

Student Challenge 2021 - Grading Rubric

The overall goal of the 2021 American Society for Precision Engineering (ASPE) Student Challenge is to fabricate diffraction gratings – arrays of repeated triangular trenches cut into a mirror-like substrate – with microscale feature size and controlled ‘performance parameters’ including pattern height, pitch, angular symmetry, and linearity (straightness) of grating lines. This rubric is intended to assess each team and their fabricated diffraction gratings in the areas of:

1. Implementation techniques
2. Presentation of preliminary results
3. Final performance, report, and presentation
4. Teamwork

Each of these categories are detailed below and an evaluation table, Table 1, is provided at the end of this document.

Implementation techniques (100 pts)

Any documented efforts towards achieving the required performance parameters will be rewarded a maximum of 100 points. It is noted that teams may choose to forego usage of the example diamond scribe holder design provided by the committee and instead implement a custom design, however no extra points will be awarded for doing so. Conversely, novel approaches to grating fabrication will be awarded points.

Submission of gratings for quality control (100 pts)

There are two methods committee-approved methods to validate grating performance parameters.

1. Optional (but helpful and encouraged): DIY Diffraction Measurement

Here optical diffraction of a laser pointer incident on the fabricated samples is measured with a consumer camera. The measurement procedure and analysis tool are provided by the committee. Teams are required to use their camera of choice, and the committee can provide suggestions to improve future measurements (*In the event of any financial difficulties in obtaining a suitable camera, the committee may make specific arrangements on a case-by-case basis*).

2. Mandatory: Zeiss Measurement

All teams will send their fabricated gratings to Zeiss metrology on, or before, **Sep 17th, 2021** so they may be measured using a confocal microscope at Zeiss’s facility. 100 points are awarded for the timely submission of the gratings. If the conference is held virtually, a second set of gratings must be sent to Zeiss on or before **Oct 15th, 2021**. In this case, 50 points will be awarded for each grating submissions (Sep 17th and Oct 15th).

The results of the performance parameters calculated from these measurements must be included in the final report. It is also noted that an uncertainty budget of the fabrication process can prove quite helpful in identifying the most significant contributors to process variations and grating quality, however it is not mandatory.

Presentation of preliminary results **(100 pts)**

Teams are required to present their initial progress in rendering the shipped (disassembled) XY fabrication stages operational and any efforts towards grating fabrication. The results of performance parameters should also be included if measurement results are available by then. The meeting will be held via Zoom on **Sep 24th, 2021**, and the committee will provide live feedback and address questions for individual teams. A maximum of 100 points may be earned based upon:

- Presentation of fabrication efforts (including well labeled and clear figures)
- Preliminary grating performance metric results from optical diffraction measurements and any results from Zeiss Metrology if available before the Zoom meeting
- Electro-mechanical control strategy
- Overall presentation structure and rhetoric

Final performance, report and presentation **(700 pts)**

Teams are required to submit their final reports by **Oct 22, 11:59 pm CST**. An excellent report will be both precise and succinct – submissions should be less than six pages (10-point font minimum, 1" margins all round, not including appendices [CAD & FEA images may be moved to the Appendix if needed]).

The final report should include

1. Mechanical design modifications (if any),
2. Grating fabrication procedure including any optimization approaches, and
3. Use of the DIY optical diffraction method to improve fabricated grating quality.

Results will be judged on:

Performance metrics: **(500 pts)**

- A. Grating height uniformity (measure of how well the force control works, if implemented),
- B. pitch uniformity,
- C. symmetricity of grating slope angles,

- D. linearity of grating lines (straightness),
- E. manufacturing repeatability and throughput

Statistics on these metrics may be determined from the measurements facilitated by Zeiss metrology in the preliminary and the final stage of the competition.

Intermediate results & any improvements implemented in team designs- (125 pts)

Results from competition grating (if virtual conf - final sample sent to Zeiss.) - (175 pts)

On **Nov 2**, each team will present their fabrication results, approach, and considerations. Presentations are limited to 15 minutes followed by 5 minutes of Q&A from the panel. A maximum of up to 200 points may be awarded for the final report & presentation.

Table 1: Components of Total Evaluation Score

Rubric for judging student challenge 2021	Points
Implementation techniques	100
Quality control	100
Preliminary design presentation	100
Fabrication performance	500
Performance metric A	45
Performance metric B	45
Performance metric C	45
Performance metric D	45
Performance metric E	20
Intermediate grating quality results	125
Final grating quality at the ASPE conference	175
Final report + presentation + Q/A	200
TOTAL	1000

Thank you, and we look forward to another successful meeting!

Any remaining questions may be directed to the student challenge organizing committee

ASPE.ChallengeCommittee@gmail.com

ASPE Student Challenge 2021 - Organizing Committee

- Luis A. Aguirre – 3M Company
- Kumar Arumugam – UNC Charlotte
- Dipankar Behara – UT Austin
- Paul Brackman – Zeiss
- Raymond C. Cady – Corning
- Jacob Cole – UNC Charlotte
- Liam G Connolly – UT Austin
- Tim Dalrymple
- Drew Devitt – New Way Bearings
- Chunjie Fan – UNC Charlotte
- Mark T. Kosmowski – Electro-Scientific Industries, Inc.,
- Mark Schmitt
- Don Martin – Martin Mason LLC
- Senajith Bandara Rekawa – Lawrence Berkeley National Laboratory
- Nilabh Roy – Canon Nanotechnologies
- Stuart Smith – UNC Charlotte
- Alex Sohn – Facebook Reality Labs
- Trevor Stolber – 3M company