Restated Project Definition and Scope

Development of Hammer Blow Test to Simulate Pyrotechnic Shock

Team 12

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1/15/16

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Acknowledgements

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1 PROBLEM STATEMENT

Harris Corp. has expressed a need for an apparatus enabling an accurate simulation of pyrotechnic shock via a hammer mechanism. The first prototype constructed the previous year, while fulfilling its purpose of gathering information on high load and high frequency shock, yielded noisy data as a result of too many parameters and high tolerances within the structure of the mechanism [1]. A device that is more stable and that would yield more repeatable results is desired in order to test the variables surrounding pyrotechnic shock.

There is a need to gather knowledge and data involved with pyrotechnic shock and the variables that affect it.

2 PROJECT SCOPE

Based on the reports from Senior Design Team 15 last year and discussion of the goals for this year, the following goal statement was developed: **Optimize the test device's stability and repeatability and in turn develop a better understanding of relations between various test fixture parameters and resulting SRS curves.**

3 PROJECT OBJECTIVES

The following is a list of objectives for this project [2]:

- Research existing methods for simulating and testing shock responses
- Improve repeatability of last year's test device
- Improve hammer mechanism stiffness and release from last year's device
- Evaluate designs in order to decouple the attachment of plate to frame
- Optimize processing for modeling SRS curves
- Improve FEM analysis process using results from improved test device

- Reduce set of parameters used for tests from last year
- Perform impact tests with improved device and improved modeling

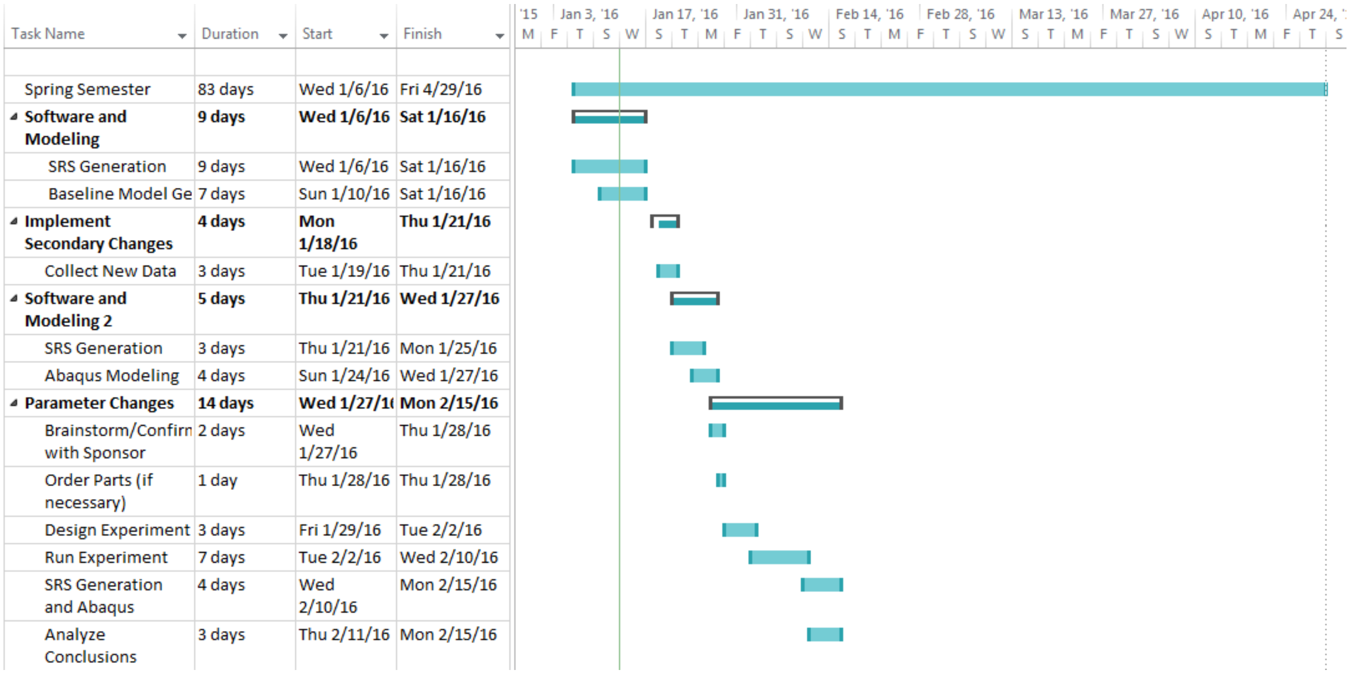
An additional goal, if time permits, is to work on adding damping effects, more mass, and stiffeners to the fixture plate and analyze these results against the previous ones [2]. Table 1 displays what was specifically provided by our sponsors at Harris.

