# Hold Down Release Mechanism
# Team Stellar Hold

## Project Management

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# DISCLAIMER

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# 1 Reflection

This section is intended to reflect and take note on the previous progress of this project and to be used as an aid in planning the next few months as the project comes to an end. This section will discuss successes and potential bottlenecks, important tasks that need to be completed, and any design aspects that remain to be fully worked out. Being partnered with General Atomics – Electromagnetic Systems (GA-EMS), this semester should result in a functional prototype that shows potential for a end-use product, and a formal symposium where the team proposes the product to GA-EMS at one of their facilities.

## *1.1 Successes*

The previous semester focused on problem definition, introduction, and system design. As one of the requirements for this project is to be fully resettable, the team selected to use shape memory alloy (SMA) springs in the reset process. This selection is a success in our eyes as it is a relatively new and under-utilized technology that we plan to integrate into the hold-down release mechanism. The team obtained an SMA spring and produced a prototype demonstrating the mechanism that the SMA will be integrated into.

## *1.2 Room for Improvement*

The previous semester came with some scheduling conflicts as the team from GA-EMS had a different preferred progression plan from the standard NAU capstone progression. This led to some last-minute delays of deadlines and some tedious planning. This may be due to communication issues between our capstone team and GA-EMS. Another area that needs more work is designing for manufacturing and assembly. Not much consideration has been taken in how the final product will be manufactured and assembled. Additionally, testing goals and procedures need to be solidified.

## *1.3 Action Items*

Firstly, the team needs to finalize the BOM and begin purchasing materials as soon as possible. Some parts, such as the SMA spring, may need to be custom manufactured from a third party, which we need to reach out to immediately. We need to re-visit CAD and take DFMA into account to ensure that the CAD can be turned into a physical functional part. More research and preliminary testing is required to integrate the SMA spring into the mechanism, as at the moment, it has not been integrated.

## *1.4 Remaining Design Efforts*

While the mechanical concept of the design will not change much, if at all, the SMA spring needs to be integrated into the mechanism. Once that is completed, an electrical system must be attached to provide heat to the spring, and ideally, attached to a timer and/or a button for actuation. A minor amount of design effort needs to be allocated to fabricating a mock-up of a CubeSat to demonstrate the mechanism and how it interacts with the satellite.

# 2 Schedule

The bulk of this semester will focus on manufacturing and assembly of the HDRM. Near the beginning of this schedule some remaining design efforts (listed in 1.4) will be worked out, specifically integrating the SMA spring into the design with mathematical verification. As manufacturing and assembly comes to an end near the end of October, multiple tests will be designed and performed to further verify and prove that the HDRM meets the engineering requirements. These tests and the schedules for them will be added to the schedule once they have been decided on. A report will be compiled, as well as a professional CAD package with part files and drawings. To finish off the project, a poster will be created to be displayed, the website will be finalized, and the product will be presented to the client with a manual containing all relevant information and instructions for use. This information is displayed in a Gantt Chart in appendix A.

# 3 Manufacturing Plan

Manufacturing the hold down and release mechanism will be done in three stages to meet each of the hardware reviews, shown in table 1. The first stage will focus on the electronic and SMA aspect as this is the most important and has the highest potential of failure. The second stage revolves around the lock mechanism, shown in figure 1. These components are the most complex and will require more planning as the team moves forward. Due to this, the team has allotted the most manufacturing time to this phase. The final phase will focus on putting everything together and manufacturing the necessary items for the demonstration.

Table 1: Manufacturing Plan

| **Component** | **Who** | **Start** | **Finish** | **Duration (Days)** | **Materials** | **Where** |
|---|---|---|---|---|---|---|
| Pin | Maia | 9/12/2022 | 9/23/2022 | 11 | Aluminum | CNC Lathe |
| Electronics/ Wiring | Valentin | 9/12/2022 | 9/23/2022 | 11 | Arduino/ wires | EE Lab |
| Lock Piece | Nate | 9/30/2022 | 10/14/2022 | 14 | Aluminum | Machine Shop |
| Bearing Lock | Valentin/ Nate | 9/30/2022 | 10/14/2022 | 14 | Aluminum | Machine Shop |
| Bottom Pin Platform | Maia | 10/3/2022 | 10/14/2022 | 11 | Aluminum | CNC Lathe |
| SMA Integration | Team | 10/3/2022 | 10/14/2022 | 11 | Nitinol | Machine Shop |
| Cube Sat Demo | Valentin | 10/15/2022 | 10/28/2022 | 13 | Acrylic | Machine Shop |
| Base | Valentin | 10/20/2022 | 10/28/2022 | 8 | Aluminum | Machine Shop |
| Front Plate | Valentin | 10/20/2022 | 10/28/2022 | 8 | Aluminum | Machine Shop |

