PROTOTYPES
a critical part of product development

Significant advances in technologies for the production of prototypes has made them easier and cheaper to construct, and has increased the range of applications for which product developers can afford to use prototypes.

Advances in computer technology have enabled Rapid Prototyping (RP) systems to produce accurate models of complex components in just hours or days, using the principle of adding layers of material to each other. This contrasts with earlier approaches of removing material from a large mass to achieve the required design.

The improved systems have created new opportunities and approaches to product development, have reduced time and costs and enabled the early detection of unexpected problems. They have also proved valuable in communicating concepts and designs to stakeholders including management, manufacturers and investors.

Varieties of Prototypes

Prototypes can range from full-scale, fully functional representations of a product (*comprehensive prototypes*) to those that represent just a small part (*focused prototypes*). *Analytical prototypes* are intangible mathematical or computational approximations used to analyse particular aspects of a product or design.

Combinations of prototypes may be also used. For example, 3D computer-generated images may be appropriate in the early stages as a means of assessing the basic design or studying the relationship between components. One or more *focused* prototypes may then be created to look like the final product, or to function like the whole or part of the product. An *analytical* prototype may also be used to analyse the product's operation.

This approach can efficiently and effectively evaluate new designs and identify potential problems. It should also avoid the cost of complex and expensive manufacturing processes before the viability of a product has been established.

Integrating Designs

Many projects require different parts of the product such as mechanical and electrical components, to be designed simultaneously. The use of comprehensive physical prototypes is a means of ensuring that parts fit together and interact as intended, as well as encouraging closer cooperation between design teams.

Benefits of Using Prototypes

A major benefit of a prototype is in helping to answer the question, *"Will the product work as intended?"*

Designers may expect a product will behave in a certain way. However, theoretical designs may have mistakes, important features may have been overlooked or operational conditions including dynamic behaviour, may not be fully understood. A physical working prototype may easily identify design faults that would have proved expensive had the product been manufactured to its original design.

In a detailed and complex product, it may be necessary to complete one part of the design before moving on to the next. Successful testing of a preliminary stage will enable designers to continue with greater confidence.

> *"Prototypes have become easier and cheaper to construct and can play an important part in product development – but there are pitfalls unless their use is planned carefully and used strategically."*

The use of prototypes provide the opportunity to test various materials, the compatibility of different materials being used, or how they can be integrated. For examples, if plastic needs to be bonded to metal, the prototype is an opportunity for testing different types of adhesives.

The "Simple" Prototype

While some prototypes will necessarily be detailed and complex, it may be possible to create an effective prototype using cheap, easily-available materials and employing simple techniques.

For example, when Gilmore Engineers were analysing forces in a scissor-lift, two days were spent developing a comprehensive mathematical model to calculate forces.

However, to help understand the physical operation, a simple scale model was built in about an hour from a disused wooden flower box. This simple model was valuable in evaluating the mechanical effect of design modifications being incorporated in the mathematical model.

Prototype Pitfalls

Some of the advantages of prototypes can also be disadvantages.

Because the creation of prototypes has become faster and easier, it can be tempting to develop a prototype earlier than necessary. However, it makes sense to refine the concept as much as possible before prototyping. As well as reducing the cost and number of prototypes required, it will allow designers to concentrate on other more subtle, but nevertheless important refinements.

There may also be a tendency to use the latest technology to create prototypes when an older more basic approach would be better. For example, using styrofoam could be a quick and easy way of creating a model that provides basic information about the shape and appearance of a product.

There is a danger that servicing and improving the prototype can become an end in itself rather than part of the overall process of developing and refining the total design. This can occur when prototype alterations become so numerous that the developer becomes engrossed with maintaining, debugging and working on the prototype and loses focus on the overall project.

A further drawback may be that because a prototype is a powerful means of communicating ideas about a new product, stakeholders may accept these ideas more readily than a more practical or innovative concept that has not been prototyped.

In summary, prototypes can play an important role in project development through refining designs, communicating ideas, identifying risks and problems and streamlining the development process. But they must be planned carefully and used strategically if they are to provide worthwhile results.

Philip Teakle

This article is a condensation of a conference paper "Creating and Testing Effective Prototypes" by Philip Teakle, Nick Agnew and Ray Hope. Philip Teakle (pictured) presented the paper at the 4th Annual Asia/Pacific Conference in Accelerated Product Development in Brisbane in October, 1998. A copy of the paper can be obtained from Gilmore Engineers Pty Ltd.

High Profile

Australian Prime Minister John Howard recently held a news conference at the Queensland Clunies Ross Centre where Gilmore Engineers Pty Ltd is based. Gilmore Engineers staff (from left) Nicholas Agnew, Ray Hope, Duncan Gilmore, and Philip Teakle took the opportunity to meet Mr Howard during his visit.

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