Development of Hammer Blow Test to Simulate Pyrotechnic Shock

Midterm 1 Presentation

Team 15

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Project Overview

- The 5 W's:
  - Who?

    Harris Corporation
  - What?

    Develop pyrotechnic shock testing machine emphasizing adaptability and tuning
  - Why?

    Current test methods iterative, time consuming, and not easily adaptable
  - When?

    August 2014 – April 2015 (8 months)
  - Where?

    FSU/FAMU College of Engineering

    (AME) Aero-Propulsion, Mechatronics& Energy Facility

    (HPMI) High Performance Material Institute

Background

- Explosive components commonly used in satellite systems
  - Stage separation, antenna deployment
- High acceleration, high frequency transient shockwaves
  - Damage or disable sensitive equipment
  - Characterized with SRS Curves due to complex nature
- Harris Corp. seeking system level method of modeling and analysis
  - Evaluate test parameters
  - Tunable response
  - Avoid trial and error
- Calls for
  - Adaptable testing apparatus
  - Reference materials from preliminary testing

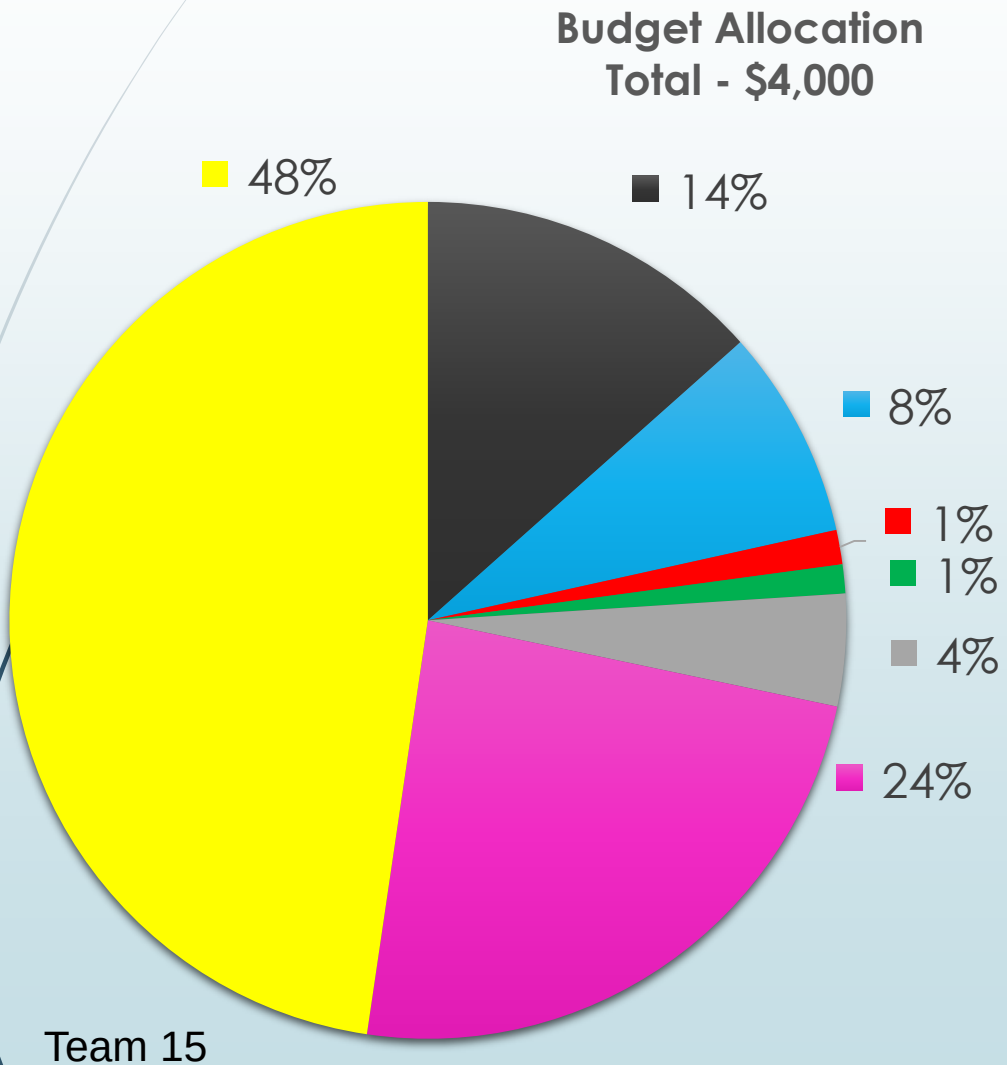
Theory

- High acceleration, high frequency, transient nature
  - Difficult to specify or recreate
- Impact Force generated: Various methods
- Effects captured by Accelerometer & DAQ system
- Acceleration time history processed into SRS Curve
- SRS – Shock Response Spectrum
  - From time domain to frequency domain
  - Provide quantitative measure
- Used to predict effects on sensitive system electronics [1]

Project Scope

- Two year project
  - *Year 1 – Proof of concept, small scale testing
  - Year 2 – Full scale testing
- Design & build a capable test rig
  - CAD Model & Simulations
  - Manufacture actual test rig
- Develop software to convert test data to graphical plot
  - Swallwood Recursive Method
- Compile catalogue of experimental data and variables
  - Matlab, Excel
- Budget: $4000

Project Scope (cont.)

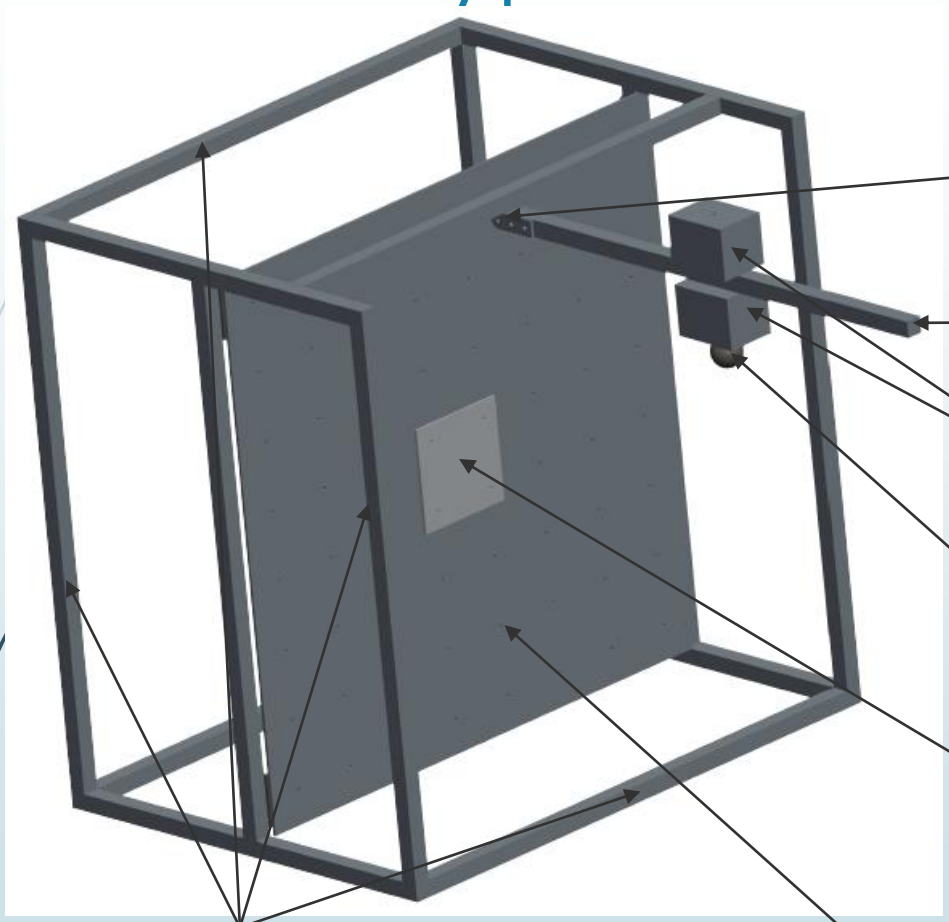


Frame	$537.00
Fixture	$324.21
Hardware	$53.14
Test Article	$44.76
Hammer	$173.24
DAQ	$960.80
Remaining	$1,926.85

