Reference: AM-VPD09-007

e=MSC engineering. education. enterprise. 2009VPD virtual product development conference

Utilization of Easy5 and Adams to Optimize G650 Main Entry Door Performance

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Problem Statement

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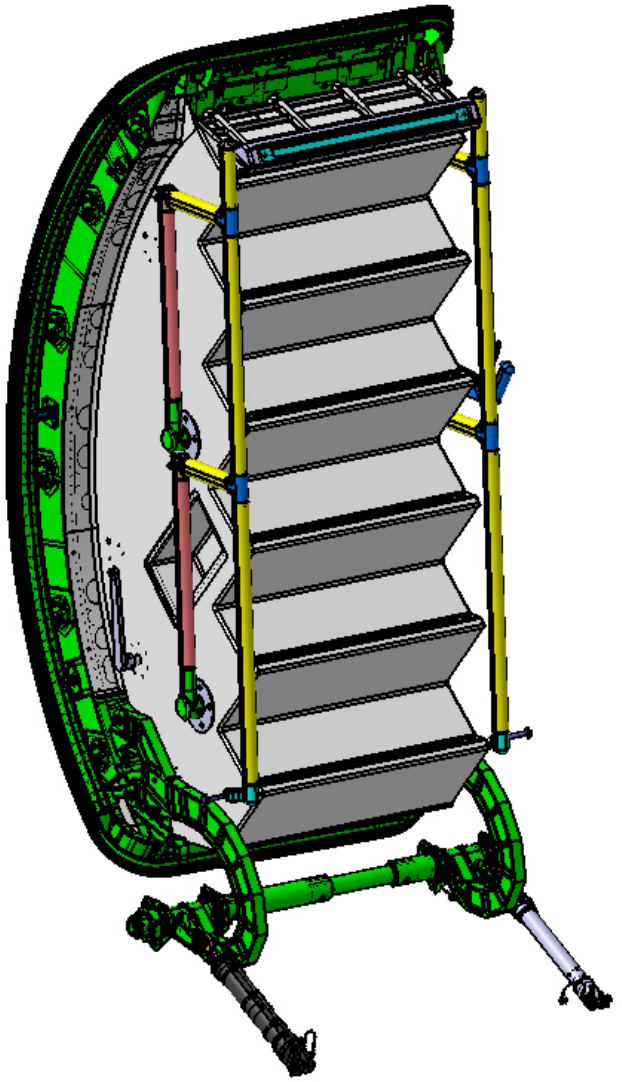
- The Main Entry Door (MED) has a specific requirement for opening time.
- The GV door showed some harmonic behaviour when closing. The G650 had a design goal to improve upon this.
- Hinge loads were unknown.
- Internal orifice sizes for the damper and actuator were needed to finalize the design.



System Description

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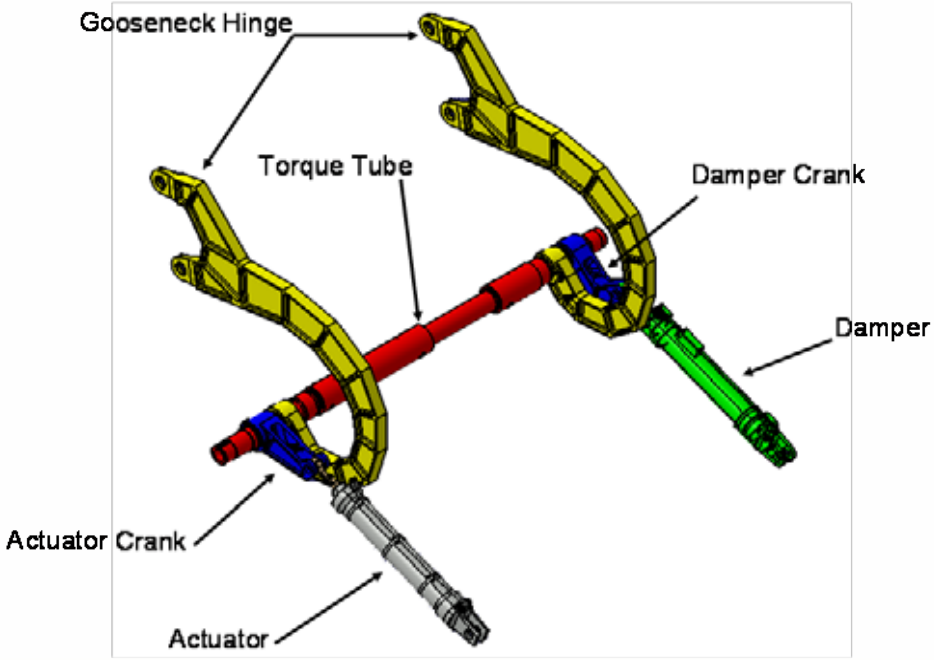
- The door is held to a torque tube by two gooseneck hinges.
- An actuator is attached to the torque tube in order to control the closing of the door.
- A damper is attached to the torque tube in order to regulate the opening and retract snubbing of the door.



