Lab 10 Structural Model Building:

Rapid Structure Design, Prototyping and Learning

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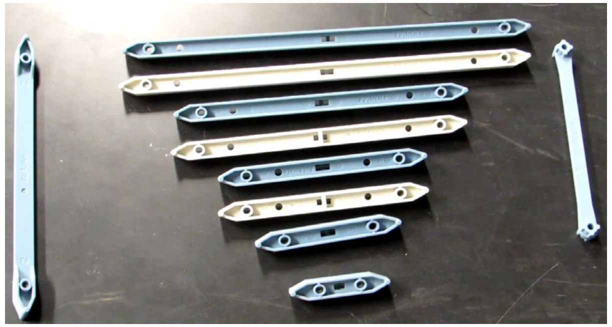
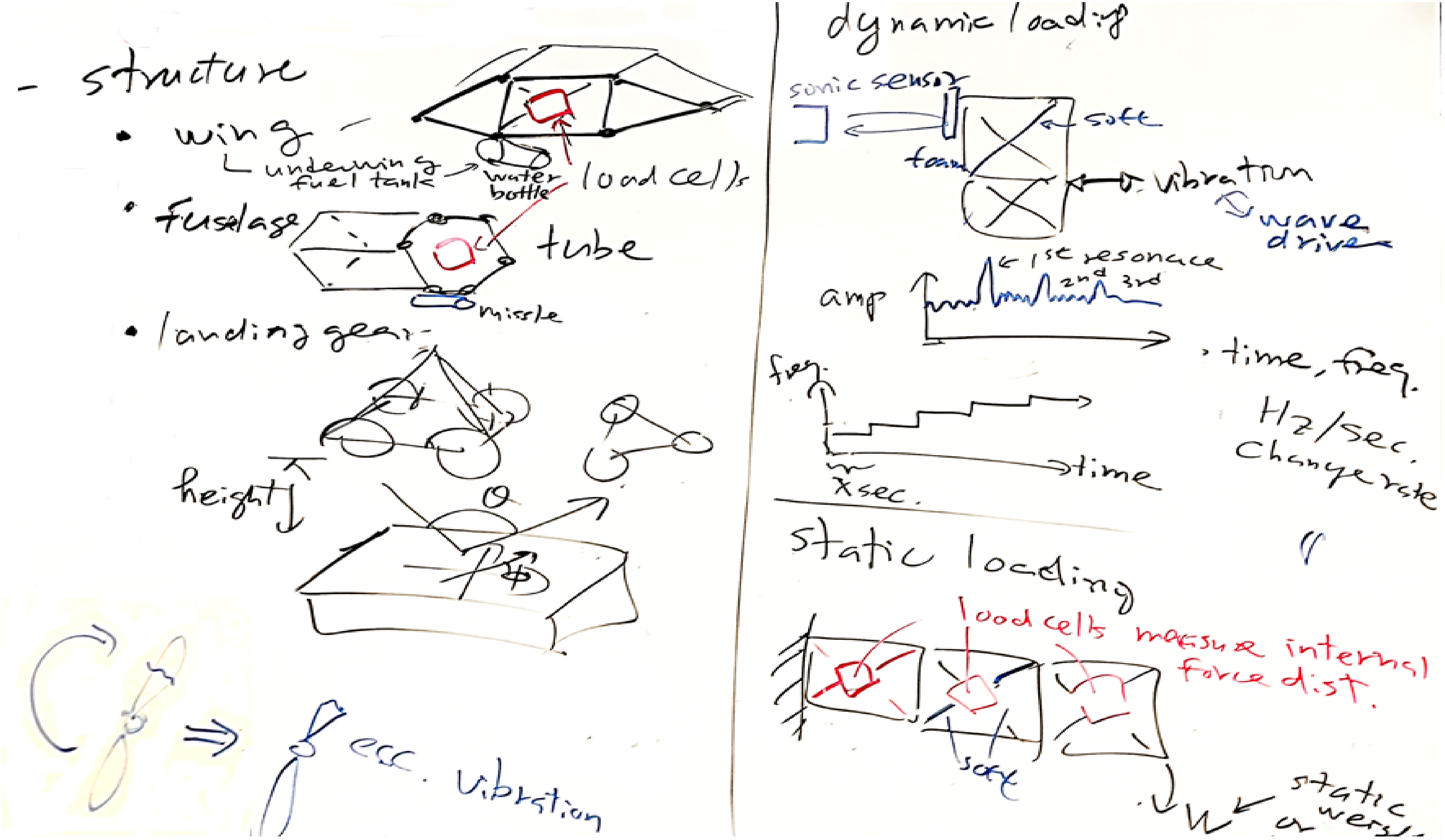
Rapid Structure Design, Prototyping and Learning