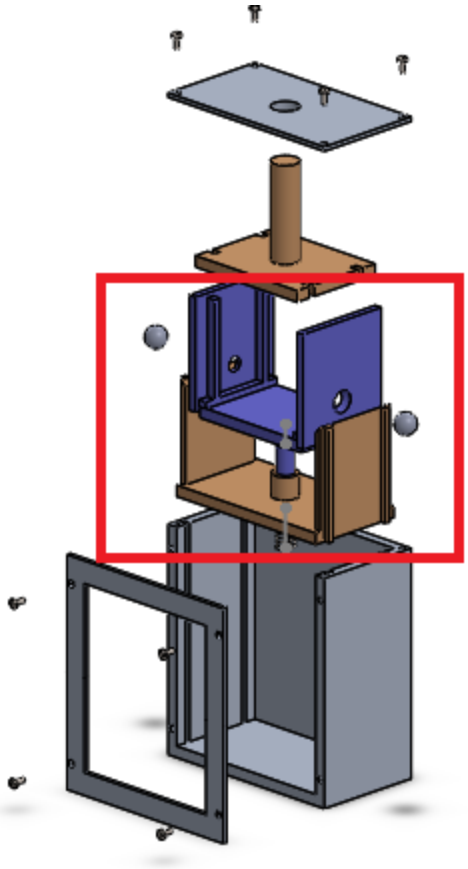


Figure 1: Lock Mechanism

# 4 Purchasing Plan / Budget

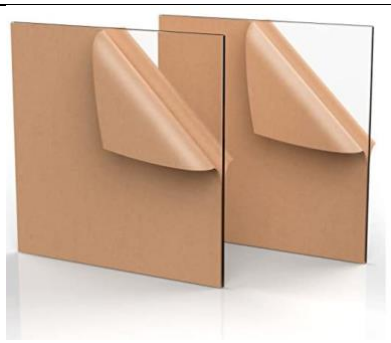
This section is dedicated to planning when and from where the team will be purchasing the parts needed for the HDRM, mock Cube Satellite, and locking mechanisms that will complete the prototype demonstration. The table shows the most up to date and detailed Bill of Materials. The Bill of Materials includes the item cost and where it's being purchased from, the quantity and manufacturer, and the date it was or is planned to be purchased. All the team's items will be purchased and then manufactured which is described in the second table below. The breakdown also includes the spending total with an estimated portion for taxes, testing/manufacturing, and repairs. The total budget the project was given is $2,000. With predicted total spending adding up to $650, we have a large margin for change at $1,350.

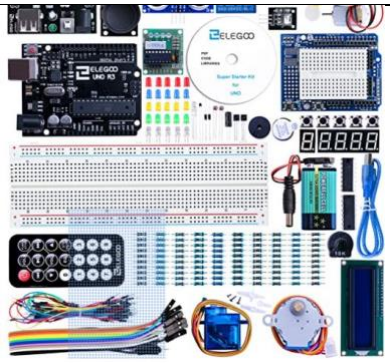
Table 2: Device Manufacturing Budget Breakdown

| **Part Description:** | **Cost: ($)** | **Quantity:** | **Part Status:** | **Make/ Buy:** | **Primary Vender:** | **Manufacturer:** |
|---|---|---|---|---|---|---|
| Acrylic Sheets | 150 | N/A | 09/06/22 | Buy | Amazon | Acrylic Mega Store |
| Nitinol Spring (2.4 mm) | 19.58 | 3 | 02/23/22 | Buy | Amazon | Kellogg's Research Lab |
| Aluminum Block | 36.99 | 1 | 09/06/22 | Buy | Amazon | VERNUOS |
| Generic Springs | 3.99 | 2 | 09/06/22 | Buy | Amazon | Ninoge |
| Custom SMA Spring | 100 | 1 | 09/25/22 (latest) | Buy | Memry | Memry |
| Ball-Nose Plunger | 8.38 | 2 | 04/05/22 | Buy | McMaster-Carr | McMaster-Carr |
| Arduino | 39.50 | 1 | 09/06/22 | Buy | Amazon | Arduino |

| | | | |
|---|---|---|---|
| **Testing Total:** | $100 | **Repairs Total:** | $100 |
| **Part Total:** | | $409.97 | |
| **Part Total with Taxes (estimated):** | | $450.00 | |
| **Total:** | | $650.00 | |

