# Tooling for manufacture

A guide to the engineering process.

Dawson Shanahan
Precision Engineering & Cold Forming

## What is tooling?

The term 'tooling' essentially describes the process required to design and engineer the tools that are necessary to manufacture parts or components. Tooling comes in many different types, of which the most common are:

- Work holding tools, such as jigs and fixtures
- Cutting tools for milling, turning and grinding machines
- Punching dies for cold forming, forging and extrusion machines and presswork
- Sheet metal welding fixtures
- Inspection fixtures

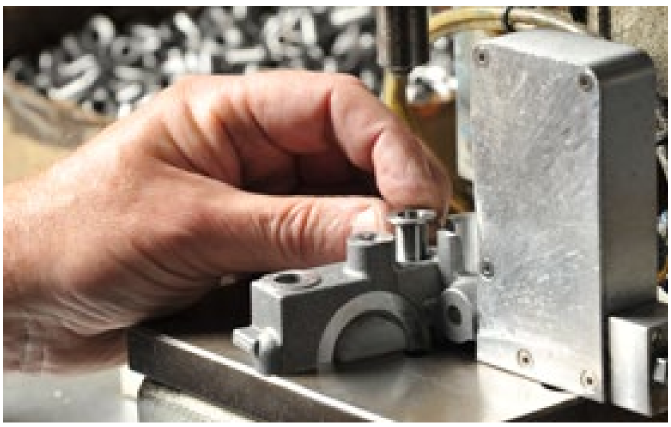
The quality of the finished part, its properties, the speed and accuracy with it can be produced and the repeatability of manufacture in high volume production runs, all depend on the precision and characteristics of the tooling.

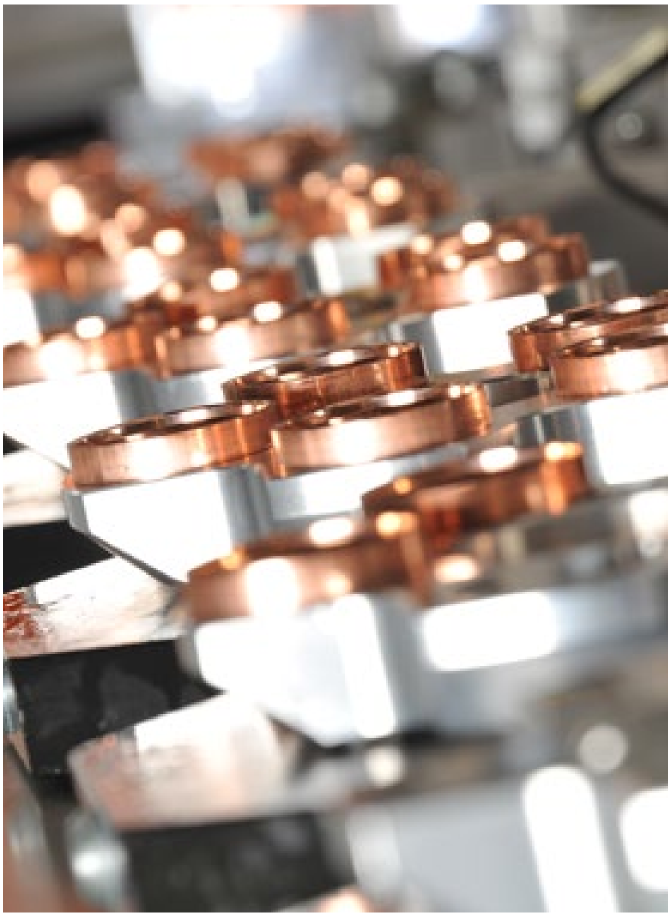
## Tooling design

The objective of good tooling design is to produce tools that are safe to use, while ensuring that finished parts are engineered consistently to the required quality and specifications, in the volumes and lead times expected by the customer and at the most competitive cost.

Engineering high quality tooling, especially for the latest high speed, multi-spindle CNC machines and cold forming systems, can be a complex and demanding process. Although this has been dramatically enhanced in recent years with the introduction of powerful computer aided design and modelling software, success still depends on the knowledge and experience of tool and die makers.

In particular, effective tooling design requires a comprehensive understanding of the conditions that a tool will encounter during the machining or cold forming process. This knowledge is then used to inform the design, type of materials and construction of the tooling, as well as potential modifications to process criteria.





The designers of high quality tooling have to consider a wide range of factors, including:

- The tolerances required in the finished part, as these will affect the configuration of the tooling
- Mechanical strength and rigidity of the tool, as this is essential to ensure workpiece accuracy, repeatability and quality
- Cutting tool strength, which has to be sufficient to withstand machining forces, especially in high volume production
- Sacrificial or weak links, which may need to be incorporated to accommodate wear and protect indexing tools from damage
- Machine tool speed, feed and size, as these determine the characteristics of each tool set
- Disposal of swarf or other waste from the machining area, as this may affect the tool design.

