Project 3

- Objective:
  - Estimate uncertainty in the helicopter design using surrogate models
  - Build/test the best design for reliability and robustness
- Uncertainty quantification
  - Identify all uncertainties in predicting the falling time of helicopter
  - Separate treatment of aleatory and epistemic uncertainties
  - Uncertainties in construction, surrogate models, measurement, environment, etc
- Uncertainty analysis for falling time T_{fall}
  - Perform a reliability analysis using MCS or FORM to estimate the probability of failure
  - PF is defined as $P_F = P(T_{\text{fall}} \leq T_{\text{second\_best}})$
  - $T_{\text{second\_best}}$ = (6.56, 6.15, and 7.05 sec)
- Design competition
  - Find a design that minimize the probability of failure, P_F.
  - Build/test the design

Project 3

- Robust design
  - Sometimes we want to sacrifice a little bit of PF in order to improve robustness of the product
  - Robustness is measured using variance (or standard deviation)
  - Find a design that minimizes the standard deviation
  - Build/test the design

Uncertainty and Safety Measures

- How do we classify uncertainties? What are their sources?
  - Lack of knowledge vs. variability
- What type of safety measures do we take?
  - Design, manufacturing, operations & postmortems
  - Living with uncertainties vs. changing them
- How do we represent random variables?
  - Probability distributions and moments
- Aleatory uncertainty: Inherent uncertainty
  - Manufacturing tolerances, noise in signal
- Epistemic uncertainty: Lack of knowledge
  - Error in failure model, error in surrogate model
- Distinction is not absolute

Uncertainty Classification

Type of uncertainty	Definition	Cause	Example of remedies
Error	Departure of the average fleet of an aircraft model (e.g., Boeing 737-400) from ideal one	Errors in predicting structural failure , construction errors, deliberate changes	Testing and simulation to improve math model and the solution
Variability	Departure of individual aircraft from fleet average	Variability in tooling, construction, and flying environment	Improve tooling and construction, quality control