Table 3: Purchased Parts

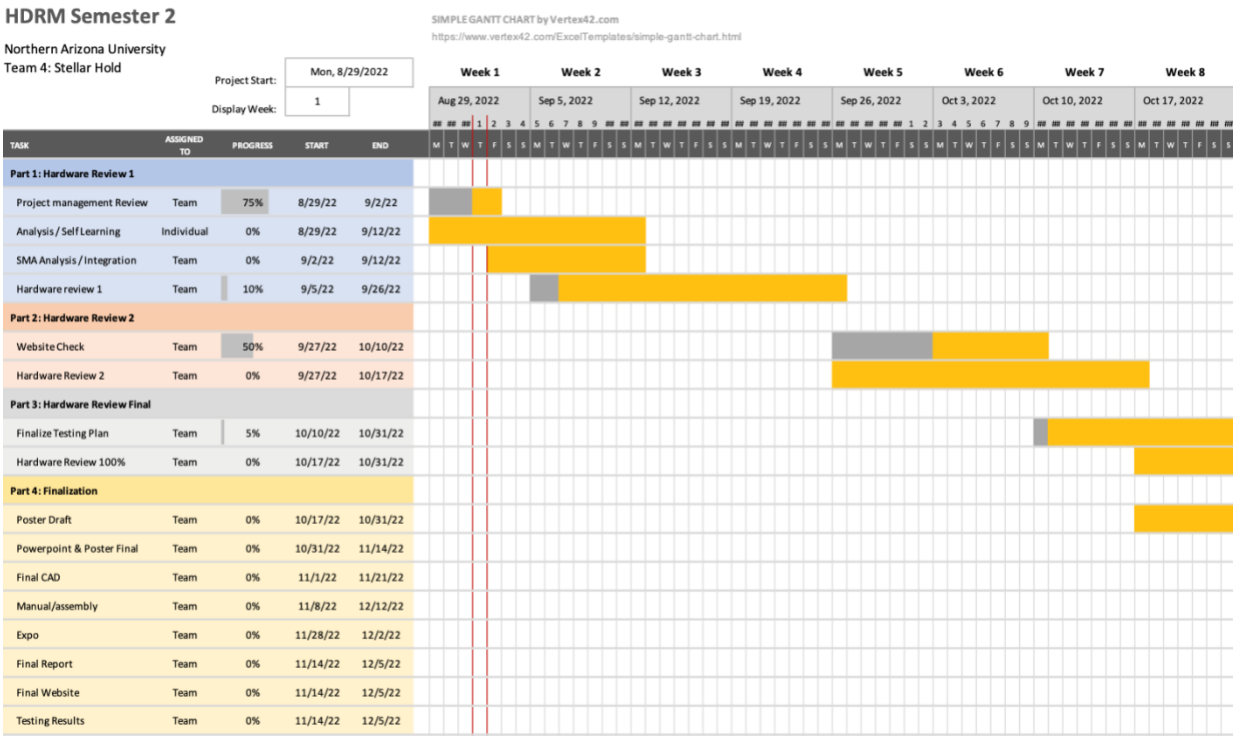
| **Purchased Parts:** | **Image:** | **Introduction:** |
|---|---|---|
| Acrylic Sheets |  | • We plan to create a mock Cube Satellite out of acrylic<br>• The sheets will be laser cut to shape and carved out where the HDRM will be attached |
| Nitinol Spring |  | • Spring was purchased just for testing and is not the right strength to actuate the device, but has served the purpose of observing how the spring reacts to heat and to time actuation<br>• It has provided data for how to customize the future SMA spring |
| Aluminum Block |  | • The aluminum blocks will be used to carve out a larger scaled version of the HDRM<br>• They will act as the outer shell and the platforms |
| Generic Springs |  | • The generic springs will be used to create tension on the platforms and move them back and forth<br>• The springs will either help hold the levels in place or aid the movement after the SMA spring has expanded |