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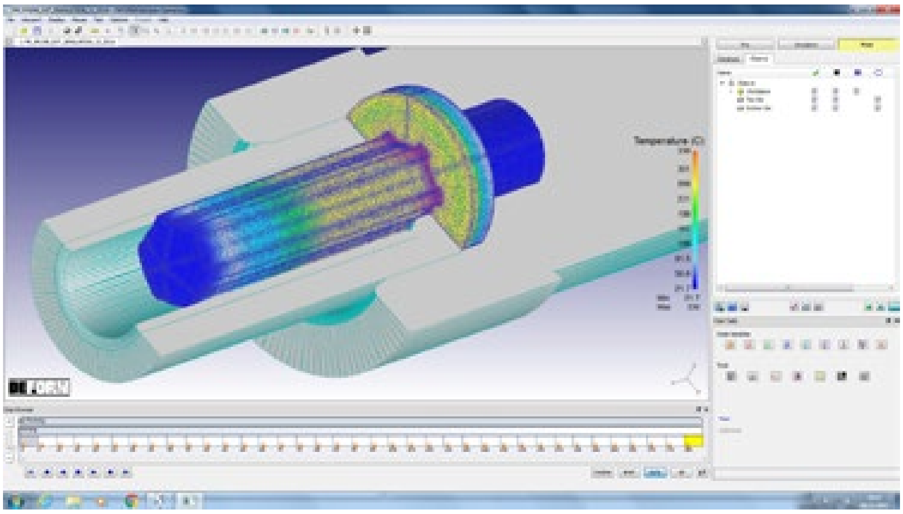


## Tooling costs

It's a common misconception that tooling is an expensive and sometimes cost-prohibitive process. In reality, modern engineering techniques now mean that most conventional tooling costs for CNC machining and precision cold forming are relatively low.

The exceptions tend to be found where low volume parts are highly complex, or where specialised or difficult to engineer materials are required. Even here, however, cost can often be engineered out through intelligent design and careful control of production processes.

Cost and time delays often occurred in the past because the development of tooling was seen as an iterative process, with improvements to tooling designs being made through a succession of prototype stages.

Although this iterative methodology continues today, the use of advanced engineering software tools, such as SolidWorks and DEFORM, has enabled the process of tool design, analysis and testing to be carried out on-screen, rather than in the tool-room. This effectively eliminates the traditional trial and error elements commonly associated with tool making and allows the correctly dimensioned and quality approved tooling to be engineered first time.

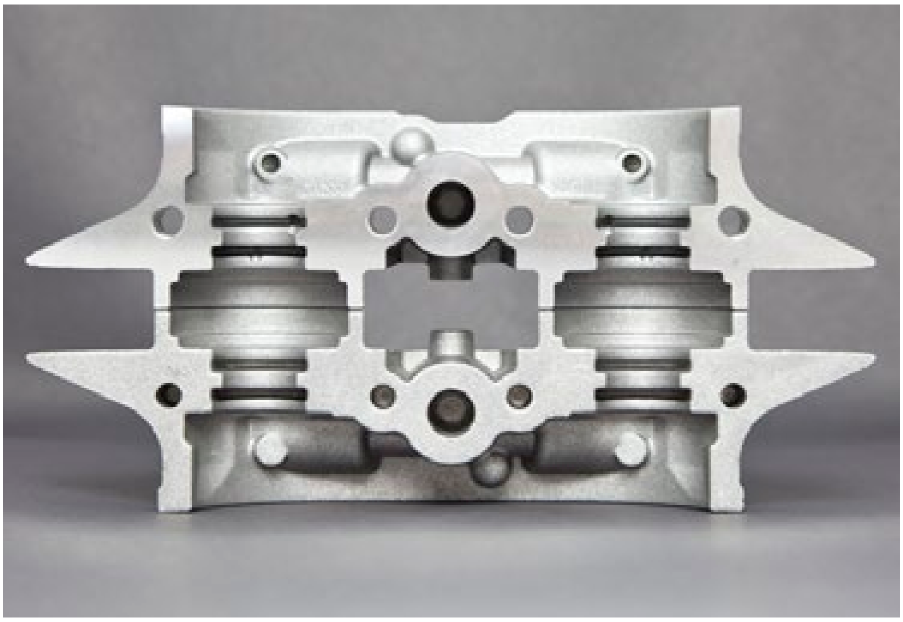
These software systems work by creating tooling from each customer's original 3D design files and allowing toolmakers to optimise the subsequent engineering processes – this is precise, efficient and fast, thereby reducing both cost and time from concept to production.

## An alternative approach

Historically, there has been a great deal of confusion over the cost of tooling and the way in which it is charged to each customer. As there were no standard definitions to guide cost calculations, suppliers adopted a variety of practices to calculate and charge-out the cost of developing tooling. Few of these were consistent, many were far from transparent and almost all depended on the expertise of a small number of experienced toolmakers and estimators.

Again, software has come to the rescue in this area, making it quick and simple for engineers to accurately assess the time, labour and materials required to produce individual tool sets. As a result, a growing level of standardisation is emerging across the sector.

Of course, those companies that have always taken a professional approach to tooling have long ago developed a consistent approach to how they price, charge-out and present tooling costs to their customers.



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At Dawson Shanahan, for example, our approach is to work with each customer, explaining how tooling costs are calculated and then finding the solution that works best for both parties. Typically, this might either be a one-off charge or an agreement to amortise the cost of tooling across the lifetime of the project.

Whichever route is chosen, a critical step in the process will always be to consider how the cost of both tooling and the overall project can best be reduced, while ensuring all other criteria, such as part quality and delivery deadlines, remain unaffected.

This is an important point, as it can be too easy to focus solely on the cost of tooling without appreciating that this may actually lead to higher part costs once the project enters the production phase; it can often be better to invest slightly more in the initial tooling development if this leads to a significant reduction in part costs – a factor which is especially relevant of course in high volume projects.

An equally important point at this planning stage is to consider the actual method of manufacture.

For example, despite the fact that the tooling for precision cold forming may be slightly more expensive that for conventional CNC machining, the actual production process is generally far more cost-effective: cold forming uses considerably less material, is faster and produces a higher quality component that, in many instances, requires little or no subsequent processing.

As a result, part costs are far lower, with the added advantage that less waste is generated and less energy is used.

Taking a holistic view of each project can therefore have a beneficial impact, not only on cost, but also on quality, part performance and delivery; all of which have the potential to enhance customer service and reputation for those companies selling upwards through the supply chain.

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