



e=MSC *ENGINEERING. EDUCATION. ENTERPRISE.*
2009VPD *VIRTUAL
PRODUCT
DEVELOPMENT
CONFERENCE*

Modeling of a Multi-Dimensional Simulation Platform

Danielle Awbrey, Quality Engineer/NAU Graduate, NAU

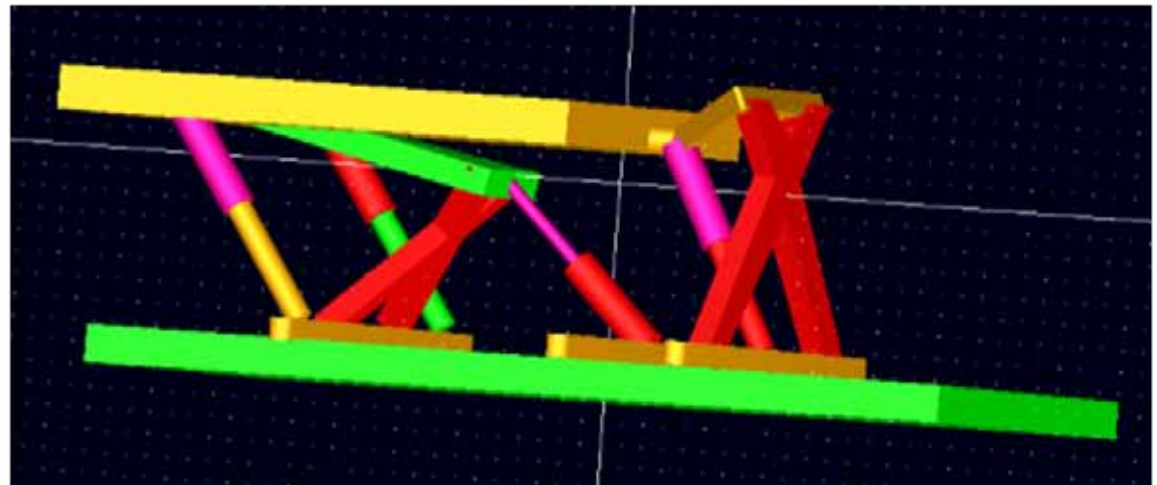
Dr. John Tester, Associate Professor Mechanical Engineering, NAU



MSC *Software*

Outline

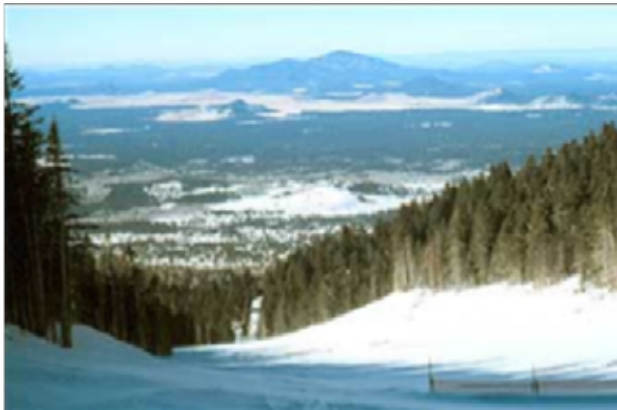
- The Problem
 - Introduction
 - From the professor
 - From the student
- The Solution
 - Narrow scope
 - Research
 - Existing platform
 - Modeling
 - Organization





Introduction to NAU

- *Northern Arizona University*
 - Third-largest Arizona public university
 - College of Engineering, Forestry and Natural Sciences
 - Bachelors and Masters in Engineering programs
 - Flagstaff, Arizona





Problem from Professor's Point of View

- Challenge talented undergraduate students
 - Interested in aerospace and mechanics
 - NAU does not have aerospace or system simulation programs
 - Only seven faculty in Mechanical Engineering
- Some options
 - Independent Study
 - Undergraduate research courses
 - Funded Undergraduate research projects
 - NASA Space Grant Undergraduate Internship
 - Hooper Undergraduate Research Program



