Engineering Design Minor Proposal (EDES)

Overview of the Engineering Design Minor
The Rice University George R. Brown School of Engineering is committed to advancing the education of its undergraduate students. With nine departments in the School of Engineering, the areas of study, research, and specialization are broad. However, all departments in the School of Engineering teach the design process, even though its application and emphasis varies between departments. The purpose of the minor is to enable our students to meet the growing interest by employers in students with authentic engineering design credentials. By implementing the minor we will keep Rice at the forefront of engineering design education. When we opened the OEDK in 2009 we were one of the first universities to create such a comprehensive, multidisciplinary facility focused on enabling authentic engineering design efforts from all engineering students. We have become a model that many universities such as UC Berkeley, Johns Hopkins, UT Austin, Vanderbilt, Boston University, and many others are working to emulate by building similar facilities.

A number of leading universities with strong engineering programs have launched engineering design minors. Schools with minors include Carnegie Mellon University, Dartmouth, and Ohio State; Northwestern University currently has a certificate option and a Bachelor of Science in Manufacturing and Design Engineering. University of California-Berkeley is currently conducting surveys of students who are interested in having a minor in Design Innovation. As far as we can find, other peer universities to Rice do not yet have cross-disciplinary engineering design programs or minors. Rice is known nationally as a leader in engineering design due to the early creation of the OEDK and its integration into courses across departments and all levels of students. By adding this academic minor, we will keep ourselves at the forefront of engineering design education nationally. Thanks to the effort and investment that has already been made in the Oshman Engineering Design Kitchen, the incremental cost of offering the minor in Engineering Design is modest and will allow Rice to maintain its position as a leader in engineering design education.

Defined simply, engineering design is the process of creating a new product or process to meet a defined need while taking into account constraints such as cost, practicality, and safety. The design process begins with creating an open-ended problem statement to address an unmet need. Through careful consideration of existing solutions and other research, students establish goals that the design should meet. Following a period of brainstorming, students select ideas that best meet the design goals. Building and testing the device is challenging and forces students to apply their ‘book knowledge’ (e.g., equations) to develop a physical or computational solution. A proof-of-concept prototype usually needs extensive revision and testing before it can be manufactured at scale. Throughout the design process, project planning and communication are essential. Because solving engineering challenges is often open-ended, it is very important to give students many opportunities to experience the steps in the process.
OEDK Training Leaders in Engineering Design

The Oshman Engineering Design Kitchen (OEDK) opened at Rice in December 2008. The purpose of the OEDK was to reduce the barriers for students in the School of Engineering to accomplish their engineering design tasks by providing tools, equipment, supplies and a workspace for teams to use as they worked on their course projects. The OEDK underwent expansions in 2012 and 2015 that have resulted in a 22,000 square foot facility with 76 student work tables, 3D printers, laser cutters, an electronics laboratory, and a machine shop. Figure 1 shows a team of students working on their design project.

Originally, the OEDK users were mostly students in capstone engineering design courses. Very quickly, it became clear that engineering students wanted to have the opportunity to work on engineering design projects starting in their freshman year. Starting in the spring of 2011, a new course, ENGI 120: Introduction to Engineering Design was offered. In this course, students learn the engineering design process by working on real-world projects from clients such as the Houston Zoo, Shriner’s Hospital for Children, the City of Houston, and local industry. The demand for this course has grown quickly and enrollees have grown from 20 to between 120-140 students per year with fall offerings having a long waitlist. Figure 2 shows the growth on overall OEDK users since 2008.

In order to meet further demand from students who have wanted to continue deeply engaging in engineering design, the OEDK has sponsored three additional courses. ENGI 200 and 300 are courses that are guided independent study courses to allow students to continue to work on and ultimately deliver projects from ENGI 120 or another course. ENGI 210 is a skills-based prototyping course. We have seen numerous examples of students and teams who have focused deeply on engineering design alongside their regular engineering major. These students have delivered final projects to clients, conducted clinical trials, written scholarly journal articles, applied for and received grants to continue their work, competed successfully in undergraduate entrepreneurship competitions and built a valuable set of leadership, design and communication skills in the process (See Appendix C for more information). These are skills that the industry partners of the OEDK tell us they seek in their engineering candidates for employment. Often the projects the students tackle have become defining experiences of their
entire undergraduate careers. These students are requesting options for obtaining academic credentials to indicate their excellent skills in engineering design. With such credentials, they will be able to demonstrate future graduate schools and employers these enhanced skills.