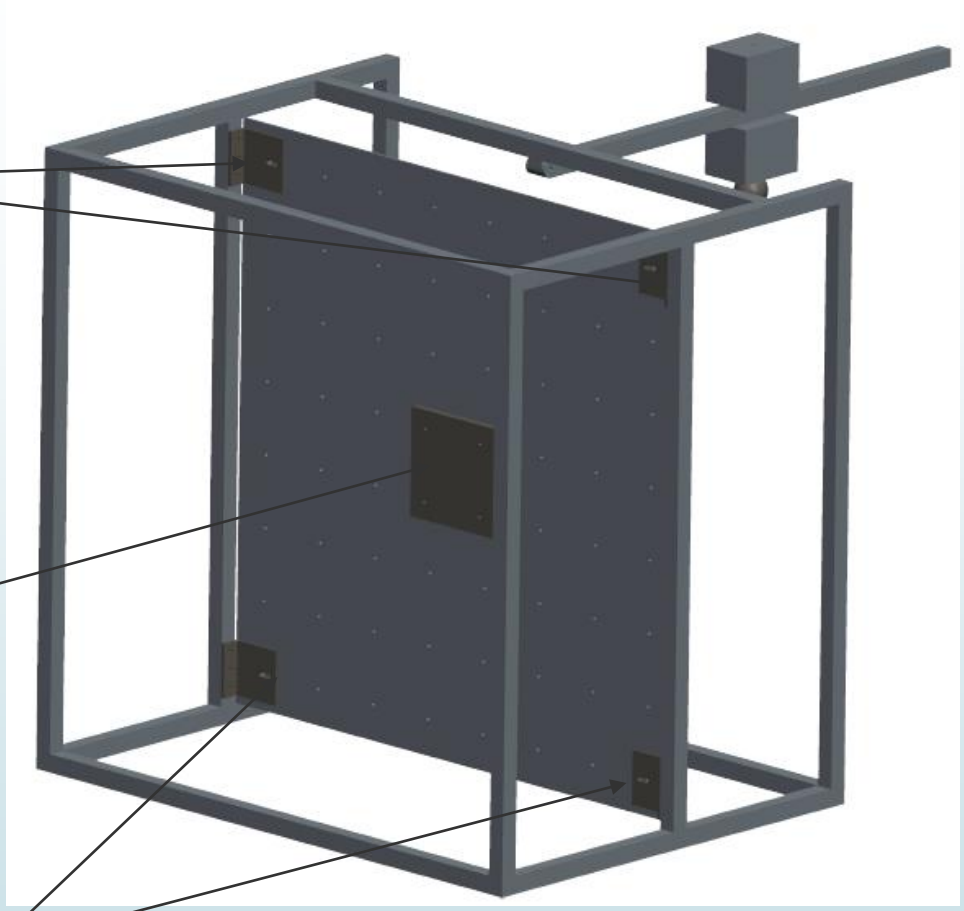
Constraints & Specifications

- Test article size - up to 8 x 8 x 6 inches
  - Selected article: 6” x 6” x 0.5” low carbon steel
- Test article weight - up to 10 lbs
  - Article weight: 5.1 lbs
- SRS response up to 500g acceleration and 10 kHz
  - Stay within tolerances set by MIL-STD-810 G, Method 517.2, Proc III
  - Anticipated Maximum Force Generated: ~6000g (8.31lb hammer)
- Project expenses must stay within allotted budget ($4000)
  - Funds Used: $2093.15
- Acceleration data acquisition that covers generated force ranges
  - DAQ Specs: Current Power Source (4110c) , Accelerometer (3086A4T), Line Filter (TBD), 12 bit A-D card (TBD)
- Software conversion for raw data to usable SRS curves
  - Smallwood Recursive Matlab script