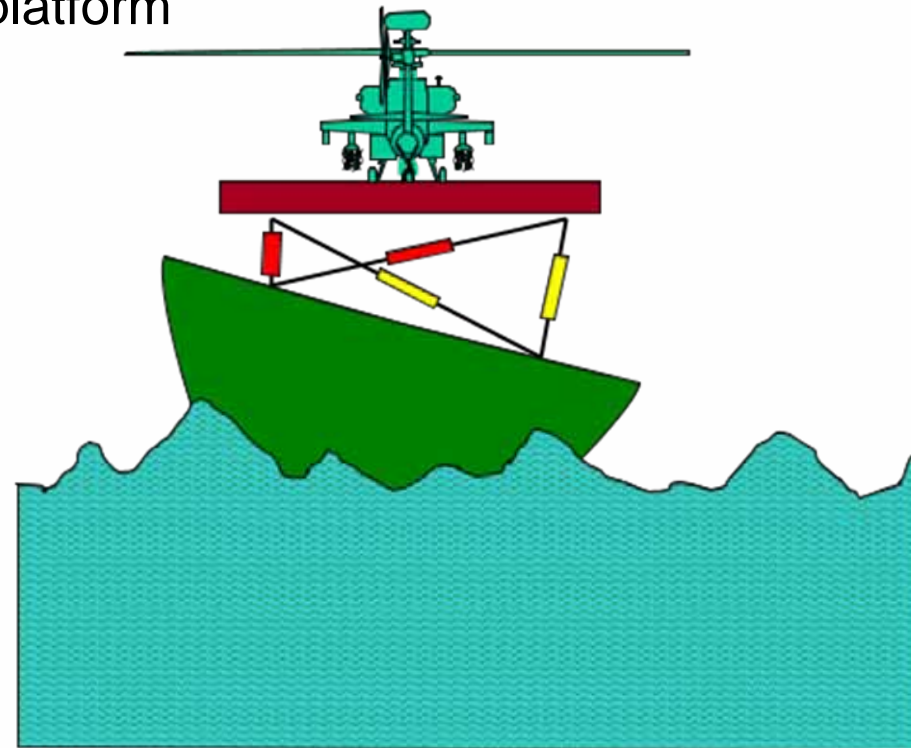
Problem from Student's Point of View

- An employee from Boeing wanted a platform designed for an Unmanned-Aerial Vehicle (UAV) as a student project
 - The senior design team was struggling
 - Put Danielle on the project as well
 - Had completed kinematics class
 - Had experience doing independent projects with wind turbines
- Application oriented
 - A 'real-world' orientation



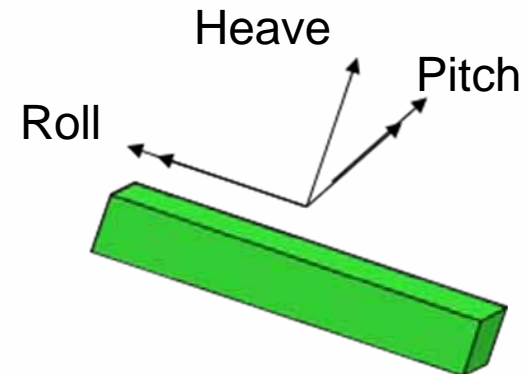
Problem Definition

- Overall general project
 - Landing a UAV on an aircraft carrier is difficult
 - Many controls involved in a UAV
- Things to consider:
 - Wave motion
 - Degrees of freedom (DOF)
- **Goal:** Take controls out of UAV and into the platform



Solution

- Narrow the scope
 - Kinematics only – model rigid bodies first
 - Use tools at hand
 - MSC.ADAMS
 - SolidWorks
- State of the Art Research
 - Ship and Wave motion
 - For ocean-going vessels three motions are sufficient: heave, pitch, roll
 - Dynamic control
 - 2D: Beam balance problem
 - 3D: Controls are difficult
 - Search for existing platforms to simulate



