# **Requirements, testing rubric, schedule, and other information for the 2020 scribe tool probe ASPE Student Challenge**

**The challenge**

The scribing Challenge has been divided in two independent challenges taking place during the 2020 and 2021 ASPE annual meeting:

1. 2020: Designing the Scribe probe is the challenge this year.
2. 2021: Mounting of the scribe design on XY stages and creating a grating will be next year’s challenge.

This document contains a detailed rubric, the challenge schedule, and hardware and other resources that will be provided to each team.

**Goals of the challenge**

The student challenge rubric is intended to assess each team and their instrument in the areas of analysis, design, teamwork, presentation and fabrication/measurement performance. Our goal is to judge and provide feedback. The following aspects will be considered during the evaluation:

1. Design novelty of the instrument
2. Uncertainty budget
3. Design presentation
4. Final performance, report and presentation

Each of the above bullets are described below and an evaluation table is provided towards the end of this document. Points awarded are based on overall grade for assessment of team organization and execution.

**Design novelty of the instrument (100 pts)**

The design of an instrument with fewer mechanical elements and a small footprint is desired. Additionally, the design will determine the performance of the system and the quality of the grating pattern. These aspects will be included in the evaluation, and a maximum of 100 points can be obtained.

**Uncertainty budget (200 pts)**

A comprehensive uncertainty budget used to estimate the quality of the final results is required. This uncertainty budget will be used to determine the repeatability and accuracy of the instrument, and will consider, among others, the measurement uncertainty for the capacitive and force sensors, the repeatability and accuracy of the Z mechanism , and the quality of the control system used. A maximum of 200 points will be given for the uncertainty budget. This should be included in the final report submission.

**Design presentation (100 pts)**

The teams will be required to present their initial designs of the mechanism via zoom meeting and the committee will provide live feedback and address any questions they may have.

A maximum of 100 points can be obtained. Points awarded are based on the following:

* Presentation of design including well labeled images to illustrate operating principles and assembly
* Electro-mechanical control strategy
* Uncertainty/Error budget
* Overall presentation structure and quality

Demonstration of the designed scribe tool mechanism could be assembled into the XY stage using a solid model assembly and included in the presentation. Error budget and design considerations will be evaluated as described previously.

**Final performance, report and presentation (600 pts)**

Teams will be required to submit their final reports by Oct 20, 11:59 pm Central time. The reports should be precise and succinct- preferably less than six pages (10 point font minimum, 1” margins all round, CAD & FEA images can be moved to the Appendix if needed). The final reports should include 1) detailed designs of the final mechanism- CAD model, FEA analysis (static, modal), 2) an uncertainty/error budget and 3) the compiled results and analysis of their final performance data. The mechanisms will be judged on the following performance metrics:

1. calibration plots for internal force measurement\* designed into the probe and the loadcell. This includes an assessment of linearity, accuracy, resolution, and repeatability/stability over a twenty-minute time-period), **(75 pts)**
2. small signal frequency response measurement when the dummy scribing tool is attached to the mechanism, and in contact with the load cell (i.e. ratio of contact force measured by the load cell divided by demand to the mechanism as a function of frequency and phase). **(75 pts)**
3. steady state controller error and control signal for static forces ranging from 0.4 N to 1 N over a period of 20 minutes **(100 pts)**
4. step responses of the controlled system over the full 1 N range, externally measured by the load cell, and **(75 pts)**
5. force measured by load cell, and controlled force for a ramp input of 1 N at a frequency for which phase shifts of the response are less than 0.05 radians. **(75 pts)**

\* internal force measurement: A way of realizing the force exerted/experienced by the scribing tool without using the load cell provided.

On Oct 21, each team will present their instrument design and discuss their approach, considerations, error budget and results obtained. Presentation should be limited to 15 minutes followed by 5 minutes of Q&A from the panel. A maximum of up to 200 points can be obtained on the final report & presentation.

Below are the components of total evaluation:

|  |  |
| --- | --- |
| **Rubric for judging student challenge 2020** | **Points** |
| **Design novelty of the instrument** | 100 |
| **Uncertainty budget** | 200 |
| **Preliminary design presentation** | 100 |
| **Final Performance** | 400 |
| Performance metric A | 75 |
| Performance metric B | 75 |
| Performance metric C | 100 |
| Performance metric D | 75 |
| Performance metric E | 75 |
| **Final report + presentation+ Q/A** | 200 |
| **TOTAL** | **1000** |

**Hardware and other resources provided to each team**

A spreadsheet containing performance specifications and other user information for the supplied hardware listed below is posted on the student challenge website. The hardware and resources include;

1) A dummy scribing tool to apply force to a load cell. This will have similar dimensions and geometry of the final scribe tool for ruling.

2) Knife edge optical sensors. Performance of the sensors and electronics will be supplied in a comprehensive hardware spreadsheet.

3) A solid model of the final XY scanning stage so that a suitable fixture/z-flexure mechanism for the fastening of the probe can be designed.

4) Linear amplifier to control currents of up to 1 A for a voice coil actuator that also has four channels of ADC with 16 bit resolution two channels of which have manually programmable gain at the input. An amplifier user manual will be supplied.

5) A National Instruments myRIO for sensor data acquisition & controlling the voice-coil actuators will be provided upon request.

6) ½ Mechblock kit for construction of scribing axis apparatus plus additional blocks as per competition rules (step files will be made available to the teams).

7) A strain gage-based load-cell having a total range of 100 g for measurement of forces up to 1 N.

8) A series of four masses for calibration with values ranging from 10 g to 90 g (masses can be stacked to obtain additional calibration points).

10) Prior to the competition each team will receive a precision capacitance-based displacement gage Lion Precision™ model #CPL350 having a displacement range of 2 mm.

**Challenge schedule**

Midnight, August 14: Last day for registrations

August 17: Start Day

August 17: Shipping hardware

September 14: Virtual Zoom meeting. Introductions and Q & A.

September 28: Virtual Zoom design presentations with feedback (incl; uncertainty budget)

October 19: Last day to submit reports (incl: uncertainty budget revisions)

October 20: Last day to submit pre-recorded presentations

10:00 – 12:00, October 21: Final project presentations

12:00 – 13:00, October 21: Awards given

Thank you, we look forward to another successful meeting.

**ASPE 2020 Student Challenge Organizing Committee**

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