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Precision Healthcare Robotics

## Mechanical Engineering Assessment

In the following three days, please tackle the following challenge.

1. Design a rotating assembly for a low torque, high precision application. The assembly shall have 1 active rotating degree-of-freedom, and shall be used to transmit a driven rotation from a motor, to a spinning shaft where a generic appliance can be coupled.
   The candidate can choose whether a direct-drive, or a transmission stage is interposed.
   The assembly must have at least the following components:
   a. Encoder (off-the-shelf)
   b. Bearings (set of bearings preloaded) (off-the-shelf)
   c. Motor (off-the-shelf)
   d. Motor housing (custom)
   e. Shaft (custom)
2. Create detail drawings for all the non off-the-shelf components.
3. List all off-the-shelf components.
4. Create a top assembly drawing with a BOM.
5. Describe briefly the rationale for the selected components and the overall design.
6. Perform a free-body-diagram analysis for the shaft supported by the bearings in your design.
7. Describe the most likely way the system will fail and why.



Additional info

We expect candidates to have been exposed (either during study or work) to machine-design courses and examples, being in front of designs and components accomplishing generic roles (driving shafts, housings with bearing support, mechanical components to transmit torque, etc).

The requirements are very broad, but here are some general indications.

- **High precision** refers to the angular positioning. In robotic surgery, most of design features become marginal when compared to the accuracy. For the scope of this assessment, consider
  - correctly assembled parts (DfM/DfA);
  - enough resolution;
  - sufficient stiffness;
  - the candidates are free to give his/her own specification. He/she can claim 0.1 degree, or 1 arcmin of accuracy, or 1/128th of a rotation: the particular value does not really matter, as long as it is met by the proposed design.
- For each of the **Off-the-shelf components**, there are specific suppliers, with different range of performances (and consequent prices)
  - the candidates are free to perform their own research, not an issue if you need more days;
  - the candidates should show some degree of knowledgeability in selecting the suppliers, pending the kind of precision/performance they want to achieve

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    - fasteners/screws can be selected from either McMaster or Misumi
- This assessment is mostly meant for us to understand candidates' design skills. Try to address Design of Custom Parts thoroughly (DfM/DfA/GDT/Materials and Finishing and Treatments)
- Regarding formats, **SolidWorks** is our preferred platform, but any Mech-CAD (Creo, Fusion, UX, etc..) can be used
    - For the 2D drawings, *.pdf files are necessary. Candidates shall imagine they will be sent out (after approval) to Machining-Shops
    - For the 3D drawings, if SolidWorks is not viable, candidates shall provide the solution also in an inter-exchange file format (*.step or *.iges).
- Please, communicate directly with Marco Cempini (mcempini@neocis.com) for any questions or doubts.

Keys for success:

a) Create a design solution that is simple, elegant, and fully functional.
b) Demonstrate an ability to work independently and make reasonable, well-supported assumptions about the problem.
c) Document the solution with any assumptions made in a clear, straightforward manner.