Prototype


Hammer Pivot
Adjustable Hammer Arm
Hammer Weights (x2)
Hammer Head
Sacrificial Plate
Fixture Plate
Chassis members

Prototype

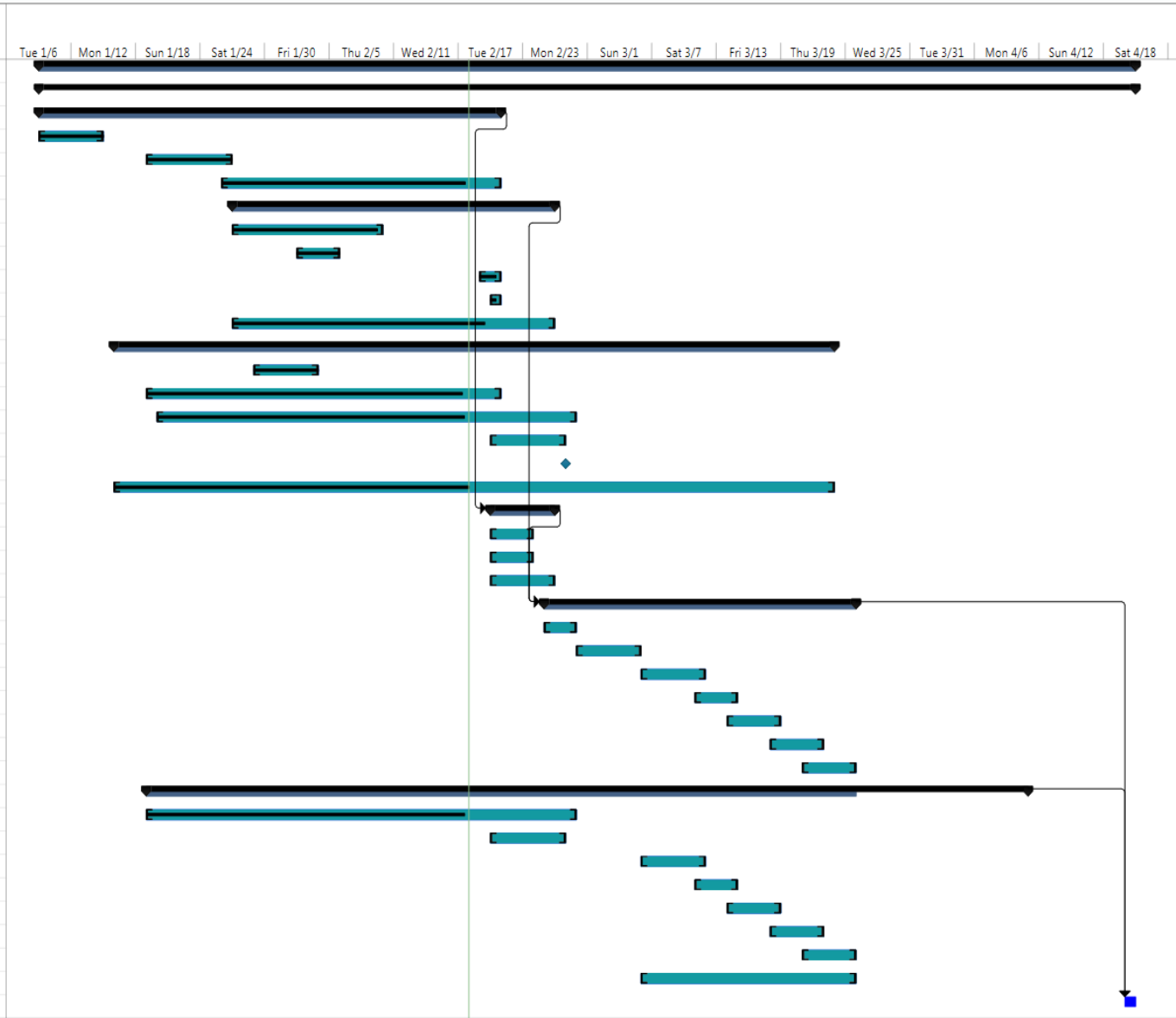

Fixture Mounts
Test Article
(Accelerometer Mount)
Fixture Mounts

Current Status

Action item	Priority (1-5)	Status
CoE Machine shop - tuning bands	1	Dimensional analysis in process; order & submit by EoW
Quick release setup	1	Developing simple & reliable catch & release.
Large plate to HPMI	2	Approved and in process
CoE Machine Shop parts	2	Approved and in process
D.A.Q. Equipment	2	P.O. Approved & in process -- Dytran 3086A4T, 4110C Power Supply, 20ft Accelerometer -> BNC Cable.
Customize Matlab Script	3	Acquired scripts. Sifting through for specifics
Documentation	3	Continuing effort: DAQ Setup, Modeling & Simulation parameters, Assembly procedure, Experimental Tracking Sheets,
Creo dynamic modeling	4	Simplified plate modeling; Impact velocity, Angular acceleration, Modal up to 10kHz done.
Abaqus drop simulations	5	Refining model; Mesh size issues, Contact interactions.
Operation Manual	5	Continuing Effort Due 4/3
Design Report	5	Continuing Effort Due 4/3

Schedule

ID	WBS	Task Name
1	**1**	**Prototyping**
2	**1.1**	**Reporting**
32	**1.2**	**Procurement**
33	1.2.1	Submit Purchase Orders
34	1.2.2	Inventory Orders
35	1.2.3	Submit Addt'l Orders (if necessary)
36	**1.3**	**Manufacturing / Assembly**