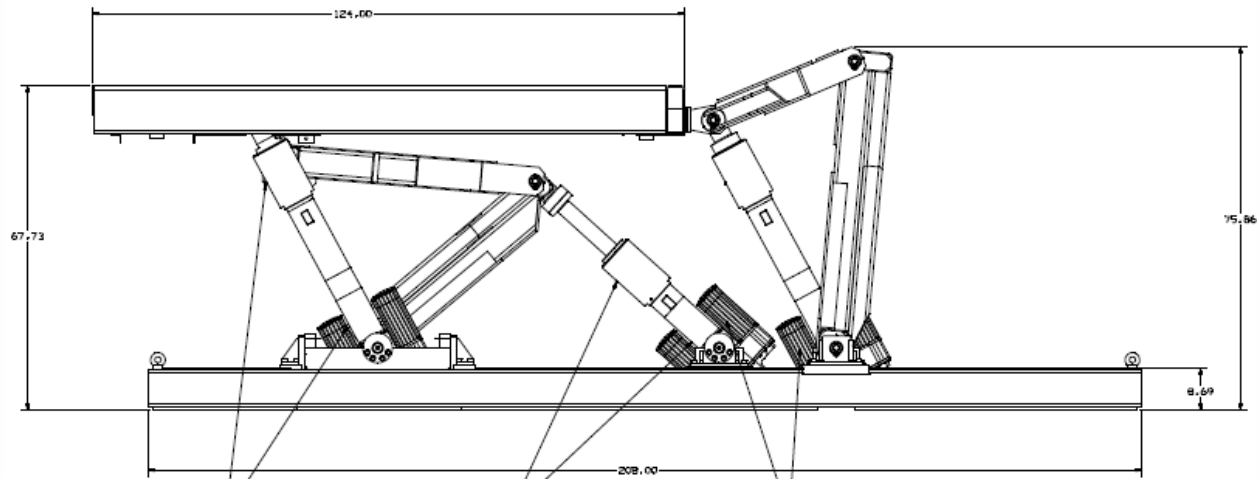
Platform Used – Moog

- Moog 4DOF 9000 Series Platform
 - Made project easier to wrap brain around
 - Four-axis inputs & outputs
 - Heave
 - Pitch
 - Roll
 - Surge
 - Drawings available



