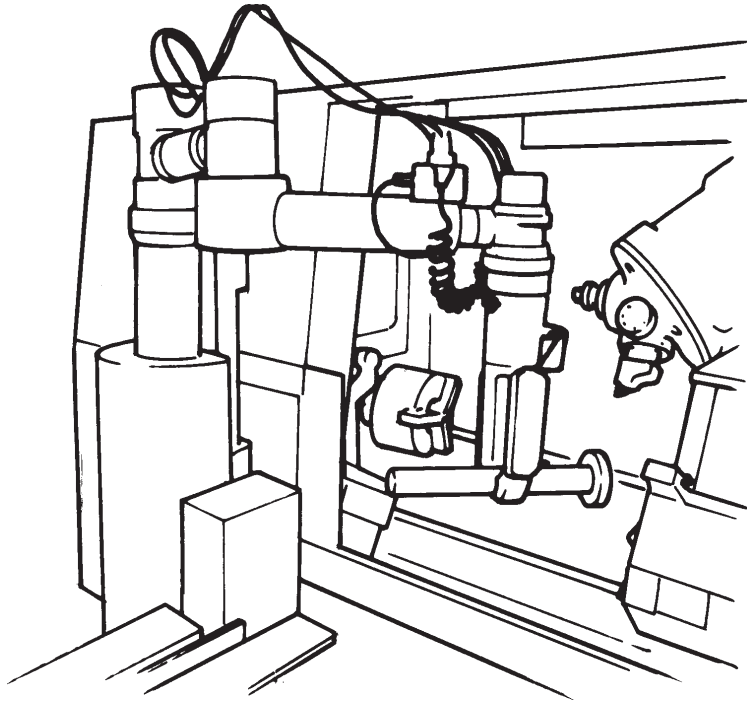


Workpiece fixture, delivered by computer operated stacker crane, arrives at CNC machining centre

Large prismatic parts (such as machine beds) are machined on three travelling centre machining centres, each equipped with an 80 tool magazine. Alongside the machining centres are 36 pallets which store fixtures (devices for clamping the workpieces on to the machine) and the workpieces themselves in the form of cast iron castings. The pallets are identified individually at the time of fixturing by the scheduling computer. Each pallet has a programmable micro-chip which stores the appropriate identity.

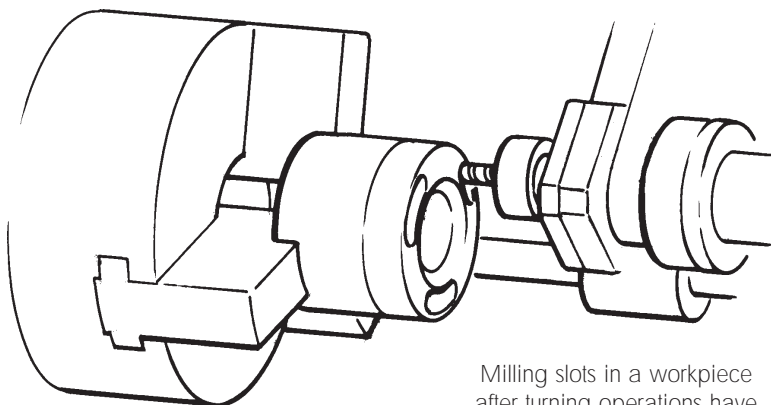
Smaller components, such as parts of gearboxes are produced on similar, but smaller machining centres, again feed automatically from pallets nearby by an automatic stacker crane.

Rotational parts are produced on three mill centre lathes.



Robot unloads finished workpiece
from mill centre lathe

These machines are fed by robots from pallets of stacked components. Both normal turning operations, and auxiliary machining such as pitch centre holes, keyways and slots can be machined in a single operation of the chuck. Automatic jaw changing of the chuck provides versatility to machine a wide variety of workpieces.



