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## DUKE UNIVERSITY PRATT SCHOOL OF ENGINEERING: **FIRST-YEAR DESIGN (FYD)**

By: Dr. Ann Saterbak, Program Director

### **PROGRAM SUMMARY**

[Engineering Design and Technical Communication](#) (EGR 101L) provides first-year students with the knowledge and experience needed to become successful engineers. Students work in a team to learn and apply the engineering design process to solve an open-ended, client-based problem drawn from a community partner. All first-year students entering the Pratt School of Engineering are required to enroll in the course.

#### **Course Outcomes**

Students completing the course should be able to:

1. Successfully solve a client-based design challenge by following steps in the engineering design process:
  - a. Define a client's need.
  - b. Complete a design context review.
  - c. Establish design criteria.
  - d. Generate solution ideas.
  - e. Select an appropriate solution using a decision matrix.
  - f. Iteratively prototype and build a physical, electronic or code solution.
  - g. Evaluate a solution against established design criteria.
2. Develop proficiency to safely deploy two or more prototyping strategies or engineering tools.
3. Work collaboratively on an engineering team to complete an engineering design project.
4. Write technical memos, present oral reports with supporting visuals and present a poster that captures critical decisions and steps during the engineering design process.
5. Apply project management skills.
6. Upon reflection, recognize the engineering process and technical content knowledge gained during the course.

### QUICK FACTS

Year founded: **2017**

Project source: **External clients**

Duration: **Semester-long**

Students per year: **400**

Interdisciplinary: **Yes**

Vertical integration: **No**

An important, defining feature of the course is that student teams solve problems that are sourced from community partners. Those partners include other university-affiliated groups, local non-profits and local companies. Popular project themes include: medical, environmental, design for individuals with disabilities, animals, infrastructure and educational. Example projects are shown on the below table, together with client, project goal and general theme. Clients are sourced from the community through a range of methods. First-Year Design team members reach out to possible partners to discuss projects and needs; community members hear about the program and reach out to a team member; or community members (especially alumni) reach out to the Pratt School and get connected to a team member.

Client	Project	Project goal	Project theme
Duke Physical Therapy	Colonic Massage	Develop a hand-held device to assist patients with arthritis in performing colonic massage	Medical
NC Zoo	Moss Dispensing System for Puffins	Dispense moss at varied distances and intervals for the horned puffins at the North Carolina Zoo	Animals
B3 Library	Coffee Lid Applicator	Create a device to help individuals with low hand strength to apply a lid to a coffee cup	Design for Individuals With Disabilities
Ellerbe Creek Water Association	Creek Trash Collector	Design a device that helps volunteers float trash down the creek for disposal	Environmental
Bell and Howell	Motorized Door Spool	Create a device to remotely close the door of a grocery pickup system	Infrastructure
Chapel Hill Public Library	Sensory Walk	Create and install an interactive display for trail visitors of all abilities	Educational

EGR 101L uses the flipped classroom model by delivering lectures outside of the class (topic-based videos, online quizzes) so that class time can be spent working in teams to solve engineering design challenges. Course sections meet in one of two maker-space classrooms. Each space is outfitted with myriad tools and resources. Spaces include worktables and benches; power tools and rapid prototyping machines (laser cutters and 3D printers); a pegboard with an array of hand tools; and fully stocked shelves and cabinets loaded with low- to medium-fidelity supplies that teams use to construct projects from paper to prototype. Additionally, soldering and sewing stations, a woodshop and a media room for private meetings are all nearby. The first half of the semester is devoted to defining the design problem; researching the problem and solution space by developing a design context review; establishing design criteria or specifications; brainstorming solutions; using a rigorous decision matrix to select a solution; and then describing the selected solution in more detail. During the second half of the semester, student teams focus on physical prototype development, iteration and testing with the goal of meeting the established design criteria. This “build” aspect of the course is critical to address the clients’ problem; it also allows students to develop important skills through an iterative process of learning.

As students engage with the engineering design process, they simultaneously learn how to communicate their ideas in a variety of formats: technical memos, oral presentations and posters. Technical memos require precise technical language supported with numerical values and justified by clear technical reasoning. Presentations are held at various times throughout the semester to update peers, clients and mentors on the status of a project. Sharing a stage, teams learn how to project professionalism and energy, maintain stance and posture, convey their ideas through a narrative arc and use effective gesturing.

