Casting or Fabrication

This document was written by a member and was originally published by The Colchester Society of Model and Experimental Engineers in November 2011

Casting or Fabrication? The use of castings for many of the components of our models has been normal practice ever since the building of small-scale replicas of engineering subjects began. The machines that are being modelled employ castings for many of their main components and the obvious way of producing a small-scale version is to follow suit.

Figure 1
This VULCAN beam engine to the Edgar Westbury design was built entirely from the scrap box. All the components are either fabricated or machined from solid

Indeed, the purist might argue that the model is not a true scale replica unless it does employ the same construction technique and materials as the original subject. Until relatively recent times the majority of castings used in model engineering subjects have been conventional sand castings. Even now, although the lost wax process is becoming more widely adopted, sand castings are still the most common, particularly for larger components. Whilst with a little ingenuity quite complex components can be produced using traditional moulding techniques and modern foundry practice enables excellent surface finish to be achieved the process has its limitations. Furthermore, it is labour intensive, and the castings produced are not cheap. If only one or two units are required, the labour content per unit is further escalated by the need to make patterns and core boxes for the specific application. In many cases fabrication can be employed to produce a component more cheaply and quickly than by casting. This has been recognised by industry for many years. As welding techniques developed and the process became more and more reliable many components that would, in the past, have been produced as iron castings began to be manufactured as steel fabrications and today this is often the preferred method of manufacture for one off or limited number production.


Figure 2
Details of Vulcan fabrications

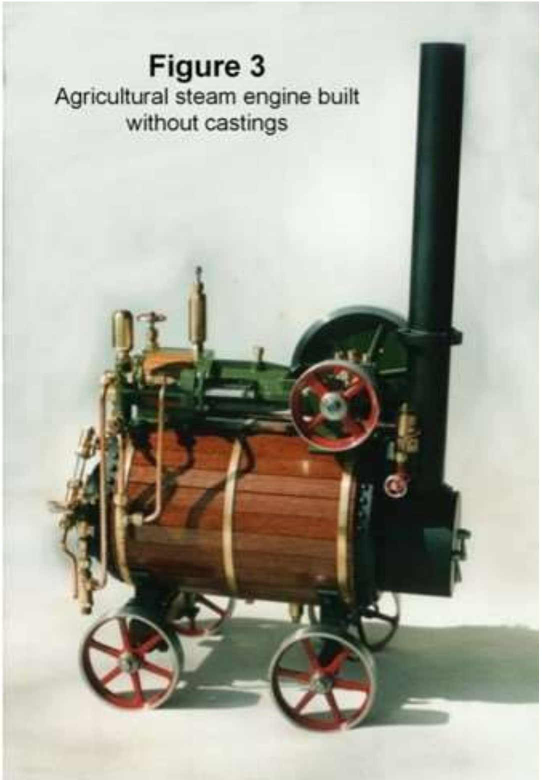
Figure 3
Agricultural steam engine built without castings

The argument in support of fabrication is even stronger in the case of our model components. Fine detail is often lost or distorted when produced as small sand casting. It is not uncommon to find that either insufficient metal has been left for a casting to clean up properly when machined or excess 13 material occurs due to moulding inaccuracies or where runners and risers have been cut off. These problems can be avoided if a fabrication is employed. Furthermore, many small fabricated components can be produced from scraps of material or off cuts from the scrap box which would otherwise find their way into the rubbish skip.

So, what do we need to consider when planning to use a fabrication in place of a casting? The answer depends on whether the component concerned is to be purely functional or whether it is to accurately represent a part which would have been a casting in the prototype being modelled. If the component is to be purely functional and its external appearance is not of importance the requirements are usually fairly simple. All that is needed is for the sections of the unit to be built into the required shape and bonded together. The bonding will usually be achieved by welding, brazing or silver soldering depending on the size of the assembly, the application and the facilities available. Welding will only be practical on fairly large assemblies whilst techniques for brazing or silver soldering can be developed for even the smallest of assemblies.

