Some Notes on Prototypes and Testing
(Product Design, Otto & Wood)

A prototype is a physical instantiation of a product, meant to be used to help resolve one or more issues during the product development.

Reasons for using physical prototypes

1. **Minimize risk** during product development process
2. **Communication/Demonstration**
   (show design form to get feedback)
3. Check **Feasibility** (uncover unpredicted phenomena)
4. **Parametric modeling** (run a matrix of tests to select design variables to optimize performance)
5. **Manufacturing/production** (test component manufacturing processes, and compatibility and assembly of components)
Should you build a prototype?

Must be driven by the need for information and must be determined to be the best way to get that information.

Examine other options: Would a digital prototype or an experimentally validated analytical model be better?

If a physical prototype is judged necessary, use a template to guide the process:

**TABLE 17.12. TEMPLATE FOR DESIGNING AND PLANNING A PHYSICAL PROTOTYPE**

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OU ME Sr. Design, Dr. Kremer
TABLE 17.13. GUIDELINES DURING PROTOTYPE DEVELOPMENT

Judge the risk of not creating a prototype vs. cost and build time. If there exists minimal risk, proceed forward without the physical prototype.

If a prototype is needed, don’t be tenuous in its fabrication, but move ahead with enthusiasm. Each prototype simply adds to a strong foundation for creating a successful product.

During proof-of-concept, prototype the difficult, trickiest components first. These undoubtedly will be the weakest links in the product concept.

Draw, sketch, or create a solid model of the prototype at an appropriate level of detail.

For electronic prototypes or subsystems, wire-wrapping and breadboarding work well. Stick to basic machines.

Use off-the-shelf components when possible.

Remove features from the prototype that are not necessary for the tests.

Know the catalogs: Thomas Registry (http://www.thomasregister.com/), McMaster-Carr (http://www.mcmaster.com/), Edmund Scientific (http://www.edsci.com/), etc.

Hardware stores, novelty stores, and product catalogs are great sources for ideas and parts.

Scavenge parts from similar or analogous products when developing early prototypes.

Prototyping with molds, at low cost, is possible.

Rapid prototyping is not always rapid and is not always cheaper. Comparisons must be made with other technologies.

Dual prototypes at a given stage of the product development process are common if a singular prototype cannot be fabricated to satisfy multiple purposes. Be willing to create two or more simple prototypes instead of one that is overly complex.
Types of Prototypes

1. Proof of Concept Model
2. Industrial design Prototypes
3. Experimental Prototypes (DOE)
4. Alpha Prototypes
5. Beta Prototypes
6. Pre-Production Prototypes
Examples of the various classes of physical prototypes

Original Moore Detacher

Mechanical breadboard proof of concept prototype

Machined foam industrial design prototypes

Non-functioning industrial design prototype conveys look and feel

Experimental prototype

Alpha prototype, with fully functional hardware

Final product
Prototypes and Mock-ups

Kart Race Heroes
Nick Taylor, Justin Funk, and Jerone Anderson
Guidelines for Usage

• Determine possible problems/areas of concern that need to be tested
• Set goal of what results need to be accomplished
• Organize a plan of how the desired test can be performed
• Determine what will need to be built, and see if any equipment can be reused
Guidelines (con’t)

• Judge risk of prototype cost and build time vs. information expected
• Don’t over-do the prototype
• Stick to basic machines/ processes
• Use basic materials (i.e. wood or cardboard)
• Scavenge parts when possible
Guidelines (con’t)

• Use off-the-shelf parts/fasteners

• Draw/sketch an idea of the model before building

• Be willing to build multiple prototypes if necessary
Testing Guidelines

• The mock-ups are not the same as the alpha prototype
• These variances must be accounted for
• Try to get multiple tests out of different setups
Testing (con’t)

- Trial and error is not design - all tests must have an analytical basis to be correctly implemented

- Testing should always supplement calculations or manufacturer supplied data, not substitute for it
Testing with a Mockup
Uses of a mockup:

• Give physical representation to CAD drawing

• Perform simple maneuverability tests

• Simulate ergonomics and visibility concerns quickly and inexpensively
Materials for a simple mockup:

- Cardboard: readily available and free
- Styrofoam: inexpensive, easy to shape
- Wood: more durable model allows maneuverability testing
What we learned from our Mockup

• Visibility is poor; design changes can be simulated quickly to resolve concerns

• Lots of unused space under basket

• Ergonomic issues; reaching around steering column into the basket can be difficult
Future Testing

- Battery Cover Leak Test
- Stability/Clearance Tests
- Slider Impact Tests
- Motor/Controller Testing
- Verify rake angle and turning radius
Questions?

- A failed stability test