Updated Project Plan

Pyrotechnic Shock Test Development

Team Number 15

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Table of Contents

Table of Figures

Acknowledgements

The work Team 15 has done, and hopes to accomplish, is only possible with the help from our sponsor, Harris Corporation, and the FSU-FAMU College of Engineering faculty. We would like to thank Mr. Robert Wells, Mr. Giann Cornejo, and Ms. Sarah Cooper at Harris for providing this project and for their contributions of both time and resources to help point us in the right direction. We would also like to acknowledge our faculty advisor. By assisting in securing critical resources as well as a testing location, Dr. Kumar has proven to be an invaluable asset to our team and project. His words of wisdom have also served to keep us on track and driven to complete the project. Finally our senior design instructors Dr. Gupta and Dr. Shih for having provided assistance in both project planning, scheduling, and technical communications.

1 Project Overview

This section discusses the project's new scope, the needs and goal statements, the project requirements, and the lessons learned from previous semesters.

1.1 Scope

The project was extended by our Harris sponsors and Dr. Shih toward the end of the last semester to two years of senior design work. With this change, the scope of the work to be accomplished over the course of this year was changed to more manageable goals with emphasis on developing a solid understanding of pyrotechnic shock testing, develop working physical and computational models, and create a solid groundwork for the next year's team. Mr. Wells, the Harris sponsor, sent a revised list of expectations for the project pertaining to each year individually [1].

The new scope for the first year involves creating working systems for the two core components of the project: a physical testing rig and computer modeling software. The testing rig will be completed at least through the prototyping phase, with concept refinement and design reviews with Harris guiding its creation [2]. The software modeling will be completed using two software packages available at the school, Matlab and PTC Creo. The team found two reliable ways to use Matlab to process the raw testing data, the Smallwood recursive method and Kelly-Richman method, to generate the desired final form of SRS curves. The Creo Parametric modeling and analysis as well as the Creo Simulate simulations will provide a reference for our initial testing conditions, as well as what results to expect. Both the physical and computer models will be used as a feedback loop to better tailor the results.

Concerning the first year of the project, over the coming semester the team will construct a test apparatus and begin testing. Testing will be done with constant values for all variables in order to determine an accurate baseline result. Once these results have been tabulated the team will adjust variables one at a time to determine the effect of the variable on the test results. While these tests are being done the team will begin programming in MatLab to create a function based off the test results with the goal of creating a program that will analytically model the experimental results and generate appropriate SRS curves. This project requires collaborative efforts in order to re-design and produce a suitable testing apparatus and modeling system. This is required to reduce inefficiencies of the current trial and error method employed by Harris for testing electronic components in regard to high load, high frequency shocks.

1.2 Revised Need Statement

This project requires collaborative effort in order to re-design and produce a suitable testing apparatus and modeling system. This is required to reduce the inefficiencies of the current trial and error methods employed by Harris Corp. for testing electronic components in regards to high load, high frequency shocks [3].

The current shock testing method lacks adaptability, requiring too much trial and error and expenditure of resources.

1.3 Project Objectives

The goal is to design an adaptable apparatus and modeling method to test, evaluate, and tabulate the measurable effect that varying individual test parameters has on SRS curve generation.

Objectives:

- Research and explore alternative testing methods
- Devise systematic approach to maximize repeatability
- Develop computational modeling method for test standardization
- Find suitable shock load sensors for hands-on testing
- Explore possible apparatus designs; Material selection
- Design selection based upon feasibility, budget, and constraints
- Produce prototype and modeling method.
- Tabulate testing results for future reference.

1.4 Constraints

The primary issue faced by Harris is not that the current hammer blow test is repetitive in nature, and time consuming in generating the desired pyrotechnic shocks [3]. This is due to the trial and error approach in tuning the apparatus prior to the actual testing procedure. Therefore, if we were to focus our efforts on better test parameter control and modeling for the current system, we can seek ways to reduce the number of necessary trial runs. The following list of constraints and considerations was developed based on both sponsor suggestions and as a result of team discussion:

1.4.1 Given Requirements

Mr. Wells and his colleagues at Harris Corp. have required some basic requirements for the newly specified project scope [1]. These are smaller scaled from the previous requirements to emphasize the focus on developing correlations between varying the selected parameters and the effects on the resulting SRS curve. These updated requirements are listed below:

- Test article size – up to 8”x 8” x 6”
- Test article weight – up to 10 lbs
- SRS response up to 500g acceleration and 10 kHz
    - Stay within tolerances set by MIL-STD-810 G, Method 517.2, Proc III
- Software allowing varied inputs to predict SRS response
- Accelerometer(s) specifications must adhere to Nyquist Sampling Theorem (2.5x minimum)
- Project expenses must stay within allotted budget ($4000)
- Acceleration data acquisition that covers generated force ranges
- Software conversion for raw data to usable SRS curves
- Test measurement documentation and storage

1.4.2 Derived Requirements

Derived requirements stem from the team’s observations throughout the course of product development. These are specifications that arise out of a need to abstain from making the project overly complex and the need to remain on schedule. Many of these derived requirements are fluid and may change throughout the current phase of the project if deemed necessary by the team, sponsor, or advisor. These requirements are listed below:

- Use of a sacrificial striking plate to preserve integrity of the more costly fixture plate
- Employing the Smallwood Recursive Method for generating SRS curves to preserve continuity of information when provided to Harris Corp. for validation
- Documentation throughout project to be provided for year two.
- Consistent force generation to minimize margin of error
- Adjustable fixture parameters
    - Fixture plate boundary conditions
    - Test article location
    - Hammer impact location
    - Hammer tip shape

1.5 Lessons Learned

One of the greatest challenges and learning points of this project form last semester was growing accustomed to the terminology, methods, and difficulties of pyrotechnic shock testing. In order to breakdown the project assignment and develop achievable objectives from what was provided, the team first had to learn the basics of shock testing from the resources provided by Harris and personal research. Additionally, last semester highlighted to the importance of communication, as discussion with Harris sponsors and faculty eventually led to the changing the project scope. Communication was proven to be such an instrumental part of keeping the project on track; we have scheduled regular teleconferences with Mr. Wells to be held all semester. This serves to keep the project up to date and synchronized between the team, our sponsor, and our advisor.

2 Current Status

The main areas of focus for the physical testing rig will be its adaptability, variability, and repeatability. The goal of the project from the beginning was to design and develop a tunable test with accompanying modeling software for pyrotechnic shock testing. Due to the time constraints of the shock testing division at Harris, they are unable to spare time to explore and research the effects of varying different testing parameters. These parameters include the mass, dampening, boundary conditions, as well as various aspects of the shock generation itself. Any extra knowledge as to how modifying these variables will affect the generated SRS curves from testing will improve the efficiency with which explicit specifications can be met by Harris.

2.1 Design Modifications

The final design from the interim report has been modified to include a new material choice which will lend to the rig's versatility. The team's faculty advisor, Dr. Kumar, suggested the use of T-slot aluminum extrusions, which will be used for the frame and hammer swinging arm as shown in Figure 1. Unlike the previous design which required drilled pin slots for adjusting the hammer location, these bars allow the hammer to be positioned anywhere lengthwise. This material is also proven durable, as it is able to withstand the impinging jet forces in STOVL testing at the AME building. The construction of this rig will be much easier as well, due to no longer needing serious amounts of welding and machining to secure the arms and plates. Additionally, the final design shown in Figure 2 will need to be either bolted in place or placed flush against a wall to limit any dynamic error while testing that could arise from the entire rig shifting or sliding.

Figure 1 - T-Slot Aluminum Extrusion

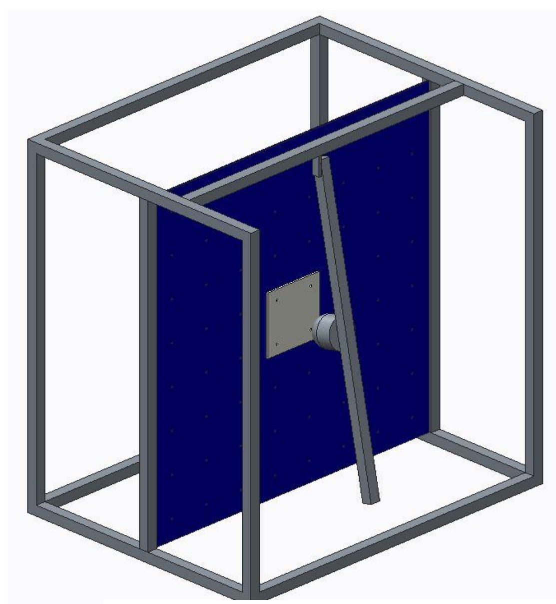

Figure 2 - Final Design: All Aluminum Construction

The results from the testing will be recorded in a database to assist in the quick assembly of test parameters that will produce the desired results. This is both a project requirement from Harris and a continuation effort to allow the second year team on this project to quickly adapt the tests as needed. Also, due to the additional year, more care will be taken to document important or helpful links and references for the future work.