Table 1- Requirements Provided by Harris for Second Year Project

Requ. #	Category	Description
1	Mechanical	Refine impact test device and fixture plate developed on year 1 project to improve repeatability.
2	Mechanical	Evaluate SRS generation from year 1 project and develop improvements to speed up processing
3	Mechanical	Fabricate design improvements and validate repeatability. Use results to improve FEM analysis process.
4	Mechanical	Perform impact test on fixture under a reduced set of test parameters. Test parameters to be identified by Harris by SDR.
5	Cost	Bill of Materials shall be generated early enough to budget costs for test fixture improvements and any needed instrumentation purchases
6	Mech (stretch goal)	Evaluate ability to tune fixture plate by adding damping, mass, stiffeners. Correlate results to FEM analysis

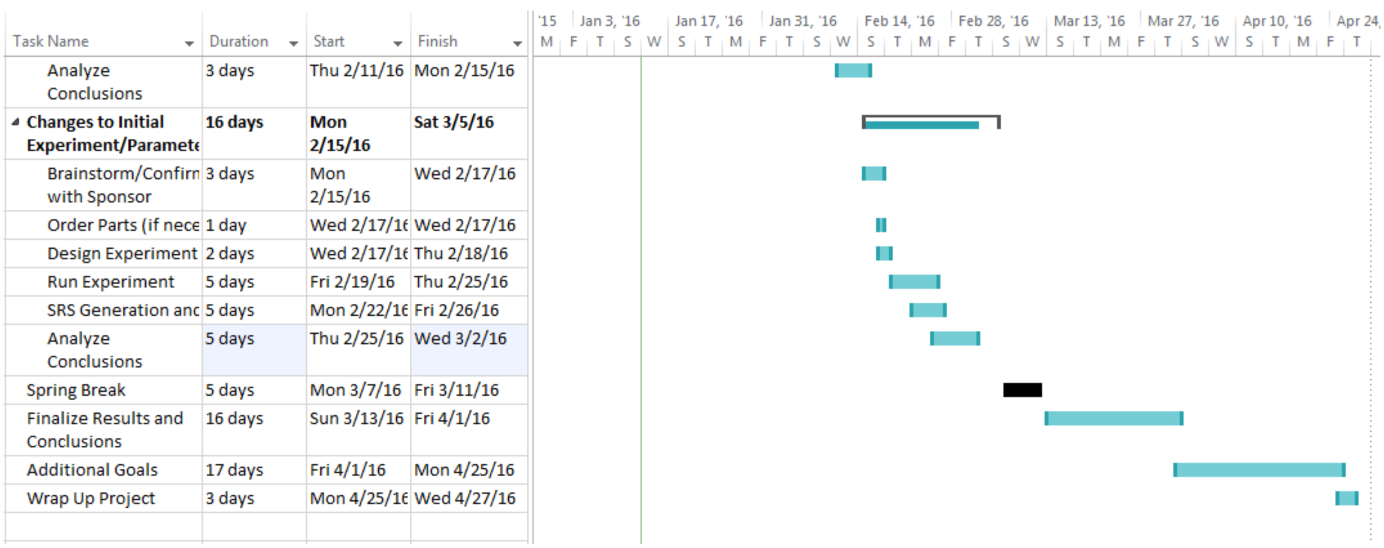
4 PLAN/METHODOLOGY

The figures below show the Gantt Chart for this semester. It can be seen that the plan thus far is to finish collecting data from to show that the initial changes to the test device did increase the repeatability of the system. Next, the team will implement the secondary changes, which include decoupling of the strike plate and attaching an electromagnet for the release mechanism. Data will again be collected. The final stages include creating a design of experiments to test various parameters, to be discussed with the sponsor, and understand their effects on the system. Concurrently, the system will be modeled with Abaqus to complement the experimental data. There is additional time at the end designated for stretch goals, but can also be used to finish the parameter testing if necessary.