- PASCO tool kits: “Lego”-like building blocks specially designed for structure model construction
- Various load cells, motion sensors, vibration generator, etc. plug-and-play with centralized interface
- Fully monitored and controlled by PC via user-friendly software
- Fast turnaround
- Cost effective

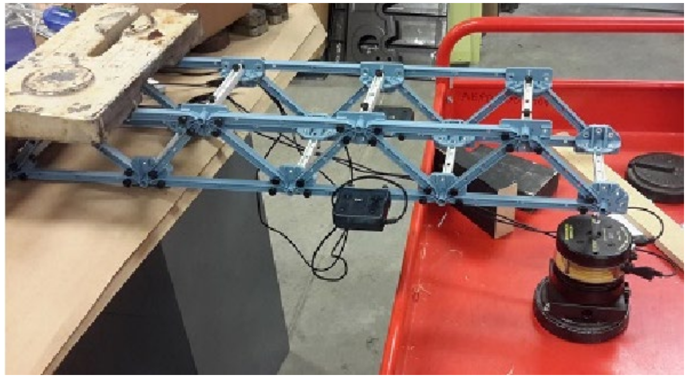


Building Ideas and Analysis Concepts

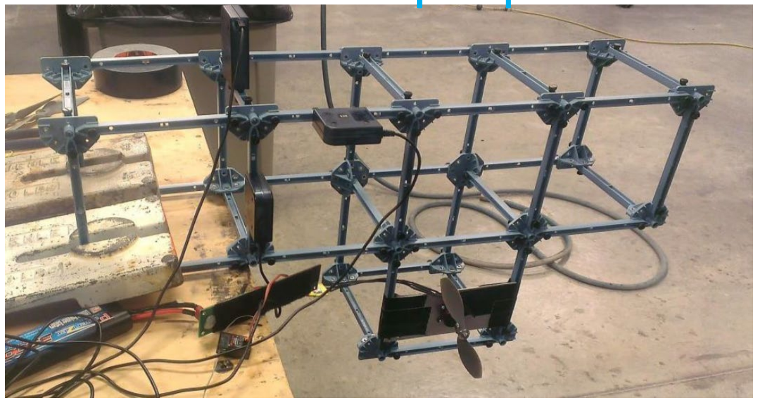


Rapid Structure Design and Prototyping: S14 Student Term Project Examples