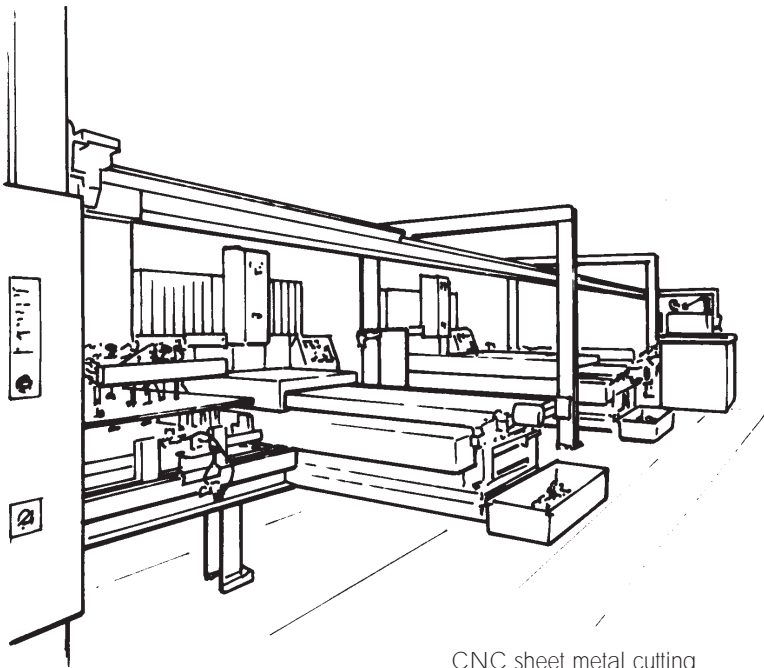
Milling slots in a workpiece
after turning operations have
been completed

Tools for these machines are carried on an overhead monorail. The highway replenishes tools directly into all the machining centres and lathes, and returns worn tools.

Superfinishing of components and quality control is carried out in a temperature controlled environment. Using high accuracy CNC grinding and jig boring machinery, roundness and precision can be controlled to levels of less than 0.5 μ m. Temperature controls of ± 1 degree Celsius ensures constancy during these high precision operations. Measurement of roundness, roughness and three-dimensional levels can be made using ultra-accurate measuring equipment. This information regarding the quality of the finished product is fed back to the central CPU for logging purposes.

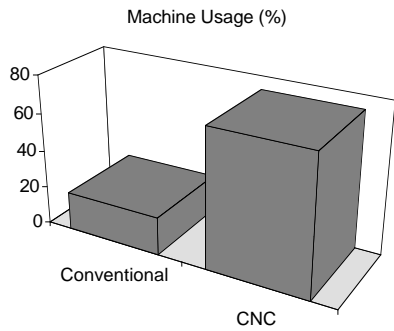
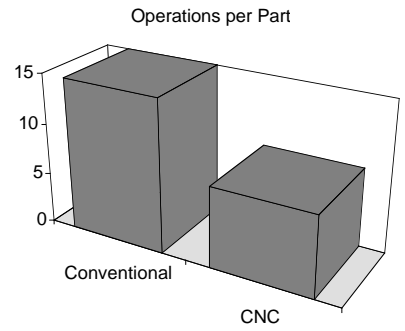
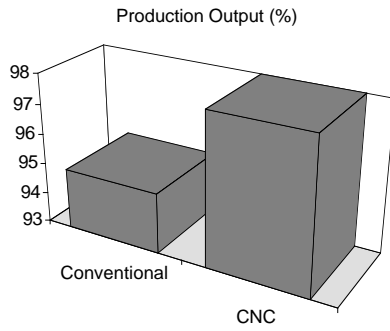
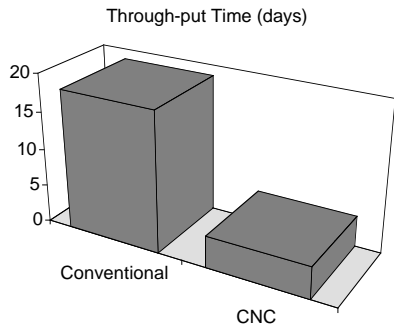
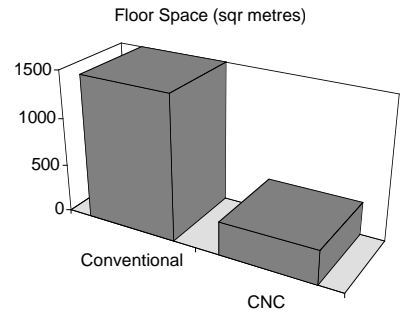
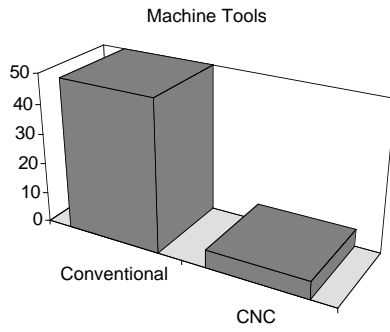
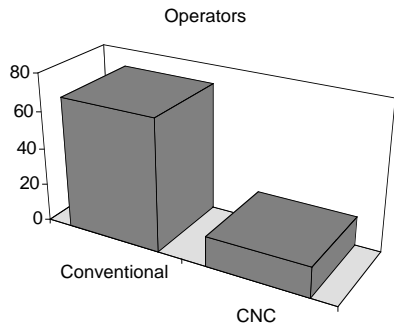
Temperature is closely controlled throughout the factory, to a tolerance of ± 2.5 degrees C. Where the high precision components are assemble, such as spindles and headstocks for NC lathes, and spindle cartridges for machining centres, the temperature is held at 19 degrees C, ± 1 degree. The air is also cleaned to Class 10,000 - as clean as the air in the middle of the Pacific Ocean!