37	1.3.1	Submit CAD Drawings for Machining
38	1.3.2	Assemble Chassis
39	1.3.3	Assemble Striking Hammer
40	1.3.4	Mate Chassis & Hammer
41	1.3.5	Test Fit Full Assembly
42	**1.4**	**Analytical Modeling**
43	1.4.1	Obtain & Verify Smallwood Code
44	1.4.2	Verify CAD Models & Simulations
45	1.4.3	Build MATLab SRS Processing Program
46	1.4.4	Test SRS Processing with CAD Sims
47	1.4.5	Submit MATLab Code to Mr. Wells for Verification
48	1.4.6	Continuous Simulations and Refinement
49	**1.5**	**D.A.Q.**
50	1.5.1	Build Lab View Module
51	1.5.2	Test Equipment
52	1.5.3	Calibrate Accelerometer
53	**1.6**	**Experimental Modeling**
54	1.6.1	Final Assembly: Chassis & Hammer
55	1.6.2	Baseline Testing
56	1.6.3	Test Parameter 1 (Article Location)
57	1.6.4	Test Parameter 2 (Strike Location)
58	1.6.5	Test Parameter 3 (Plate Boundary Conditions)
59	1.6.6	Test Parameter 4 (Hammer Tip Shape)
60	1.6.7	Test Parameter 5 (Stiffining plates)
61	**1.7**	**Documentation**
62	1.7.1	Track MATLab Modifications
63	1.7.2	Record D.A.Q. Setup and Calibration Procedure
64	1.7.3	Record Testing Results (1)
65	1.7.4	Record Testing Results (2)
66	1.7.5	Record Testing Results (3)
67	1.7.6	Record Testing Results (4)
68	1.7.7	Record Testing Results (5)
69	1.7.8	Assemble Database of Results
70	***1.8***	***Final Product***



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.

http://eng.fsu.edu/me/senior_design/2015/team15/