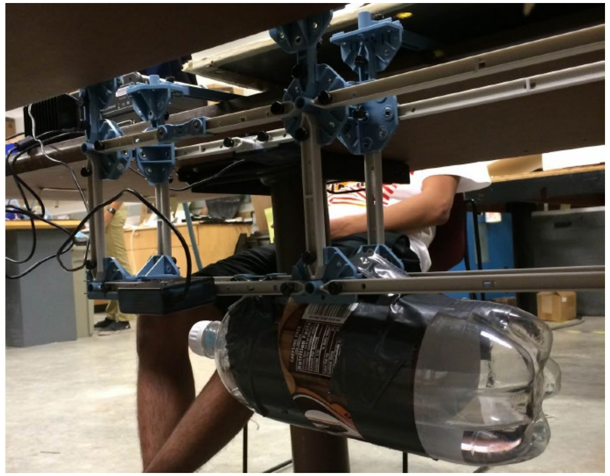
Wing structure vibration

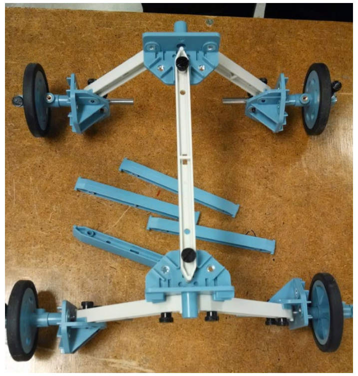


Unbalanced propeller



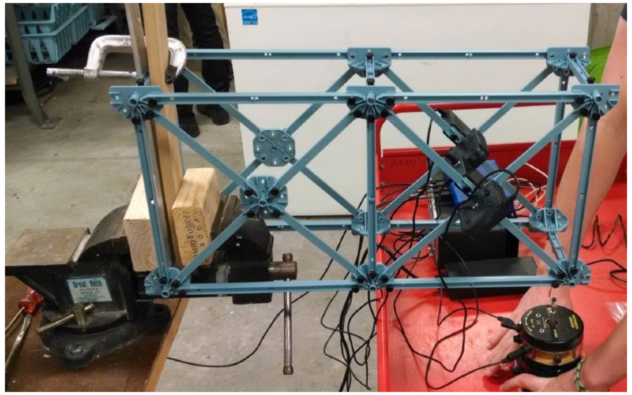
Underwing fuel tank





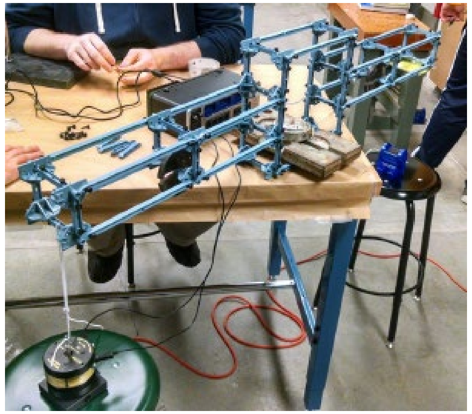
Impact loading of landing gear

Truss force distribution



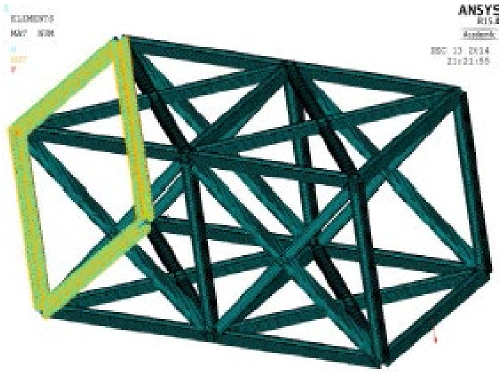
Rapid Structure Design and Prototyping: F14 Student Term Project Examples

Wing structure vibration (flutter)