Sheet metal panels for the machines are produced using fully computer-controlled equipment.



CNC sheet metal cutting
using twin lasers

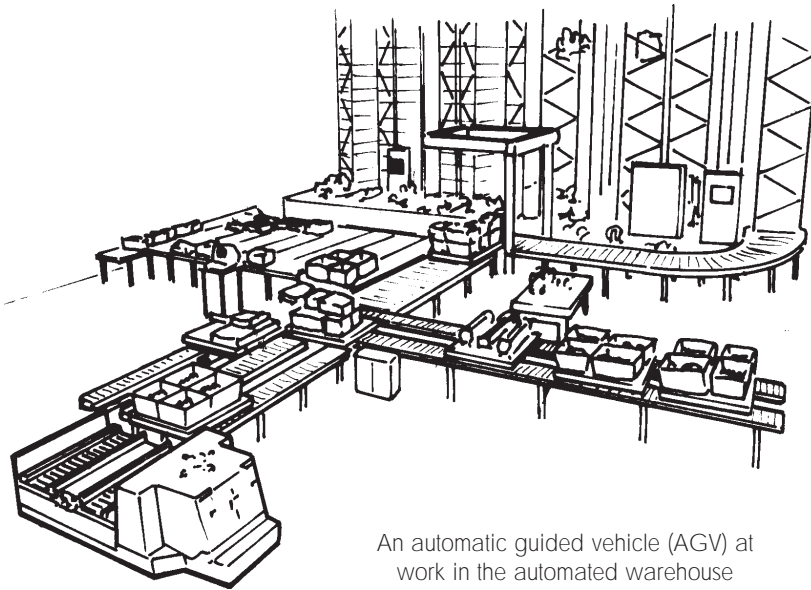
These metalworking operations can be performed in approximately half the time taken by conventional factory methods using up-to-date laser cutting and CNC materials manipulation equipment.



Automatic guided vehicles (AGVs) are used for transporting raw materials and machined parts to various locations in the factory. They are also used in the automated warehouse.

The parts loading centre controls the passage of work from the machining to the assembly departments. Under computer control, machined parts, purchased goods and assembled goods are held in the warehouse. 4420 varieties weighing up to 1000kg can be stored at any one time.

Yamazaki Machinery UK Ltd uses an IBM hardware system for total production and scheduling information control. This system is connected to three FMS CPUs (central processing units) which control all the on-line systems - from the moment the raw material enters the factory to the despatch of the finished product. One CPU system schedules the automated warehouse and assembly requirements. A second schedules the flexible manufacturing system lines, the third organises the entire tool management including tool offsets, tool life and replacements.



An automatic guided vehicle (AGV) at work in the automated warehouse

Artificial intelligence (AI) involves the use of computers and machines to replace human intelligence. Computer-controlled systems are becoming capable of learning from experience and making decisions. **Expert systems**, which are basically intelligent computer programs are being developed rapidly to perform tasks and solve difficult real-life problems as well as human experts would.

It is now possible to imagine the **factory of the future** in which production takes place with little or no direct human intervention. The human role will be confined to supervision, maintenance and upgrading machines, computers and software.