Ten Step Precision Machine Design Process

1. Identify need
   a. Background study
2. Start FRDPARRC table
   a. Identify dominant overall physics, references, risks
3. Create Solution Strategies
   a. Stick Figures
   b. FRDPARRC table for each strategy
   c. Error Apportionment for different strategies
   d. Model 1\textsuperscript{st} order loads, stiffness requirements
   e. Geometric error budgets for “top” strategies
4. Ruminate, play, evolve, pick “best” strategy
5. Create Concepts for best strategy
   a. Sketches, coarse (realistic proportions) solid model
   b. Error Apportionment
   c. Model 1\textsuperscript{st} order loads, stiffness requirements
   d. FRDPARRC table for each concept
   e. Sketch models
   f. Bench level tests
   g. Safety review
   h. Ergonomics and manufacturing review
6. Preliminary Error Budgets for top concepts
   a. Study options for primary structure, bearings, actuators, sensors
      i. Model preload method, stiffness, life, accuracy
      ii. Parasitic & environmental errors
7. Select “best” concept for detailing
   a. Final component selection, modeling, and detailing for prototype axis (Most Critical Module)
   b. Update error budget
   c. Update FRDPARRC
   d. Solid model parts, assembly, and make drawings
8. Build and test prototype axis (Most Critical Module)
   a. Computer control
   b. Measure performance and compare to predicted performance
   c. Load capacity, stiffness, accuracy, repeatability, resolution
9. Complete engineering analysis and detail of entire machine
   a. Final component selection, modeling, and detailing for prototype axis (Most Critical Module)
   b. Update error budget
   c. Update FRDPARRC
10. Build and test
    a. Computer control of axes
    b. Measure performance and compare to predicted performance
    c. Load capacity, stiffness, accuracy, repeatability, resolution
11. Document
Note—there should be a continual assessment of Risks and Countermeasures!