**Materials Selection versus Manufacturing Process**

<http://technoman.hubpages.com/hub/Materials-Selection-versus-Manufacturing-Processes>

Material selections can determine what manufacturing processes are available, form can determine what materials can be used and manufacturing processes can determine what form can be created.

**1**

So what you have is a merry go round of decisions and compromises to make in order to elicit the best choice. It also goes a little deeper than that, because it’s also about the physical properties of the material and of course the design specifications that have to be met.

**2**

Often the decision process that has to be made is simpler than it might first appear, there will be required properties that will rule out certain materials for example. Something like a need to be non-magnetic would rule out a good deal of metals and might lead the designer towards a plastic. Then the next requirement might be that it has to conduct electricity which in turn would rule out most plastics and so the process goes on. It is natural for most of the decisions regarding material type selections to be done without too much thought, intuitively engineers and designers will know from past experience or training which groups of materials to consider.

**3**

Anyone with basic engineering training will be aware of the different types of materials that are generally available and what groups they fall into. Typical groupings for materials are metals, ceramics, polymers and composite materials.

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**Metals** form a significant proportion of the materials chosen during the selection process because of the ability to manipulate their physical condition during various manufacturing process stages. They offer a very flexible and attractive solution to a material choice decision at an affordable price.

**5**

One example of this is producing aircraft parts made from aluminum alloy; the manufacturing process will nearly always consist of an annealing stage, maybe several while the material is being worked into a complex shape. After which it would receive a solution treatment to introduce changes at the atomic level that result in a high strength condition. Finally it is common to apply a precipitation treatment which is in effect an accelerated age hardening process to quickly strengthen the component ready for final function. These are relatively straight forward heat treatments that allow the manufacturer to get the shape, when the material is soft, and required physical properties from the material, when it is hardened and aged, that will allow the end item to meet the design specification.

**6**

**Ceramics** are one of the most difficult materials to process with only a few limited techniques being available usually involving some form of powder processing, very high pressure and temperature being applied. Ceramics tend to be brittle and/or porous but they still have their uses, a common one is to utilize them as a hard wearing coating. Components that could potentially erode, for example under flow conditions when drilling an oil well, can be protected to an extent with a carbide coating. Even better would be the use of a solid carbide component and this is often possible if the designer arranges the assemblies so that there are only compressive forces present and no tensile forces.

**7**

You will probably have realized from the dialogue that the use of ceramics is fairly specialized in whatever form they are used and as such this tends to be an expensive option, which, on occasion, is unavoidable.

**8**

**Polymers**, more easily recognized by most as 'plastics', are also widely used and versatile in nature. Particularly the thermoplastic plastics which can be reused time and time again as they can be melted and re-used without degradation, unlike the thermosetting plastics which once formed will degrade if subsequently re-melted. These characteristics raise further potential requirements criteria, which are asked for more and more these days, of being able to be recycled. A consideration that every manufacturer now has to take into account.

**9**

Plastics generally suit molding processes very readily and consequently are adopted frequently for components with complex shapes. The price that can be paid for that level of flexibility is strength and resistance to high temperature. The strength drawback can be overcome by introducing structural elements utilizing alternative materials, often metal. But for high temperatures the solution has been to develop specialist compounds that will withstand high temperature up to 200C. They are typically produced at a very high cost however and are more difficult to mold, although not impossible.

**10**

**Composites**this is where a mix of two or more base elements are used to provide properties that the base elements cannot provide standalone. There are a huge range of materials that could be considered composites; one example was alluded to previously where a ceramic coating was used to provide a hard wearing surface on a component to prevent erosion. Together these could be considered a composite material where each element solved a different problem. Another example was the plastic reinforced with metal to provide structural strength.

**11**

Composites are widely used in order to ensure that products can be made using manufacturing processes that are available and result in components that will meet the design specifications using materials that are often also commonly available.

**12**

The primary manufacturing processes fall into 4 general categories: Machining, Casting, Forming, and Joining.

**13**

Not every material will be able to be processed with every manufacturing process available, so again you can see that there are a set of inter-dependencies that determine the way forward.

**14**

History has shown over the years that the use of materials required resolving engineering problems can sometimes only be achieved by the development of new or improved manufacturing processes or equipment. Modern electronics is a great example of this, excuse the pun, but miniaturization has grown at an exponential rate. Massive amounts of memory can now be stored on tiny chips as a result of process improvements and changes in manufacturing techniques that allow these components to be manufactured.

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