

**Work Plan**

**Harvey Mudd College Engineering Clinic**

Project Team

**Fall Semester**

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ABSTRACT

[Insert abstract here]

*An abstract is similar to a short executive summary. In about 100-150 words, it should summarize the report and the key results in a form accessible to the general reader (e.g. a junior engineering major). Common mistakes in an abstract are to use generalities and to omit the most important information.*

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introduction

*This section may be mostly or entirely the same as in the workplan. Be sure verb tenses make sense for this report.*

## Northrop Grumman

## Project Statement

*If the project statement has been revised since the work plan, give the new project statement and explain why and how it has been changed. Same applies for objectives, constraints, functions, and deliverables.*

### Objectives

### Constraints

### Functions

## Deliverables

*At this point, it is not uncommon for the team to have negotiated a modified set of deliverables with the sponsor. One of the key functions of the midyear report is to document what has changed and why the decisions were made. The liaison and Clinic program will assess your results in May against your revised deliverables.*

By the end of the fall semester, the team will deliver:

* Four conceptual designs for capturing roadrunners
* An evaluation of the four designs
* SolidWorks model of the preferred alternative
* A test plan for evaluating the prototype
* Project documentation and presentations including:
  + Work Plan
  + Midyear Report
  + Design Review at Acme
  + Three internal Clinic presentations

By the end of the spring semester, the team will deliver:

* An optimized prototype of a device for capturing roadrunners
* Test results
* Project documentation and presentations including:
  + Final Report (including engineering drawings)
  + Spring semester presentation at HMC
  + Projects Day presentation
  + Final Presentation at Acme

The fall deliverables in the Work Plan had called for an evaluation of three conceptual designs and a SolidWorks model sent for manufacturing. When the team completed the evaluation, it became apparent that several features of the two leading designs could be combined to create a fourth concept superior to the original ideas. The team is now pursuing this improved concept of jet-powered anvils. The team fell behind schedule because of this additional conceptual design work and has been unable to catch up. An initial SolidWorks model has been completed, but the manufacturing has been delayed until January to give time to make revisions based on the design review at Acme Corporation. The team expects to be able to complete the spring deliverables as initially planned.

## Project status

*This section succinctly summarizes what the team has achieved and the status of the deliverables. In doing so, it also outlines the contents of the rest of the report.*

*The team and advisor should have a candid discussion at this point about what has gone well and what has not. If the project has not met the milestones specified in the work plan, the team should come to an understanding of why. In some cases, the direction of the project has shifted in ways that could not be anticipated at the time of the work plan. In other cases, the project has slipped because of insufficient planning (e.g. not realizing that a supplier on the critical path had a 6-week lead time). In yet other cases, part or all of the team may not be putting in the effort required to meet the milestones. This may require some difficult discussions, particularly when members of the team feel the teammates are not pulling their weight. The team should articulate a plan in the Midyear Report to get on track to meet the spring deliverables. However, it is better that issues of team dynamics be addressed verbally within HMC rather than in writing in a way that goes to the client.*

This fall, all of the deliverables given in the previous section were finished and provided to the client. The background research about the diet, habitat, and locomotion of roadrunners and the capabilities and limitations of Acme’s existing products was completed. This information is summarized in Section 2. Section 3 address the potential impact of this project, including changes in roadrunner and coyote populations, the spillover of these changes into the broader ecosystem of the Southwest, and the economic benefits. The team has developed four design alternatives and selected the jet-powered anvil concept for reasons described in Section 4. Section 5 documents the detailed design of the jet-powered anvil, including the SolidWorks model, finite element analysis modeling indicating a maximum velocity adequate to catch a road runner, and a bill of materials. A recent design review at Acme raised several areas that need redesign before manufacturing. This report lists the known issues and plans for modifications; the revised device will be sent for manufacturing in January. Section 6 contains the test plan, including a protocol for animal research.

In the spring, the team plans to manufacture and test the prototype device. Based on test results, an improved second prototype will be designed, built, and tested. The management plan for the second semester is presented in Section 7.