Task Name	Duration	Start	Finish
Spring Semester	83 days	Wed 1/6/16	Fri 4/29/16
Software and Modeling	**9 days**	**Wed 1/6/16**	**Sat 1/16/16**
SRS Generation	9 days	Wed 1/6/16	Sat 1/16/16
Baseline Model Ge	7 days	Sun 1/10/16	Sat 1/16/16
Implement Secondary Changes	**4 days**	**Mon 1/18/16**	**Thu 1/21/16**
Collect New Data	3 days	Tue 1/19/16	Thu 1/21/16
Software and Modeling 2	**5 days**	**Thu 1/21/16**	**Wed 1/27/16**
SRS Generation	3 days	Thu 1/21/16	Mon 1/25/16
Abaqus Modeling	4 days	Sun 1/24/16	Wed 1/27/16
Parameter Changes	**14 days**	**Wed 1/27/1**	**Mon 2/15/16**
Brainstorm/Confirn with Sponsor	2 days	Wed 1/27/16	Thu 1/28/16
Order Parts (if necessary)	1 day	Thu 1/28/16	Thu 1/28/16
Design Experiment	3 days	Fri 1/29/16	Tue 2/2/16
Run Experiment	7 days	Tue 2/2/16	Wed 2/10/16
SRS Generation and Abaqus	4 days	Wed 2/10/16	Mon 2/15/16
Analyze Conclusions	3 days	Thu 2/11/16	Mon 2/15/16

Fig. 1- First Part of Gantt Chart for Spring Semester



Task Name	Duration	Start	Finish
Analyze Conclusions	3 days	Thu 2/11/16	Mon 2/15/16
Changes to Initial Experiment/Paramete	**16 days**	**Mon 2/15/16**	**Sat 3/5/16**
Brainstorm/Confirn with Sponsor	3 days	Mon 2/15/16	Wed 2/17/16
Order Parts (if nece	1 day	Wed 2/17/1(	Wed 2/17/16
Design Experiment	2 days	Wed 2/17/1(	Thu 2/18/16
Run Experiment	5 days	Fri 2/19/16	Thu 2/25/16
SRS Generation anc	5 days	Mon 2/22/1(	Fri 2/26/16
Analyze Conclusions	5 days	Thu 2/25/16	Wed 3/2/16
Spring Break	5 days	Mon 3/7/16	Fri 3/11/16
Finalize Results and Conclusions	16 days	Sun 3/13/16	Fri 4/1/16
Additional Goals	17 days	Fri 4/1/16	Mon 4/25/16
Wrap Up Project	3 days	Mon 4/25/1(	Wed 4/27/16

Fig. 2- Second Part of Gantt Chart for Spring Semester

5 CONSTRAINTS

Rather than creating an entirely new testing apparatus for shock testing, the primary issue faced by Harris is not that the current hammer blow test is not an effective means of generating the desired pyrotechnic shocks, but that it is currently inefficient due to required trial and error time beforehand. Therefore, if we were to focus our efforts on better modeling the current system and finding ways to reduce the number of necessary trial runs, our constraints are then limited only to the current models used for testing.

- Device capable of testing unit between 5-50 lbs
- Must accommodate a parcel of dimension up to 16” L x 16” W
- Must generate SRS pyrotechnic shock responses of up to 5000g peak and 10kHz (max levels for mid field range shocks)
- Response must be captured by an analysis system
- Test parameters must be controllable through accessible software tool (MATlab)
- Project expenses must stay within allotted budget ($5000)

It is important to note that although the proposed design changes should work within these parameters, there is always room for adjustment for a change that would provide a better viable outcome, if it is agreed upon between the team and our sponsor. Other typical constraints regarding the size of the machine, the required material used, and so forth, are not included in this section because to this point, no such constraints exist. We are planning to make use of sensors and software available at the school to the highest extent we can. The material choice, for example, is purposefully not a constraint as it represents a variable of the shock generation process that we are able to explore as a way to better control the parameters of shock testing.

