

Research project meeting summary: Trajectory Module for Launcher MDAO

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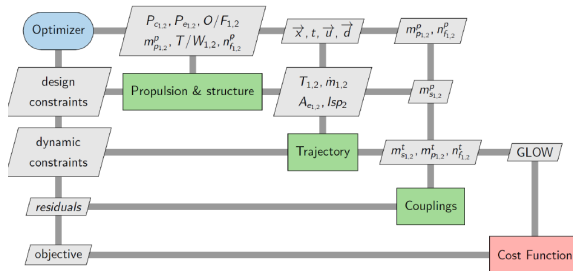
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- 1 Review of previous work
 - Couplings between disciplines
 - NLP problem size
 - Axial Load Factor plot
 - On the propulsion model
- 2 Key points discussed
 - Questions
- 3 Future actions

All-at-Once MDO architecture using Dymos and OpenMDAO:



\vec{x} : State var. vector P_c : Chamber pressure T : Thrust
 t : time P_e : Exit pressure \dot{m} : Mass flow rate
 \vec{u} : Dynamic control O/F : Ratio oxidizer / fuel A_e : Exit Area nozzle
 \vec{d} : Design parameters T/W : Ratio thrust / weight I_{sp} : Specific impulse
 $GLOW$: Gross liftoff weight m_p : Propellant mass m_s : Structural mass

$$GLOW = M_{p1} + M_{p2} + M_{s1} + M_{s2} + M_{payload} + M_{fairing}$$

NLP variables and constraints for LGL of order 3. 2 optimization variables per segment. 56 segments. 5 states. 4 boundary constraints.

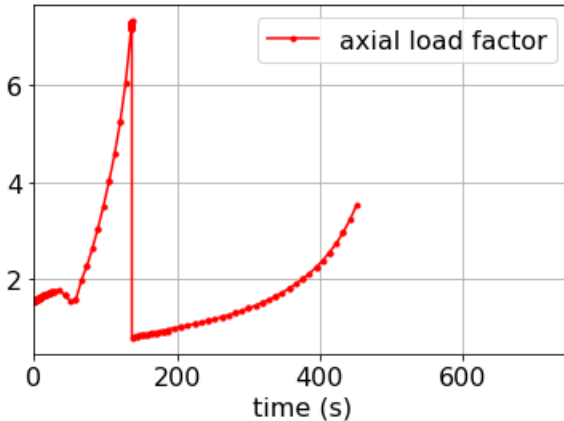
- state optimization variables = $2 \times 56 \times 5 - 4 = 556$
- defect and continuity constraints: $(56 + 56 - 1) \times 5 = 555$

We have seven phases. Optimization of initial time and duration for each.

- time variables: $2 \times 7 = 14$
- time continuity constraints: $(7 - 1) = 6$

Review of previous work

Axial Load Factor plot



- To use the I_{sp} from Rocket CEA we would need interpolation in 3 variables: O/F , P_c , P_e
- Last meeting we agreed on calculating I_{sp} at vacuum and based on this calculate the nozzle exit area A_e . Is this ok for the first stage?

- In traditional launcher MDAO few optimization variables and constraints are used, thus the implementation of AAO strategies is quite penalizing. On the other hand, pseudospectral methods transcribe the problem into a high dimensional NLP with hundreds of constraints and variables. Thus the relative effect on computing because of introducing a few more constraints and variables using AAO is smaller.
- What is SAND?
- Dimension of MDAO in a real case application
- What's the process to write a paper? We need to improve the structural model and then define a comparison method first. Then, I could write my research project report as if it were a paper to save some work.

- I will meet Dr. Urbano to solve my doubt on the calculation of A_e in the propulsion module.
- Check on LAST structures module to integrate it in my code.
- Comparison of methodologies could be done against FELIN
- In the XDASM diagram I could better represent the jettisoned mass variables as it's confusing to name them m_s