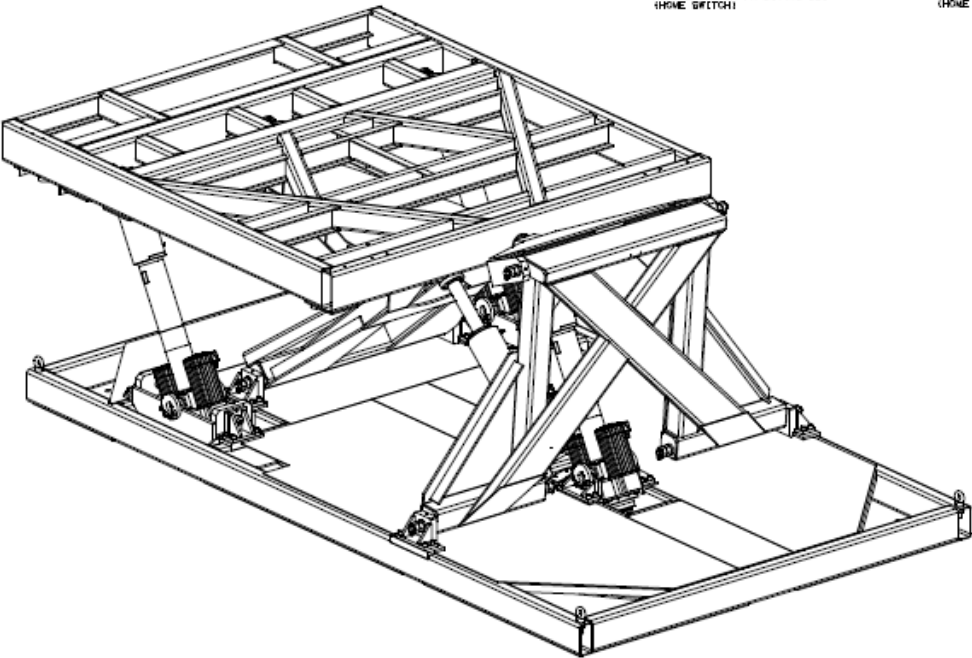


Platform Drawings



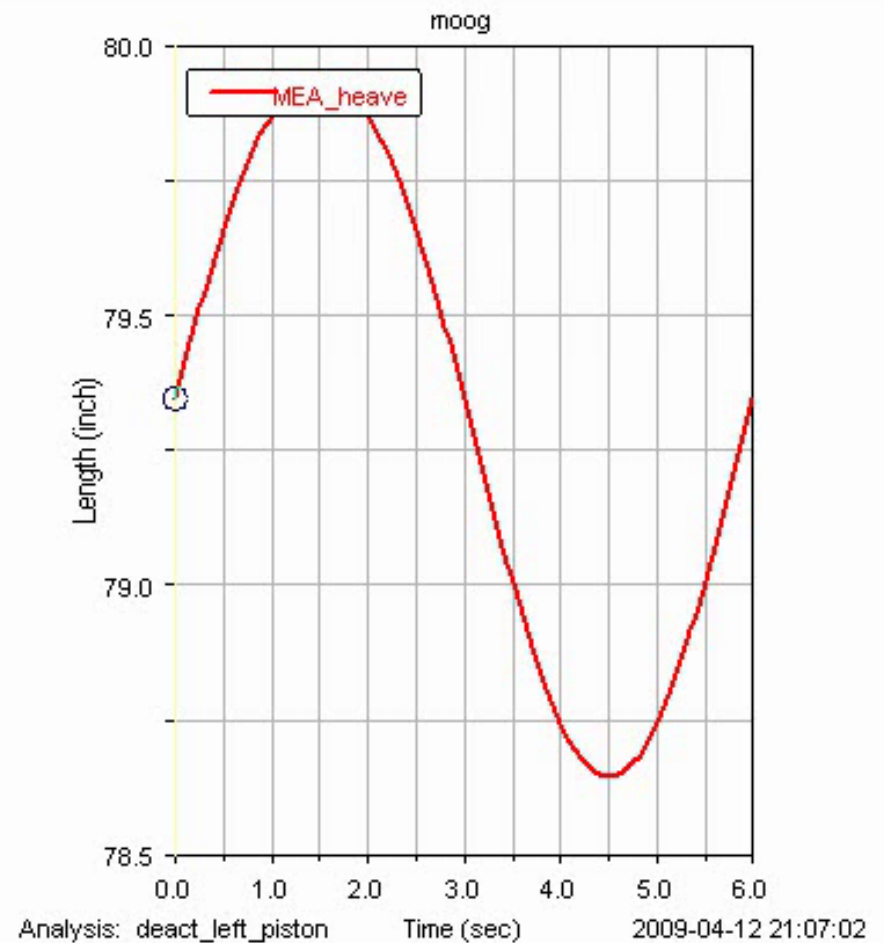
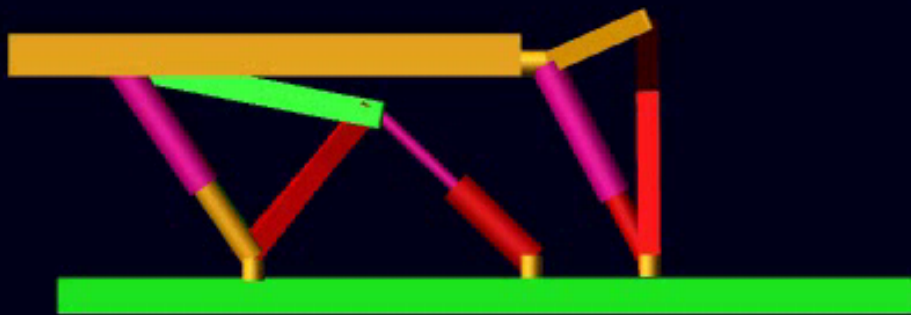
- PROXIMITY SWITCH
 - NORMALLY CLOSED FN C19495-002 (EXTEND AND RETRACT LIMITS)
 - NORMALLY OPEN FN C19495-003 (HOME SWITCH)
- PROXIMITY SWITCH
 - NORMALLY CLOSED FN C19495-002 (EXTEND AND RETRACT LIMITS)
 - NORMALLY OPEN FN C19495-004 (HOME SWITCH - SURGE ACTUATOR ONLY)
- BRUSHLESS MOTOR
 FN 3405-006