Adams Model Development

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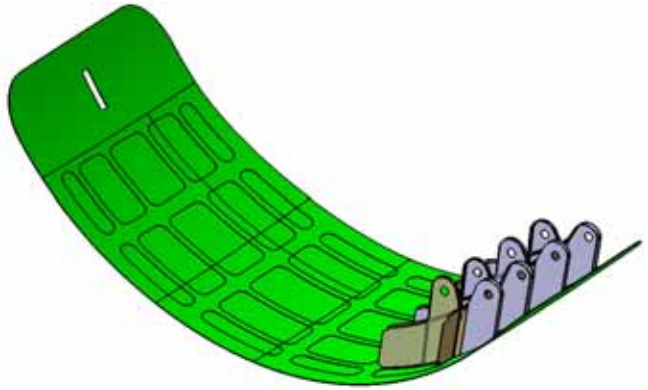
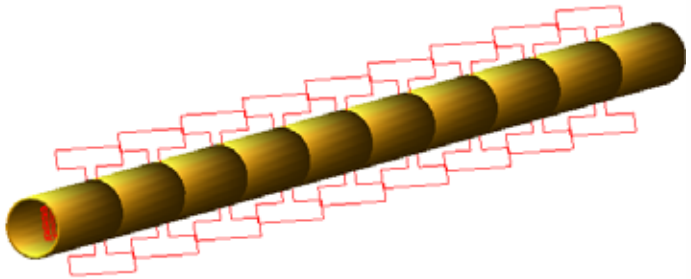
- For simplicity, the door was assumed to be a rigid body, allowing this basic door model to be used. The total door weight was applied to a center-of-mass location on this basic door.



- The flexible properties of the torque tube was modelled by separating the tube into 10 beam elements connected by flexible links.