### Simulation

### Hardware implementation

## Impact

*The HMC mission statement calls for preparing you to be ready to assume leadership in your fields with a clear understanding of the impact of your work on society.*

*This section addresses the significance of your project and its implications. Why does the sponsor want the deliverables? If the project could eventually lead to a new product, what is the size of the market? Who are the potential users and how would they benefit from the project? How will you personally benefit from your experience on the project? What are the implications for society? Benefits? Costs? If your technology became widely adopted, how would it impact the world? Are there any controversies related to the technology you are working with? Impacts on health or quality of life? The environment? Privacy? Security? Energy? Entertainment? Our understanding of the universe? If the impacts seem trivial or obvious at first glance, take the time to probe more deeply.*

*Most projects have both positive and negative potential implications for society. Consider ways in which the negative implications could be avoided or alleviated. Word this section honestly but tactfully because your sponsor is one of your important audiences.*

# Background

*This section may carry over from the Work Plan. In most projects, the team has come to understand the technology better and the new information should be incorporated into the work plan. A key audience is the spring semester junior(s), who will likely depend on this section to get up to speed about the technology.*

# design alternatives

*The next sections of the report should be tailored to the specific nature of the project. For this project, “Design Alternatives,” “Detailed Design,” and “Test Plan” line up well with the deliverables, but for most projects, the headings will differ. A “Results” section is particularly valuable if the team has gotten far enough to have results.*

## States of the quadrotor

## Sensors

## Secure state estimation algorithm

## Hardware

### Quadrotor

### Flight controller and computer

# Detailed design

*This section is often the heart of a Midyear Report. It should fully document the design. Common figures and tables in this type of section include block diagrams, detailed drawings, schematics, printed circuit board layouts, and a bill of materials (BOM). The section should explain why design decisions were made, such as how tolerances were selected or why certain component values were used.*

*A bill of materials should list everything that the reader would need to order the components. Component designations should match those in the detailed drawing or schematic to assist assembly. An example is shown in Table 1.*

Table 1 Bill of Materials

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Component** | **Description** | **Supplier** | **Supplier Part #** | **Unit Price** | **Quantity** | **Total** |
| R1-R7 | 1 k resistor | DigiKey | 1.0KQBK-ND | $0.01 | 7 | $0.07 |
| C1 | 0.1 F capacitor | DigiKey | P4525-ND | $0.18 | 1 | $0.18 |
| U1 | Spartan XCS3400-4TQ144C FPGA | Nu Horizons | XCS400-4TQ144C | $19.10 | 1 | $19.10 |
| D1 | Common anode 7-segment display | Jameco | 24715 | $1.26 | 1 | $1.26 |
| … |  |  |  |  |  |  |

*If the design includes source code, the body should give an overview of the design and operation, but the code should be placed in an appendix.*

## Simulation

### Dynamic Model

### Closed-loop simulation

### Closed-loop simulation with SSE

## Hardware implementation

### Onboard computer

#### ROS environment

#### SSE algorithm

#### Data logging

### Sensors

#### 9DOF sensor

#### Laser scanner

#### Optitrack vision system

### Quadrotor

### Controller

### RC receiver

### Power grid

# Results

## Dynamic model

## Closed-loop simulation

## SSE algorithm

## Sensor data

### 9DOF sensor

### Laser scanner

# Project Management

*By this point, you will likely have obtained new information not available at the time of the Work Plan that causes the plan for the project to shift in minor or major ways. You also are likely to have a much better sense of which parts of the project are easy and which parts are hard. This section is a good place to critically reflect on how the fall semester actually proceeded in comparison to your plan and to use the experience to create an effective spring plan.*

[Introduction here, you should not have two headings in a row without text between.]