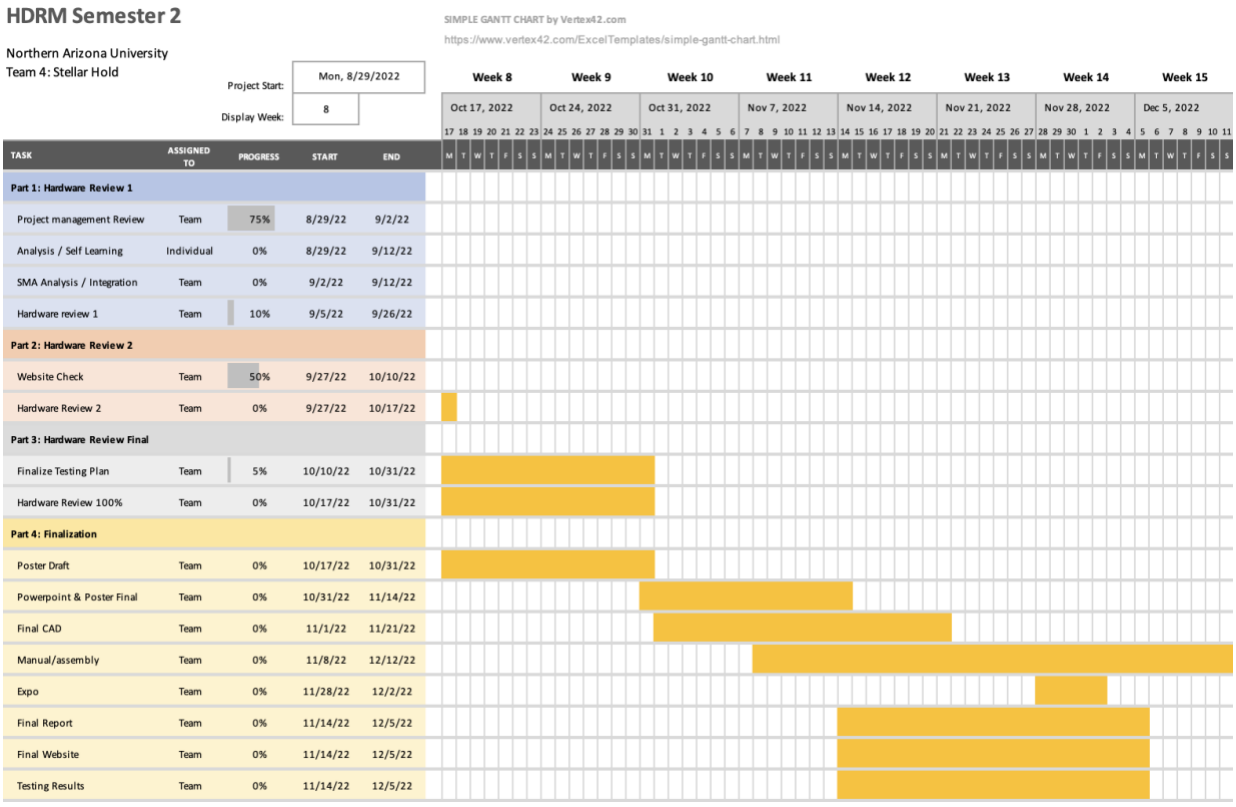
| | | |
|---|---|---|
| Custom SMA Spring |  | • The SMA spring we will design will have a much thicker diameter to create a larger force that is capable of actuating the HDRM movement |
| Ball-Nose Plunger |  | • The plungers are no longer in use in our current design but are included in the BOM because they were already purchased for testing |
| Arduino |  | • The Arduino will be used in testing the amount of heat needed to actuate the SMA spring and the time required<br>• It will be attached to both the HDRM and the mock Cube Satellite |

# 5 Appendix

## 5.1 Appendix A: Gantt Chart

**Displays Gantt chart in two views: weeks 1-8 (top) and weeks 8-end (bottom).**



## 5.2 Appendix B: Bill of Materials v1

| ITEM NO. | PART | manual explode/QTY. | COST |
|---|---|---|---|
| 1 | Base | 1 | $20.00 |
| 2 | Bottom Pin Platform | 1 | $4.00 |
| 3 | Lock Piece | 1 | $4.00 |
| 4 | Bearing Lock | 2 | $2.50 |
| 5 | Ball Bearing | 2 | $3.74 |
| 6 | Pin | 1 | $3.00 |
| 7 | Top | 1 | $4.99 |
| 8 | Front | 1 | $3.00 |
| 9 | SMA | 1 | $21.25 |
| 10 | Spring | 1 | $3.99 |
| 11 | B18.6.7M - M2 x 0.4 x 5 Slotted PHMS --5N | 8 | $0.40 |