2.70/2.77

Practical Uploadable Problem Set # 5: Machine Design Concept Detail Exploration

Remember when doing this problem set:

- Problems must first be completed individually, and then group effort starts with peer review, then:
  - With your Peer Review Evaluation Partners and no talking, review each other’s work.
  - THEN discuss and make changes as needed.
- It is important the teacher see the original work, the PREP comments and then any changes needed.
- All math should also be done with a spreadsheet or Matlab script, so you can easily play “what if”.

Problem (Opportunity!):

Create detailed concepts for your machine.

1. Create several concept sketches for your design that include the structure, bearings, and carriage for one simple “precision” linear motion axis of your design (make sure to leave room for the actuator!) (2 pts):
   a. Label the sensitive directions!
   b. Assign coordinate systems (label), which will be used for error budgeting.
   c. Assess Risks and Countermeasures
2. Allocate allowable errors (feel free to use Axis_error_apportionment_estimator.xls) for each axis and components of your envisioned machines (2 pts).
3. Pick at least two concepts for further exploration (2 pts):
   a. FRDPARRC table for each concept
   b. Label the sensitive directions and coordinate systems used for error budgeting!
   c. Create sketch models (wood, cardboard, Legos™) for at least two of your concepts
4. Create first order error budgets for your favorite design(s) (just like you did in PUPs 3) (2 pts):
   i. From the error apportionment, assign errors to structure, bearings...
      1. From the stiffness estimates obtained in PUPs 2, assume a distribution of
         stiffness between axes and bearings... (play, explore... use spreadsheet
to test ideas and assumptions).
   ii. As a result of building the error budget for each concept and wiggling values to
      see the effects on performance, try to pick the “best” concept you want to move
      forward with, or if needed its OK to take more time).
5. Assess Risks and Countermeasures and use to evolve designs and trim options to help converge
   on a design: (2 pt)
   a. Risks include:
      i. Safety review: pinch points, cutters, impacts, tipping, electrical shock...
      ii. Wiring (cable tracks, isolation power and signal...)
      iii. Seals, bellows... (survival of the machine in use)
      iv. Coolant delivery and containment (if needed)
      v. Chip handling
      vi. Ergonomics (does it look good? Will people want to use it?)

Peer review can be done along the way or at the very end after all the individual elements done. The
former is suggested