Adams Model Development

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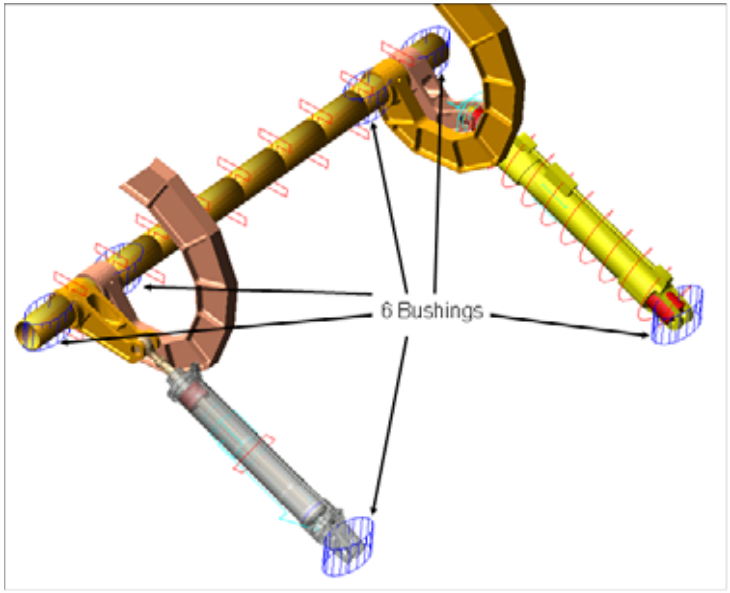
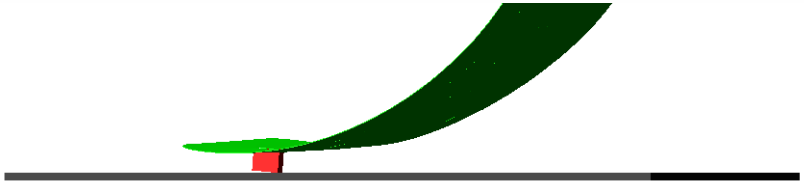
- Each mounting attachment to aircraft structure was modelled as an Adams “bushing” joint. Values were set using MSC recommendations. Calculated values based on our aircraft will be updated when available.



- A finite element model of the gooseneck hinges was provided by our stress group. The FEM of the hinge was converted to a modal neutral file using Nastran, which was then imported into Adams.

- A ground plane was added to provide a surface for the door to contact. The plane was adjusted according to the height of an average weight aircraft.



Adams Model Development

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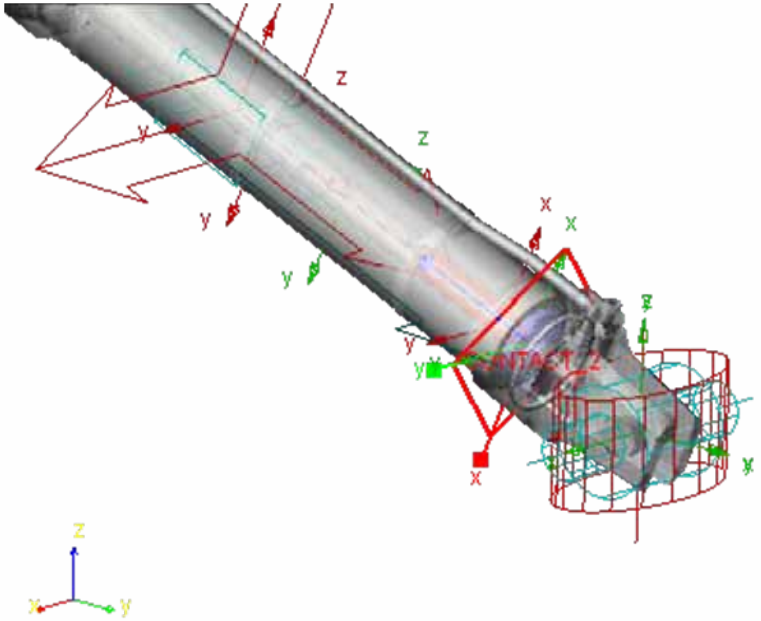
- The actuator is set to bottom-out during retraction (door closing). This “contact force” was modeled in Adams using values recommended by Adams help documentation, MSC forum and an Adams consultant.



- Changes to these values do effect the force results drastically and will need to be studied when more test data is available.

Stiffness	1.1025E+006
Force Exponent	1.5
Damping	1.1025E+004
Penetration Depth	3.937E-004