## RESOURCES AND ADMINISTRATIVE MODEL

EGR 101 is a required course for all incoming Pratt students. The vast majority enroll during the fall semester (approximately 350 students) in one of eight sections. As a result of scheduling challenges, approximately 20–30 students enroll in one section in the spring semester. The director of the program reports to the dean of the Pratt School of Engineering.

Funds for the program are supported from a budget provided by the School of Engineering. Costs are personnel- and non-personnel-related. Two faculty and three staff members comprise the administrative leadership team. Approximately 50 student staff (typical teaching assistants and technical teaching assistants) are an integral part of our team. Undergraduate students hold this role. They apply and are selected after an in-person interview. Student staff focus on supporting teams through the prototype process with an emphasis placed on safety. Lab supplies and materials are purchased to stock the two maker-space classrooms. In addition, each team receives a budget, and on average each team spends \$150 to cover prototyping materials. A small stipend is paid to consultants, or “technical mentors,” who work with each team. Instructors volunteer and are selected to teach a section of EGR 101 in exchange for a department-specific course. Each section is co-taught. Finally, students are provided with a “workbook” that serves as the required text for the course.



Student team installs an otter playground at the NC Zoo.

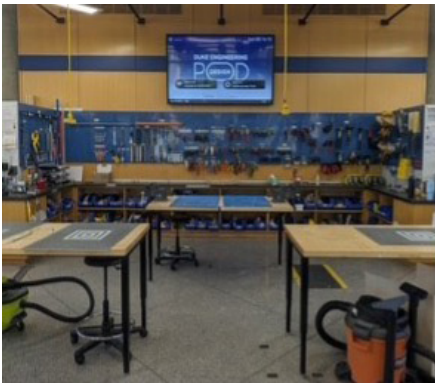
## BEST PRACTICES AND LESSONS LEARNED

The success of the program is driven by a few components: 1) finding high-quality, student-centered instructors; 2) identifying the appropriate number of client-based projects that involve a reasonable scope for first-year students; and 3) providing sufficient administrative support. Team leaders are passionate about engineering education; organized; solutions-oriented; and driven to impact and improve the student experience. During the fall semester the instructor team meets with the First-Year Design leadership team on a bi-weekly basis, allowing instructors to learn from one other by discussing key components of the course and sharing teaching strategies.

This course requires a significant amount of preparation and oversight with a course management system (CMS). The course itself has many moving parts, assignments and points of online interaction for students. Course sections are set up within a CMS (at Duke, Canvas) and must be monitored daily. Client communication is another area of importance. The leadership team must collaborate and communicate with different constituents, some of whom are familiar with the University, and some of whom who are not, requiring nuanced and audience-centered communication to cultivate and maintain community partnerships.

At the conclusion of each fall semester, 10–15 student teams (of ~75 teams) continue to EGR 102: Design to Deliver. This elective independent study course is the right fit for student teams that want to continue testing and refining their prototype. These continuing team members are passionate about engineering design and meeting the clients' needs. Often, teams enrolled in this course attend research conferences to share their prototype with the appropriate audience.

## CHALLENGES AND PRIORITIES FOR THE FUTURE



One of the EGR 101 lab classrooms

This program aims to continue delivering a high-quality experience for first-year students by focusing on the implementation of course learning outcomes. Recruitment of appropriate new projects and clients, while also strengthening existing relationships, requires significant effort. Looking ahead, we would like to involve more Duke alumni as clients, even if those individuals are not located in Durham. We also strive to deliver as many prototypes as possible to clients. Student teams have varied levels of success finishing fully workable prototypes. Even when prototypes do not meet client specifications, we would like to ensure each client receives

plans, a poster presentation or a high-fidelity prototype. Finally, we also strive to leverage the course as a springboard for a continued interest in design work, and as a result, professional development for students.

**Duke University's Pratt School of Engineering is a highly ranked educational and research institution focused on providing engineering in service to society. To its more than 3,200 students, it offers six undergraduate majors (including a customizable interdisciplinary option), 18 specialized master's degree programs and four doctoral programs.**