**Rice University Collaborative Capstone Design** 

**Documentation Instructions**

*Testing Plan*

**Why you do it**

Engineered products are defined by their specifications. A product’s specifications provide a quantitative measure of the performance of a product as measured by well-defined, objective testing methods. It should always be possible for an impartial observer to determine whether a product is meeting its specs. Products that fall out of spec may require warranty repairs, costing the manufacturer significant expenses. Some specs are visible to the customer, but usually many more specs deal with internal subsystems. Manufacturers need to test their products against the specs. Products that don’t meet their specifications usually can’t be sold for revenue.

The Testing Plan document is where teams describe the tests they will perform to determine whether their project meets the specs that have been determined. This document will be folded into the Final Report.

Teams will perform the tests specified in the Testing Plan document before the end of Cycle 4 and will present the results of the tests as part of their Final Design Review, and will write up the results as part of their Final Report.

**Designing precise test plans**

First, every specification in the Product Development Worksheet needs an associated test. Think in detail about how you would test whether your project meets each spec. There should be enough detail that someone not intimately familiar with your project could perform the test and unambiguously determine whether the project meets the spec.

Sometimes the test is rather obvious. E.g. suppose your spec is “System volume less than 10 cm x 10 cm x 20 cm”. Then the associated test could be “Use calipers to determine maximum dimensions of system along 3 major axes.” Or perhaps more appropriate would be “Verify that system fits inside box of dimensions 10 cm x 10 cm x 20 cm.” Which test is better could depend on whether the system is irregularly shaped, making caliper measurements difficult.

Sometimes the test method may require more detail. E.g. suppose the relevant design criterion is “Easy to use” and an associated spec is “At least 80% of users rate the system 4 or 5 5-point usability scale (N> 6.)”. In this case describing the test would require (1) describing how subjects are chosen for the test; (2) describing the procedure that the subjects would be asked to perform; and (3) describing the questionnaire the subjects would be asked to fill out. (Since this example involves human-subject research, the test-method description is a distillation of your team’s IRB documents.)

Data taking methods might need to be described in detail. For example suppose the spec is “battery life > 10 hours.” The test method could be “Put the system in normal operating mode with fully charged battery. Verify that after 10 hours of use, the battery still has charge left.” Normal operating mode would need to be defined more precisely if the system’s power draw depends on the exact usage. Sometimes a test is impractical to perform in the timeframe of a senior project -- suppose the battery life spec were 200 hours. In this case you could write the test as an extrapolation. If you know your battery has a 2 amp-hour capacity then a 200 h spec would require average current draw of less than 10 mA. So you could write the spec as “Put the system in normal operating mode and measure current draw using a calibrated ammeter in series with the battery. Record the current measurement at least 50 times over 1 hour of normal use and verify that the average is less than 10 mA.” Note in the real world this might not be sufficiently detailed -- battery life depends on temperature, for instance, so the operating temperature (or range) might need to be stated.

Be careful about testing durability specs if you can’t afford to lose your prototype! If your spec is “system should survive a drop from 10 feet” then the appropriate test could be “Using a ladder, drop the prototype from a height of 10 feet onto a concrete surface. After the drop, power-on the system and verify that a user can log in.” All well and good, but what happens if you break your prototype? Unless you have a backup system or fixing the prototype is easy you shouldn’t write such a test. In this case, perhaps it is possible to either (a) change the original durability spec -- assuming your customer and course faculty will allow such a change; or (b) make the test into a weaker “correct by design” test, e.g. “A faculty member not associated with the team verifies that proper design methodology has been used to enable the system to meet spec;” or (c) identify the weakest subcomponent and perform a suitable durability test, i.e. weakest link analysis.

Many tests require statistics. This may require doing multiple runs of a test, or performing the test on multiple samples. In Cycle 3 your Testing Plan should discuss your use of statistics and justify the sample size chosen.

**Creating the Testing Plan document**

***Cycle 2 -- Preliminary Test Plan***

The Testing Plan document is essentially the Test Methods section of the Product Development Worksheet along with sufficient supporting detail to enable an engineer to determine whether the project meets the associated specs.

Fill out the Test Methods table in the “HOQ/ FOSS/ Specs/ Objectives” tab of the Product Development Worksheet. Place this table in its own document which will become the Testing Plan document. The hardcopy of this document should be placed in the appropriate binder section. Every spec should have an associated test. Use a few sentences at most for each test associated with teach spec. If you need additional space, such as in the user questionnaire example above, refer to necessary figures/ documents/ questionnaires/ procedures which should be included in the Testing Plan document.

***Cycle 3 -- Final Test Plan***

This section is similar to a “methods” section of a peer-reviewed technical paper, and will be included in the final report. This is a full document with a complete test procedure for each test. Each test should be sufficiently well described that someone outside the team could reproduce the test. Each test should contain the following elements:

1. The scope of the test: what are you trying to learn?
2. The equipment to be used: what will you need to do the test?
3. A step-by-step plan for carrying out the test: how will you do it?
4. Acceptance criteria: how will you know if the test is successful?
5. Statistical techniques, as appropriate: how uncertain are you about the results? The nature of this element will vary greatly based upon the type of test carried out. For tests with many data points, you can use the standard statistical analysis with standard deviations, T-tests, etc. For tests with one or only a few data points, a Klein-McClintock uncertainty analysis might be appropriate. This element might not be appropriate for all tests.

**Grading**

The Testing Plan document is graded at Cycle 2 and Cycle 3. The Cycle 3 test plan will be used by the team to determine whether they meet their specs in Cycle 4 so having a complete and feasible testing plan is very important.

[Testing Plan Rubric](https://docs.google.com/a/rice.edu/document/d/10TjuNP5O8Qs183SyfmPPyv0VKF0ze5B8aQsnsLZSG9Q/edit?usp=sharing)

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