

A Summer Engineering Internship Program Offered at a Liberal Arts University

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Engineering programs that are in traditionally liberal art schools have to overcome unique challenges to bolster their curriculum and be competitive in the world of higher education. Before the launch of a BS-Engineering program at Biola University in Fall 2023, there was no engineering design or project based curriculum in the previously existing majors. Therefore, engineering faculty decided to offer a Summer Engineering Internship (SEI) program to give lower-division students a more hands-on internship-like experience that would be enriching and relevant for students' future careers.

The program provides students 128 hours (16 hours per week for 8 weeks) of hands-on engineering experience. During SEI, students go through the whole engineering design process from client interviews, to designing, prototyping, and presenting their final product to a variety of audiences in a poster session. Students also receive training in hard skills like Arduino programming, CAD design, and 3D printing, as well as soft skills like writing resumes, giving presentations, SCRUM, etc. A few sample projects are listed below:

1. Automation of a cannulation apparatus that only had manual capacities before;
2. Prototype a swim tunnel for zebrafish where water flows at a predetermined velocity for a research laboratory;
3. Literature search to compile a database of water contaminants characteristics and treatment methods and development of a user interface with recommended treatment methods for each type of contaminant;
4. Development of a mechanical model of the Windkessel effect to be used for cardiovascular education and research;
5. Prototype of a teleoperated 5-Degrees-of-Freedom robotic arm;
6. Development of a testing rig to automatically verify that motion sensors are properly relaying data to a system that an AI company developed to remotely monitor the daily activities of elderly people;
7. Prototype of an inverted pendulum to be used in a Controls Systems course;
8. Designing a photoplethysmography device to detect deep vein thrombosis.

After three years of offering SEI, we conducted an anonymous survey to collect data and assess the effectiveness and impact of this program. The thirty-one SEI participants from 2021-2023 were invited to fill out the survey and sixteen of them responded. Students were asked to rank their level of experience in technical skills before SEI. Level 1 was "never heard of", level 2 was "basic knowledge", level 3 was "had some informal training", level 4 was "had project experience applying those skills", and level 5 was "expert". 81.3 % of the students chose level 1-2 for 3D CAD design and 3D printing. 31.2% of the students chose level 1-2 for computer programming. 62.6 % of the students chose level 1-2 for circuitry. 75% of the students chose level 1-2 for sensors and motors and testing and validation. 43.8% of the students chose level 1-2 for literature search. Students were then asked to rank their level of experience in the same technical skills after SEI. Level 1 was "no exposure at all", level 2 was "some exposure", level 3 was "improved", and level 4 was "competent" and level 5 was "excelled". 87.6% of the students chose level 3-5 in the testing and validation process after SEI. 75 % of the students chose level 3-5 in 3D CAD design and 3D printing. 68.7% of the students chose level 3-5 in computer programming and circuitry and 62.5% chose level 3-5 in sensors and motors. 37.5% of the students chose level 3-5 in literature search. From this data, we can see that the greatest number of students gained experience in the testing and validation process. This makes sense since every team had to go through the iterative engineering design process in which testing and validation plays an essential role.

Same descriptions were provided for Level 1 through Level 5 for the soft skills before and after SEI. The top three soft skills with the most improvements are engineering design process, documentation, and client interaction. 68.8 % of the students chose level 1-2 for the engineering design process before SEI,

while 93.7% chose level 3-5 after SEI. For documentation, 62.5% of the students chose level 1-2 before SEI while 81.2% chose level 3-5 after SEI. For client interaction, 81.3% of the students chose level 1-2 before SEI while 93.7% chose level 3-5 after SEI. This correlates with the technical skills data.

Students were asked if they felt more confident going to an interview for an industrial internship. Ten of the thirteen respondents answered yes. Seven of the eleven respondents who participated in SEI in 2021 and 2022 said that they did find external internships.