Adams Model Development

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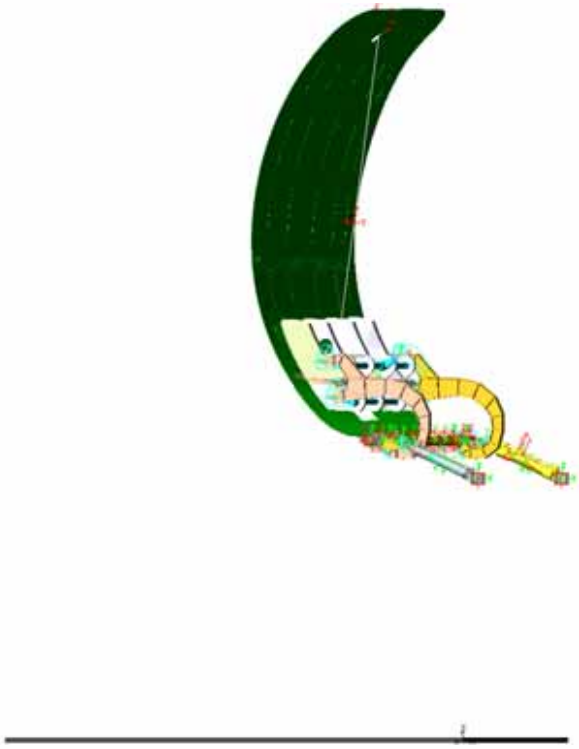
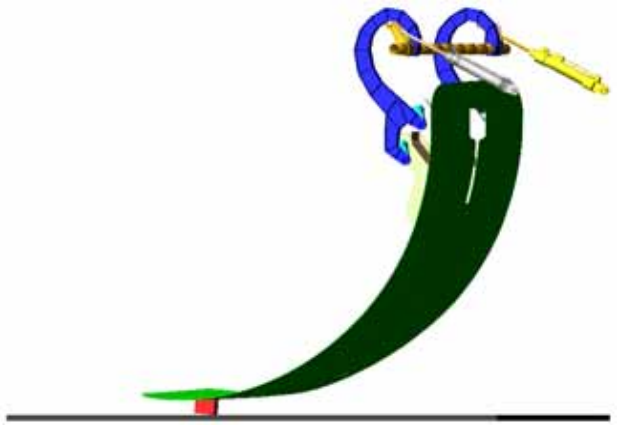
- The assembled model can be seen below:

Raised Position



Lowered Position



Easy5 Model Development

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- Our actuator supplier provided us with the detailed design parameters needed to build a model of the actuator in Easy5. Our final Easy5 model included the supply valve orifice areas and all snubbing orifices internal to the actuator.

- Our damper supplier provided us with a detailed design of the component and preliminary results using an Easy5 model they created. With permission to adjust the internal orifices to tweak performance, we matched their performance with our Easy5 model and made adjustments within their constraints to optimize the MED performance.