Figure 4
Fabricated frame for agricultural engi

If the fabrication is to contain fluid passages which cross the joint line between parts, it will be necessary to employ a method of assembly which ensures a continuous bond between the joint faces to prevent unintentional flow paths or leakage. In such a case silver soldering is likely to be the most satisfactory procedure, the silver solder flowing between the mating faces more readily than brazing spelter. Welding is unlikely to be suitable. Soft soldering and even resin bonding may be options, depending on the application and strength required. If the component being fabricated is to represent what would have been a casting in the prototype being modelled the requirement is a little more complicated. In this case the original casting will usually have incorporated features such as webs, flanges, bosses and fillets which are unnecessary in the model but are required for authentic appearance. These features would have been provided in the full-size casting to ensure adequate strength and stiffness. The effect of scaling is such that loadings and stress levels are greatly reduced in the model whilst the material properties remain unchanged. Strength and stiffness are seldom a consideration in the miniature reproductions. A basic functional fabrication can be 14 produced by brazing or silver soldering the various parts of the assembly, as in the case of the purely functional component and details such as webs and ribs can be added by soft soldering or even glueing with epoxy resin. Fillets can be produced with soft solder or epoxy resin thickened with a suitable filler. If the component being fabricated is likely to reach a high temperature in service (an engine cylinder, for example) care must be taken to ensure that the materials used will not melt or decompose at the expected operating temperature. Assemblies intended to represent castings will invariably be painted on completion and the fact that a mixture of materials has been employed will not be apparent, although it is necessary to ensure that any unpainted or machined surfaces are of a material with the correct colour and texture. Brass should not be used, for example, if the original would have been exposed cast iron. Steel would give an acceptable appearance. Some commercially available kits of castings for stationary engines include flywheel castings in bronze or gunmetal. This is, in my opinion, quite inappropriate when the rims of the wheels are to be machined and left in the unpainted condition Full size engine flywheels were invariably of cast iron. Stainless steel should also be used with care, whether as part of a fabrication or as a standalone component. It is highly improbable that the connecting rods, valve linkages, etc of a full-size engine would be made from stainless steel. The material has a distinctive appearance quite different from ordinary carbon steels and it looks wrong when used for these components of a model, particularly if the prototype being modelled is of a historic nature. When planning a fabrication, it is often useful to incorporate features which will not form part of the finished assembly but assist in holding the various components in the correct relative position during the bonding process (silver soldering, brazing, etc.) Once the assembly process is complete these features can be machined away. In this connection it is usually worthwhile designing the fabrication so that, once completed, it can be finish machined in the same way as a casting. This is not always necessary, but it does ensure that any dimensional errors resulting from distortion or small movements occurring during the bonding process are corrected. It is often useful to incorporate features in the fabrication which will facilitate the machining process, and which can be removed when this has been completed.

Figure 5
A Heinrici hot air engine to a design by Edgar Westbury built without the use of castings

The pictures in Figures 1 to 5 illustrate use of the techniques described above. The Vulcan beam engine was built entirely from the scrap box at virtually zero cost, the only commercial components being the nuts and bolts used in the construction. Castings are available for this engine. Comparison of the cast components with the fabricated equivalent shows far crisper detail in the fabricated parts. The agricultural engine was built to a design by John Haining published in Model Engineer magazine. 15 With the exception of the boiler materials which were purchased specifically for the project this engine was also built from the scrap box and stock materials, the engine frame, feed pump and drive pulley being fabricated, and the remainder of the main components machined from solid. Figure 5 shows a hot air engine built to a design by Edgar Westbury. Castings for this engine are also available but the example shown was, as in the case of the other engines illustrated, built from the scrap box and stock materials. In this case the flywheels were not fabricated but machined from steel discs. The final picture, Figure 6, shows examples of small components which can be fabricated with much crisper detail than can be obtained with sand castings. This type of small detail lends itself to lost wax casting, which process will produce the same quality of detail as can be produced by fabrication. The work involved in producing lost wax castings is considerable however and whether it is worthwhile following this route will depend on the number of components required and, of course, the facilities available

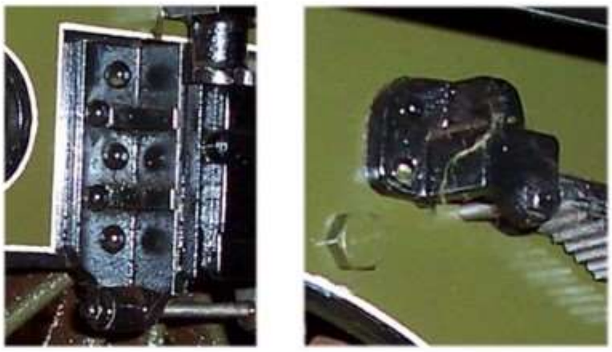

Figure 6
Examples of Fabricated Tender Horn Cheeks
and Spring Hangers