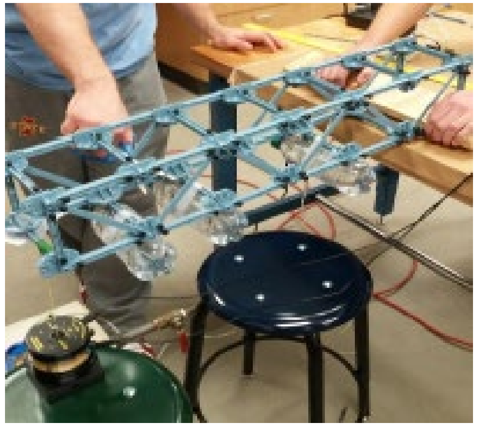
Vibration of quad-copter

FEM (ANSYS)
Stress analysis



Force analysis of landing gear

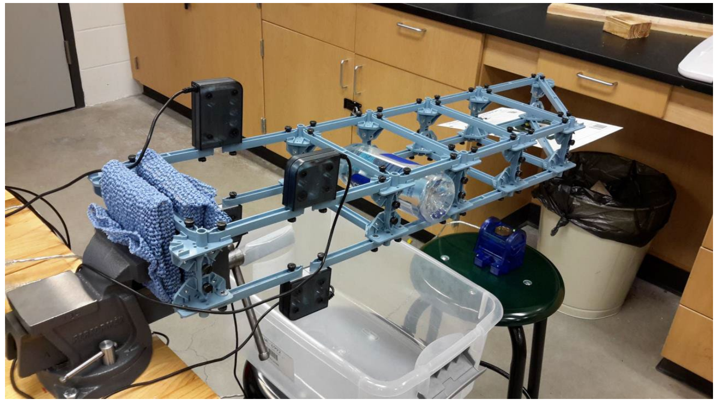
Missile payload under wing



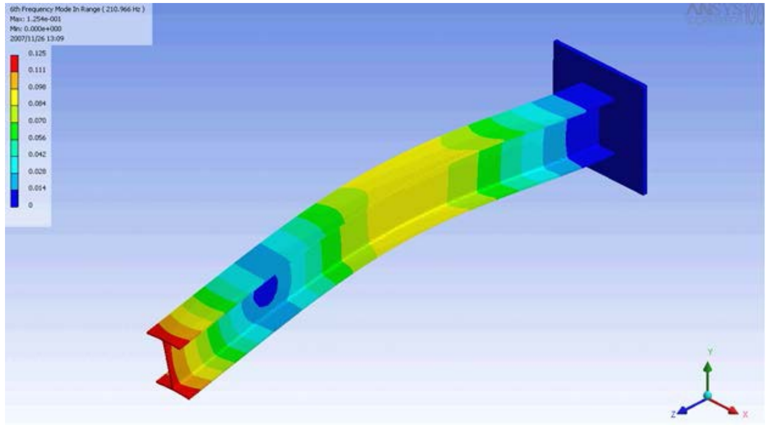
Rapid Structure Design and Prototyping: S15 Student Term Project Examples

Stress analysis of wing structure with payload

more quantitative!



Vibration (resonance) analysis of cantilever beam



More Than Just a Fancy Structure Model !

- This lab is not a “show-and-tell” project back in grade school! We expect to see in-depth quantitative analysis rather than nice-looking qualitative structural model
- In addition to typical load/stress analyses of structures, statistical means to seek for key variable trending, regression of experimental data, etc. can be equally useful

How about building this simple cantilever beam with in-depth analysis using e.g. dynamic stiffness method?!

Dynamic Stiffness Method for Structure Vibration Analysis

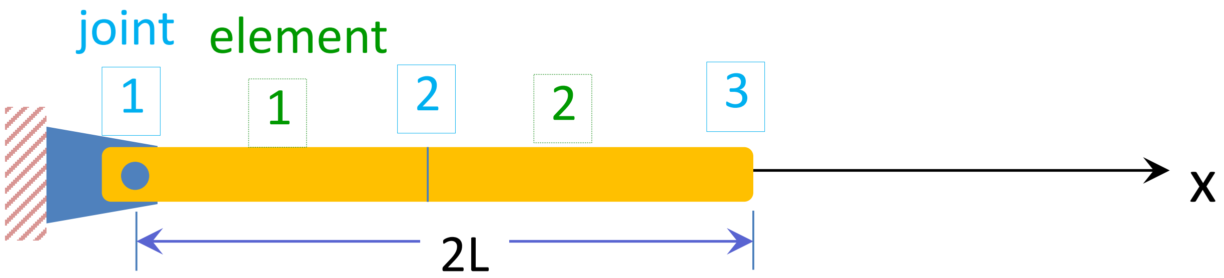
A simple hinged bar can be discretized into multiple elements:

node number

$$k_{element\,\#1} = \frac{AE}{L}\begin{array}{c} \begin{array}{cc} 1 & 2 \end{array} \\ \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \end{array}$$

$$\begin{array}{c} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \\ \begin{array}{cc} 2 & 3 \end{array} \end{array}\frac{AE}{L} = k_{element\,\#2}$$

$$k_{global} = \frac{AE}{L}\begin{array}{c} \begin{array}{ccc} 1 & 2 & 3 \end{array} \\ \begin{bmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{bmatrix} \end{array}$$



Modulus of elasticity E, cross sectional area A, mass density ρ

Additional Info Available in Class Canvas

- For knowledge base coverages on vibration, FFT and structural dynamics, see Week 13 and 14 lecture notes
- For calibration of load cell, see “AerE 322 How to calibrate load cell sensors.pdf” in Misc module
- For mechanical properties and modeling of PASCO building blocks, see “PASCO beam model info.pdf” in Misc module