Easy5 Model Development

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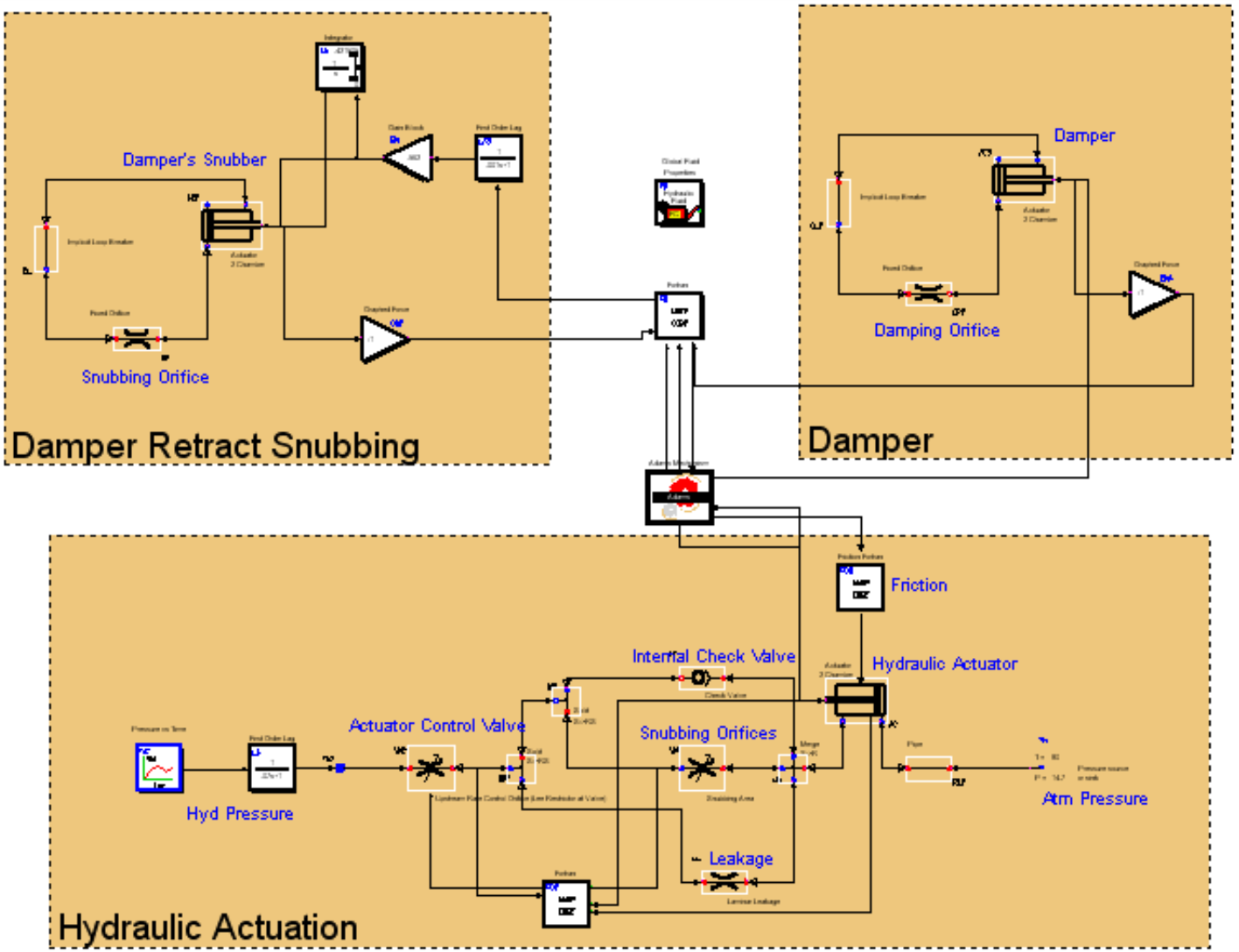

Linking Adams and Easy5

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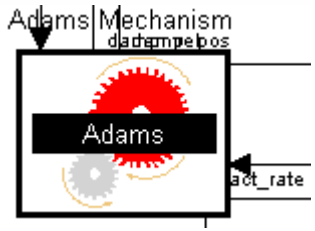
- Using the “AD – MSC.Adams interface” block in our Easy5 model allowed a link to our Adams model.

Input into EASY5 from ADAMS	Input into ADAMS from EASY5
Actuator Position	Actuator Force
Actuator Velocity	Damper Force
Damper Position	
Damper Velocity	



- When the Easy5 model is being exported, any number of display outputs can be added so that you can view the corresponding Easy5 data of a simulation in Adams viewer.
- If there is a value that needs to change regularly it can be added to a list of design parameters to adjust while in Adams. This minimizes the time of opening and resaving an Easy5 model to tweak a design.

Preliminary Validation of the Model

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- Load curves of our actuator model were shared with our actuator supplier to ensure the model's fidelity. Our actuator supplier has a proprietary model which uses load curves as an input to determine extension times, and within a few iterations the models were calculating results within 1% of each other.

- The load curves from our model match our damper supplier's Easy5 model of their component.

- The results from this door model match all expected trends.

- Final validation will be complete once the component or system level test results are available.