6 RESOURCE ASSIGNMENT

This semester focuses heavily on testing and data collection. We are currently in the final stages of setting up the data acquisition system and will begin collecting data within a week. Justin has been primarily working on getting the DAQ system up and running. LabView is installed on his laptop, and therefore he will continue the process of data acquisition throughout the semester unless something interferes. Tiffany is learning how to use Abaqus and model our system while also assisting in time management and keeping the project on track for deadlines. Max will continue to edit the website for the project as needed while assisting in any other task that needs immediate attention. Sarah has been updating deliverables for the class while helping others with tasks, and Luis is also a multi-function member that will help with important tasks and meeting project deadlines.

7 PRODUCT SPECIFICATIONS

7.1 PERFORMANCE SPECIFICATIONS

The performance specifications are a clear set of objectives. With the stability changes made to the apparatus, these things must be accomplished by the test. It must be able to create and then model in software a maximum level, matching SRS curves on a consistent basis. In addition, it must be able to do so for different masses without losing accuracy or precision. It must save the time previously spent in trial and error by providing modeling software that controls the test parameters. The frequency range must stay in the resolution set by company standards, and by extension, NASA and military standards. The information must display in a software that can be accessed by the company to perform analysis reliably. The apparatus will be improved in stages in order to obtain more consistent data and track individual component improvements. In order to provide a viable solution for Harris Corp., these conditions will at the very least have to be maintained to preserve the integrity of the testing and subsequent data analysis.

7.2 DESIGN SPECIFICATIONS

In order for this hammer blow test to be of use to Harris Corp., it must allow for repeatable events. This means that when the test object is subject to the simulated pyrotechnic shock or hammer blow and the subsequent SRS is generated, when the same conditions are met and the test is repeated, a similar SRS should be created. The purpose of the hammer blow test is to predict the behavior of particular shocks and their consequences on specific hardware, however if the test cannot generate the same results under the same conditions, then the test is not valuable. This is why our design consists of anchoring the mechanism to the ground and preventing unwanted variables from affecting the test rig. By cultivating the model's sturdiness, we hope to consequently improve the repeatability of the test. After this customer requirement is met, then we will continue to refine the prototype by including mechanisms that would widen the range of experiments that could be carried out. For this reason, many of the design specifications that may account for welcomed experimental variability and freedom are hard to define at the moment.

Our sponsor has indicated the specific needs of the hammer blow test. The test rig must be able to test a plate of 16''L x 16'' W with weight of 5-50lbs. In regards to improving the previous design, the massive amount of friction as it pertains to the pendulum hammer will be minimized as well as the friction and vibrations that resonate throughout the frame. The quick release mechanism, which was previously a pin and socket will be replaced possible with a magnetic design. Also, the methods of damping the strike plate will be further explored and optimized to create isolated shocks. There is no specified size for the overall machine, so we will continue valuing the sturdiness of the design over optimization for compactness. Furthermore, we will be utilizing the software designed by the previous Harris design team, which generates SRS curves. However, there will be time spent refining this software with the aim of making the analysis process more efficient and precise. Lastly, to insure the simulated shocks are as close to real pyrotechnic impacts, at least half of the SRS magnitudes maximum must be greater than the nominal test specification.

8 REFERENCES

1. Wells, Robert. “University Capstone: Development of Hammer Blow Test Device to Simulate Pyrotechnic Shock (Second Year Project).” 14 Aug. 2015.

2. DeMartino, Charles, Chad Harrell, Chase Mitchell, and Nathan Crisler. *Development of Hammer Blow Test Device to Simulate Pyrotechnic Shock.* Senior Design Team 15. 10 Apr. 2015. Web. 21 Sept. 2015. <http://eng.fsu.edu/me/senior_design/2015/team15/NeedsAssessment.pdf>.