## Fall progress

*Discuss what the team completed in the fall and how it matched the Work Plan in terms of deliverables, schedule, and division of labor. Include a comparison of the fall elements from the work breakdown structure with the actual work performed. The comparison will show new tasks added to the work beyond the original plan. Review the minutes from the team meetings. If the project deviated from the plan, why did the deviations occur? What can the team learn from the experience to create a more realistic plan to reach the spring deliverables?*

…

**Activity Planned Time (hours) Actual Time**

Background research *(already complete)*

Roadrunners

Diet 6 7

Habitat 6 5

Locomotion 6 3

Existing Acme products 6 8

Review footage of product failures 3 × 4 = 12 12

Conceptual Design

Research

Skates 12 8

Boulders 12 9

Anvils 12 7

Jet-Powered Anvils new 4

Brainstorming, sketching, component research

Skates 18 13

Boulders 18 15

Anvils 18 12

Jet-Powered Anvils new 9

Drawings

Skates 4 7

Boulders 4 8

Anvils 4 5

Jet-Powered Anvils new 9

Comparison of Alternatives 5 × 4 = 20 16

Detailed Design *(significant uncertainty in these initial estimates)*

Initial SolidWorks model 24 18

Finite Element analysis 48 60

(note: ideally this would be broken down further to better estimate time)

Component selection 20 30

Manufacturer selection 12 7

Send prototype for manufacturing 8 not done

Test Plan

Initial Test Plan 8 9

Team Meetings

Teleconferences 15 × 4 × 1 60

Internal Team Meetings 15 × 4 × 1 60

Tuesday Presentations 15 × 4 × 1 40

Team Leader Meetings 3 3

Planning 15 × 0.5 8

Logistics

Register to drive Clinic Van 2 1

Presentation and Preparation

Orientation Day 3 × 4 = 12 12

Fall Review #1 2 × 4 = 8 8

Fall Review #2 3 × 4 = 12 12

Fall Review #3 3 × 4 = 12 12

Fall Site Visit 12 × 4 = 48 55

Reports

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Schedule 2

Division of Labor 1

Other sections 3

Writing Center review 2

2nd Draft n/a

3rd Draft n/a

Midyear Report 40

Total Time (Fall) (add up here) (add up here)

Figure Comparison of Planned and Actual Fall Work Breakdown Structure

## Spring overview

[Lay out the big picture of what the team plans to do in the spring, how the work will be divided, and what the major milestones are along the way.]

## Work breakdown structure

*Spring semester work breakdown structure with expected hours; see the work plan for an example from the fall.*

Figure 1 Spring Work Breakdown Structure

## Schedule

[See work plan. Focus on spring semester Gantt charts.]

Figure Spring Gantt chart

Figure 2 Detailed Spring Gantt chart

## Division of labor

[Similar to work plan, but for spring semester tasks]

**Activity Owner**

Detailed Design

Send prototype for manufacturing Coyote

Revised SolidWorks model Coyote

Revised analysis Bunny

Revised components Pig

Second prototype manufacturing Spring Junior

Test Plan Bunny

Testing Pig, Bunny

Presentation and Preparation All

Reports All

# References

*If your field has a standard format for references or your liaison or advisor prefers a format, follow that convention. Otherwise, use the IEEE format given below. Note that different sources such as books, conference papers, journal papers, and web sites have different forms to reflect the different information. A unifying principle is that a reader in the distant future should be able to track down the reference using the information you supplied. When doing your research, go to the library and check out books and papers rather than simply relying on Google; there is a vast amount of technical knowledge in the world that is still not available through Internet searches.*

*All the references in this section should be cited in the text.*

1. P. Cha, J. Rosenberg, and C. Dym, *Fundamentals of Modeling and Analyzing Engineering Systems*, New York: Cambridge University Press, 2000.
2. M. Watkins, M. Cianchetti, and D. Albonesi, “Shared reconfigurable architectures for CMPs,” in *Intl. Conf. on Field Programmable Logic and Applications* *(FPL `08)*, Heidelberg, Germany, Sept. 2008, pp. 299-304.
3. Q. Yang and K. Bergman, “Performance of the Data Vortex switch architecture under nonuniform and bursty traffic,” *J. Lightwave Technology*, vol. 20, no. 8, pp. 1242-1247, Aug. 2002.
4. “SN7404 Hex Inverters Data Sheet,” Jan. 2004 [Online]. Available: <http://focus.ti.com/lit/ds/symlink/sn74ls04.pdf>. [Accessed: August 22, 2010].