Results

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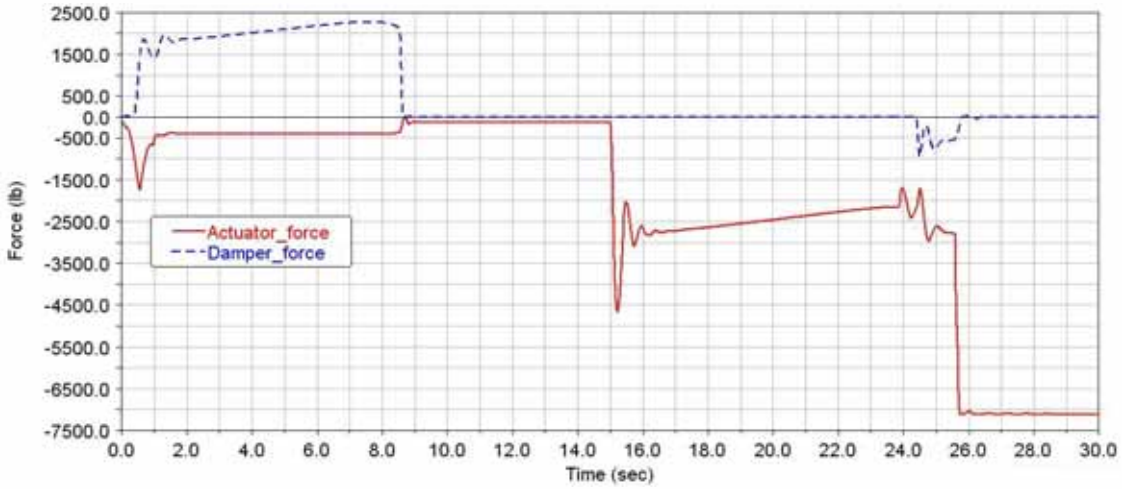
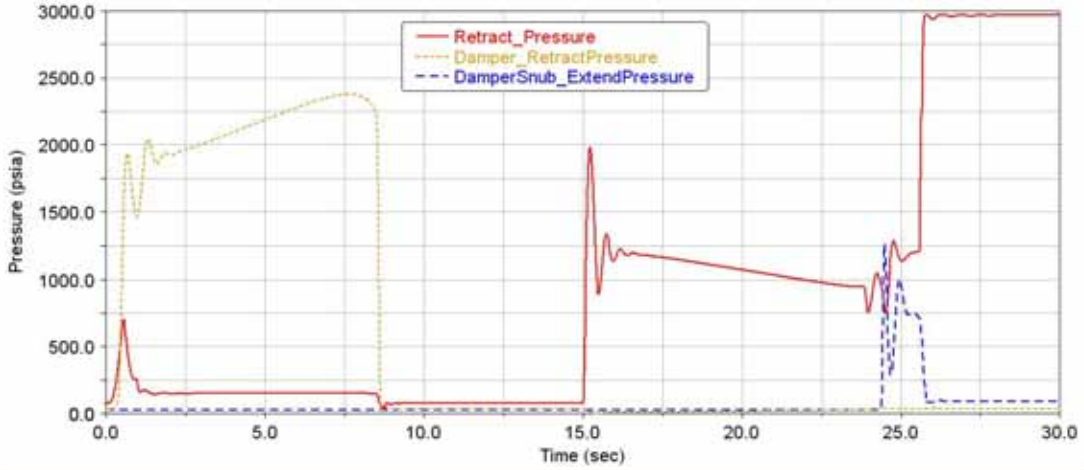
- Adams viewer allows us to visually analyze any result or variable.





Conclusions

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- These MSC products allowed our engineering team to visualize the effects of design changes before a working prototype/mock-up. This reduced testing cost.
- The model can easily be adjusted to simulate results for different:

  - temperatures
  - entrained air percentages
  - fluid types
  - damper orifice sizes
  - actuator orifice sizes
  - degrees of door swing
  - actuator control valve specifications
  - check valve specifications
  - available hydraulic pressure
  - weights
  - friction forces

- Once a working mock-up is assembled, we will find where the current simulation may slightly differ from “real world” results and validate the model.
- The model can be used as a baseline for future analyses.

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