

The Ten Commandments for good casting design

The design and manufacture of cast components is a complex process and has traditionally been carried out by designers and manufacturers undertaking their activities as discrete processes. This has caused many problems in the past, where the required design is difficult to manufacture needing costly and time consuming modifications during the part production. The Castings Development Centre has made efforts to resolve this situation by establishing a 'Casting Design' bureau. Experienced casting engineers are available to identify the requirements of designers and bring them together with the castings producers.

This list of 'Ten Commandments' represents a summary of the major factors which a designer should consider when designing a cast component.

1. *Design the component shape using the minimum wall thickness required to achieve the performance criteria*

Each component will have its own specific performance criteria and some of these are listed below:

- Tensile and proof strength
- Impact strength and notch sensitivity
- Corrosion resistance
- Weldability
- Fatigue resistance

2. *Design the component shape using gradual and progressive blends to section changes*

Most components are now designed using CAD drawing systems, and these readily produce straight lines and rectangles. Cast components are best produced with blended sections and actions should be taken to:

- Minimise the number of section changes
- Blend sections with tapers
- Reduce stress concentrations
- Allow feeding of sections

3. *Design to avoid isolated heavy sections*

The design of cast parts can be improved by avoiding heavy sections which are isolated from the metal feed path:

- Heavy sections can induce stress concentrations and tears
- Lack of feed metal can cause shrinkage defects
- Defects can result in reduced material properties

4. *Design to avoid sharp corners and sharp re-entrant angles*

The cooling characteristics of the casting and the moulding media are a major influence in the production of cast parts. Design of corners has an important influence:

- Sharp corners induce high thermal gradients
- Hot spots are caused by re-entrant angles

- Corners produce differential cooling rates
- Shrinkage, tears and distortion defects can occur

5. *Design junctions to avoid heavy mass concentrations*

Much of the benefits with cast components are achieved by producing near net shaped parts which can involve numerous and often complex junctions:

- Junctions between sections create mass concentrations
- There are five types of Junctions – L,T,V,X and Y
- Drawing an inscribed circle identifies the mass concentration in a junction
- Defects can be shrinkage, tears and cracks

6. *Identify critical and special areas of the component*

From the performance criteria of the part, the designer can identify the more critical or special areas which require attention in manufacture:

- The design criteria and analysis data should be considered
- Highly stressed areas can be identified
- Critical surfaces need to be defined
- Machined surfaces should be marked with machining allowance
- Areas of high material quality should be specified
- Cosmetic areas are important for process considerations

7. *Identify the key dimensions and tolerances necessary for the component function*

In the production of the cast shapes, a knowledge of the finished part dimensional requirements is desirable to achieve near net dimensions at optimum cost. It is important for the designer to:

- Specify dimensions only where required
- Apply as high a tolerance as possible
- Include geometric tolerances
- Indicate datum points
- Detail any weld ends

8. *Identify any jiggling or fixture points and place away from any natural line of symmetry*

Many cast components undergo some form of machining or finishing operation before service, and these activities usually require fixtures or clamping operations to be employed. The designer should:

- Identify areas for jiggling or fixtures
- Locate these away from natural 'casting joint' lines
- Advise if CNC machining is to be used to finish the part

9. *Quantify the quality and material specification consistent with optimum economy and fitness for performance*

There are many cases in the past where the quality and material specification for cast components have not been detailed from the outset, and this can result in major consequences of re-design and repeat manufacture. The designer should:

- Choose the material properties to suit cast parts
- Take advantage of the wide range of available cast materials
- Specify the surface quality
- Specify the internal quality
- Apply the approach of 'fitness for purpose'
- Do not over specify

10. *Establish a liaison with a foundry expert at an early stage of the design process*

Significant benefits can be achieved by involving a foundry expert at an early stage of the design process, particularly where the ultimate process route may not be well defined. This joint or 'concurrent' activity can:

- Give guidance on the most suitable casting process
- Agree on the quality levels which can be achieved
- Evaluate the implications on cost
- Evaluate the implications on delivery
- Evaluate the implications on volume availability
- Establish the implications on product consistency
- Achieve significant savings on 'through cost' manufacture

These 'ten commandments' are not intended to be an exhaustive list of all factors involved in the design of cast components. They should be used by the designer as basis for the development of a good casting design process which is applicable to all cast products.

Copies of this and other Broadsheets can be obtained from:

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