2.2 Procurement

Due to scheduling conflicts with Dr. Kumar the team was unable to push purchase orders through before the semester break. Since returning from break the team has been able to meet with Dr. Kumar and after discussions with him have decided to alter their initial material selection. This new material will decrease construction time, and provide the team with a greater degree of adjustability. Updated purchase orders were completed and taken to Dr. Kumar for final approval before being submitted for fulfillment. Finalized versions of the purchase orders were submitted to Ms. Ashley Cope on the afternoon of 1/14/15. Order confirmation was received on 1/15/2015, and the team now awaits for the material to be delivered.

3 Updated Schedule

This section explains the new timeline for producing the prototype and modeling system. In addition the updated timeline can be found via the task list in appendix A as well as the Gantt Chart in appendix B. The task list has grown quite substantially. With the realization of the project coming to fruition, the detailed tasks have amassed and are much more particular than in the previous phase of the project. There is a lot less theory in this phase of the project, requiring more in-depth planning.

The task list shown in appendix A was broken down into seven categories that best summarize the prototyping phase of the project. These categories are much more sequential than in the previous phase, requiring each part to go as planned in order to avoid time delays in beginning the next portion. This is further reinforced by the Gantt chart in appendix B. Its more obvious in this chart that the tasks are highly dependent upon the prior tasks being completed on time.

The most time consuming part of this project, specifically within the prototyping phase, is the Experimental Modeling category. The reporting and documentation categories can be overlooked here because they involve tasks that occur regularly throughout the rest of the project. The experimental modeling phase includes the part of the project that requires iterative testing in order to produce documentable results that will later be assembled into a database for reference use.

4 References

[1] Robert, Wells. "University Capstone Development of Hammer Blow Test Device to Simulate Pyrotechnic Shock 2 Year Project." 6 Jan. 2015. Web. 7 Jan. 2015.

[2] Wells, Robert. "Conference Call with Robert Wells." Telephone interview. 14 Jan. 2015.

[3] Wells, Robert. "Conference Call with Robert Wells." Telephone interview. 24 Sept. 2014.

Appendix A: Task List

WBS	Task Name	Duration	Start	Finish	Resource Names	% Complete	Predecessors
2	**Prototyping**	**79 days**	**1/9/2015**	**4/29/2015**	**All**	**4%**	**22,35,54**
2.1	**Reporting**	**68 days**	**1/14/2015**	**4/17/2015**	**All**	**11%**	
2.1.1	Web Page Update	1 day	2/6/2015	2/6/2015	Nathan	90%	
2.1.2	Final Web Page	1 day	4/10/2015	4/10/2015	Nathan	0%	
2.1.3	**Deliverables**	**61 days**	**1/16/2015**	**4/10/2015**		**17%**	
2.1.3.1	Updated Project Plan	1 day	1/16/2015	1/16/2015	All	100%	
2.1.3.2	Team Evaluation Report I	1 day	1/23/2015	1/23/2015	All	0%	
2.1.3.3	Team Evaluation Report II	1 day	2/20/2015	2/20/2015	All	0%	
2.1.3.4	Team Evaluation Report III	1 day	3/20/2015	3/20/2015	All	0%	
2.1.3.5	Operations Manual	1 day	4/3/2015	4/3/2015	All	0%	
2.1.3.6	Final Report	1 day	4/10/2015	4/10/2015	All	0%	
2.1.4	**Presentations**	**62 days**	**1/22/2015**	**4/17/2015**		**0%**	
2.1.4.1	Presentation I	1 day	1/22/2015	1/22/2015	All	0%	
2.1.4.2	Midterm Presentation I	1 day	2/19/2015	2/19/2015	All	0%	
2.1.4.3	Midterm Presentation II	1 day	3/19/2015	3/19/2015	All	0%	
2.1.4.4	Walk-Through Presentation	1 day	4/9/2015	4/9/2015	All	0%	
2.1.4.5	Final Presentation	1 day	4/17/2015	4/17/2015	All	0%	
2.1.5	**Teleconference - Harris Corp.**	**61 days**	**1/14/2015**	**4/8/2015**		**8%**	
2.2	**Procurement**	**15 days**	**1/9/2015**	**1/29/2015**	**Chase**	**29%**	
2.2.1	Submit Purchase Orders	4 days	1/9/2015	1/14/2015		100%	
2.2.2	Inventory Orders	6 days	1/19/2015	1/26/2015		0%	
2.2.3	Submit Addt'l Orders (if necessary)	4 days	1/26/2015	1/29/2015		0%	
2.3	**D.A.Q.**	**6 days**	**1/26/2015**	**2/2/2015**		**0%**	
2.3.1	Build Lab View Module	2 days	1/26/2015	1/27/2015	Chad,Charles	0%	
2.3.2	Test Equipment	3 days	1/27/2015	1/29/2015	All	0%	
2.3.3	Calibrate Accelerometer	2 days	1/30/2015	2/2/2015	All	0%	