FRONT VIEW
 PLATFORM SHOWN IN HOME POSITION



Platform Model

Last_Run Time= 0.0000 Frame=001



Platform Model

Last_Run Time= 0.0000 Frame=001





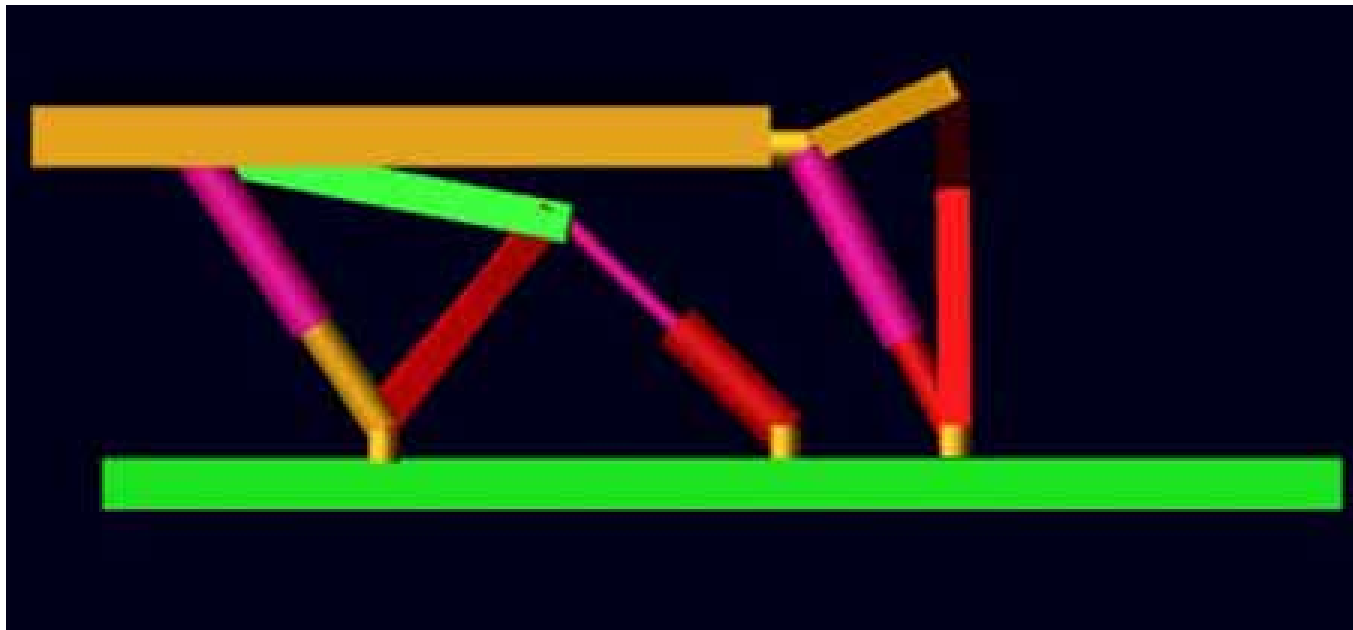
Organizational Tools

- Organize model orientation and location for each part and joint.
- Keep track of model versions.

| Joint Name | Type | Global Orientation |
|------------------------------------|-------------|--------------------------|
| bot_plate_ground_jt | fixed | none |
| ctr_bot_connector_piston_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| ctr_bot_connector_plate_jt | fixed | none |
| ctr_piston_jt | cylindrical | 229.0, 90.0, 0.0 (deg) |
| ctr_top_piston_tri_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| ctr_tri_cross_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_bck_bot_connector_connector_jt | revolute | 90.0, 90.0, 270.0 (deg) |
| lft_bck_bot_piston_connector_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_bck_piston_jt | cylindrical | 203.0, 90.0, 0.0 (deg) |
| lft_bck_top_connector_piston_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_bck_top_connector_plate_jt | revolute | 270.0, 90.0, 90.0 (deg) |
| lft_bot_connector_cross_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_bot_connector_plate_jt | fixed | none |
| lft_ctr_top_connector_plate_jt | revolute | 270.0, 90.0, 90.0 (deg) |
| lft_ctr_top_connector_tri_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_frt_bot_connector_connector_jt | revolute | 90.0, 90.0, 270.0 (deg) |
| lft_frt_bot_piston_connector_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_frt_piston_jt | cylindrical | 203.0, 90.0, 0.0 (deg) |
| lft_frt_top_connector_piston_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| lft_frt_top_connector_plate_jt | revolute | 270.0, 90.0, 90.0 (deg) |
| rght_bot_connector_cross_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| rght_connector_plate_jt | fixed | none |
| rght_connector_piston_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| rght_piston_jt | cylindrical | 208.3, 90.0, 180.0 (deg) |
| rght_top_connector_piston_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| rght_top_connector_plate_jt | revolute | 270.0, 90.0, 90.0 (deg) |
| rght_top_connector_tri_jt | revolute | 0.0, 0.0, 0.0 (deg) |
| rght_tri_cross_jt | revolute | 0.0, 0.0, 0.0 (deg) |

Future Plans

- Controls are much more advanced than when this project started.
- If sponsorship is obtained, then development of algorithms to control platform orientation would be ideal.
- Continue to use undergraduate students who are inspired by system modeling.





Acknowledgments

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