2.4	**Manufacturing / Assembly**	**12 days**	**1/27/2015**	**2/11/2015**		**0%**	
2.4.1	Submit CAD Drawings for Machining	2 days	1/27/2015	1/28/2015	Charles	0%	
2.4.2	Assemble Chassis	4 days	1/27/2015	1/30/2015	Charles,Nathan	0%	
2.4.3	Assemble Striking Hammer	2 days	1/30/2015	2/2/2015	Chad,Chase	0%	
2.4.4	Mate Chassis & Hammer	3 days	2/3/2015	2/5/2015	All	0%	
2.4.5	Test Fit Full Assembly	5 days	2/5/2015	2/11/2015	All	0%	
2.5	**Analytical Modeling**	**21 days**	**1/16/2015**	**2/13/2015**		**0%**	
2.5.1	Obtain & Verify Smallwood Code	4 days	1/16/2015	1/21/2015	Chad,Sponsor	0%	
2.5.2	Verify CAD Models & Simulations	5 days	1/19/2015	1/23/2015	Chase,Charles	0%	
2.5.3	Build MATLab SRS Processing Program	14 days	1/20/2015	2/6/2015	Chad,Nathan	0%	
2.5.4	Test SRS Processing with CAD Sims	5 days	2/6/2015	2/12/2015	All	0%	
2.5.5	Submit to Mr. Wells for Verification	0 days	2/13/2015	2/13/2015	All	0%	
2.6	**Experimental Modeling**	**27 days**	**2/13/2015**	**3/23/2015**		**0%**	**96,92,88**
2.6.1	Final Assembly: Chassis & Hammer	3 days	2/13/2015	2/17/2015	All	0%	
2.6.2	Baseline Testing	5 days	2/17/2015	2/23/2015	All	0%	
2.6.3	Test Parameter 1 (Article Location)	5 days	2/24/2015	3/2/2015	Charles	0%	
2.6.4	Test Parameter 2 (Strike Location)	5 days	3/3/2015	3/9/2015	Chase	0%	
2.6.5	Test Parameter 3 (Plate Boundary Cond)	5 days	3/10/2015	3/16/2015	Nathan	0%	
2.6.6	Test Parameter 4 (Hammer Tip Shape)	5 days	3/17/2015	3/23/2015	Chad	0%	
2.7	**Documentation**	**66 days**	**1/16/2015**	**4/17/2015**		**0%**	
2.7.1	Record D.A.Q. Setup/Calibration Procedure	6 days	1/26/2015	2/2/2015	Chase,Nathan	0%	
2.7.2	Track MATLab Modifications	21 days	1/16/2015	2/13/2015	Charles,Chad	0%	
2.7.3	Record Testing Results (1)	5 days	2/24/2015	3/2/2015	Chase	0%	
2.7.4	Record Testing Results (2)	5 days	3/3/2015	3/9/2015	Nathan	0%	
2.7.5	Record Testing Results (3)	5 days	3/10/2015	3/16/2015	Chad	0%	
2.7.6	Record Testing Results (4)	5 days	3/17/2015	3/23/2015	Charles	0%	
2.7.7	Assemble Database of Results	20 days	3/23/2015	4/17/2015		0%	
3	***Final Product***	***1 day***	***4/27/2015***	***4/27/2015***		***0%***	***108,115***

Appendix B: Gantt Chart