**Proposed Scope of Engineering Design Minor**
With careful consideration of the curricular requirements of the ABET accredited engineering departments, the School of Engineering has determined that there are opportunities to expand and enhance the learning and practice of design for interested students. In many engineering programs, design requirements are often focused on the senior year, and many students have only that one design-build opportunity. As described above, the freshman design course (ENGI 120) has whetted the appetite of many students, who have taken additional elective courses in design and related areas. The proposed program has been designed to enhance all engineering majors, but we believe it will be particularly of interest to students in Mechanical Engineering, Electrical and Computer Engineering, Chemical Engineering, Material Science and Nanoengineering, Civil & Environmental Engineering, and Bioengineering (~63% of engineering students who have declared a specific major). The proposed program is a multidisciplinary, four-year program that deepens and refines the education of engineering students with an interest in engineering design.

**Relationship Between EDES Minor and Existing Degree Programs**
The Engineering Design minor is meant to complement existing B.S. and B.A. degree programs in the School of Engineering and is open to any student earning a major in any department in the School of Engineering. The program is not designed for students outside the School of Engineering because applied engineering practice is expected in the higher-level courses- and this knowledge will come from student’s work in their engineering majors. A strength of the minor is that students from many different departments will work together on projects in highly collaborative, multi-disciplinary teams. Students will come out of these experiences with enhanced engineering skills as well and leadership and communication skills that will serve them well in any future endeavor.

**Student Learning Outcomes for the EDES Minor**
The learning outcomes associated with earning the minor are as follows:
1. Students execute steps of the engineering design process including problem identification, needs assessment, context review, defining design criteria, idea generation, solution selection, iterative prototyping, and testing.
2. Students are familiar with other steps of the engineering design process including market assessment, design for manufacturing, field testing, and implementation.
3. Students apply technical knowledge from their major within the School of Engineering to solve a design challenge.
4. Students develop breadth in design by working on at least two different design projects.
5. Students work in multiple teams, filling the role of a team member and a team leader.
6. Students apply project planning tools to guide design projects.
7. Students effectively communicate their design problems and solutions through written, oral and visual communication tools to a wide variety of audiences.
8. Students are proficient in low and high fidelity physical and digital-based prototyping.
An Integrated Course of Study
The proposed minor in Engineering Design capitalizes on strengths in engineering design at Rice- both innovative and successful engineering design courses and unsurpassed facilities that are available for undergraduate engineering students starting in their freshman year. Students may begin the minor in their freshman year and take course throughout their course of study. The skills they gain will complement their academic major and provide a deep understanding and skill set to successfully embark in engineering design careers.

Students will complete 18 academic credits in engineering design to earn the minor. There are four core courses each at 3 credit hours that are required for every student in the minor:
- ENGI 120 (or ENGI 220 or FWIS 188) – Introduction to Engineering Design (3 credit hours)
- ENGI 210 – Prototyping and Fabrication (3 credit hours)
- ENGI 350* – Problem Identification and Implementation (3 credit hours)
- ENGI 355* – Digital and Computer Aided Design OR MECH 403 (3 credit hours)
  *Denotes NEW course with tentative number

ENGI 220 is identical in content to ENGI 120 except that it is focused on students who are not in their matriculation year. As such students can begin the minor after their first year on campus if they decide later to pursue the minor.

Students take at least two elective courses, worth a total of 6 credit hours. The current list of elective courses is:
- Departmental design or project-based courses, excluding capstone or final-year design, with approval. Examples of such design-based courses include but are not limited to BIOE 360, CEVE 314, ELEC 491, MECH 488, ELEC 342, and CHBE 490.
- ENGI 200 – Engineering Design Studio
- ENGI 300 – Engineering Design Workshop
- PSYC 370 – Introduction to Human Factors and Ergonomics
- ENGI 315 – Leading Teams and Innovation
- BUSI 221 New Enterprises
- BUSI 463 – Foundations of Entrepreneurship: Strategy and Financing

One additional requirement for the minor is that students must participate in at least two different design projects during their undergraduate experience. This requirement is in place to ensure that students have some breadth in their practice of design. This can be satisfied by taking the courses above and/or capstone design. Note that while in-major, departmental capstone design courses (e.g., BIOE 451-2, MECH 407-8, ELEC 494, etc.) may NOT count as an elective, a project in this course may count as a second design project. For example, a student may work on one project in ENGI 120 and 200 and then a different project in their capstone CHBE 404 course. Table 1 shows a sample academic plan for completing the Engineering Design Minor.
Table 1. Sample academic plan for completing the minor. Note that students may complete courses any time during their academic careers as long as they satisfy prerequisites.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Course Numbers and Titles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>ENGI 120 – Introduction to Engineering Design</td>
</tr>
<tr>
<td>Year 2</td>
<td>ENGI 210 – Prototyping and Fabrication</td>
</tr>
<tr>
<td></td>
<td>ENGI 350 – Project Identification and Implementation</td>
</tr>
<tr>
<td>Year 3</td>
<td>ENGI 355 – Digital and Computer Aided Design</td>
</tr>
<tr>
<td></td>
<td>Elective 1</td>
</tr>
<tr>
<td>Year 4</td>
<td>Elective 2</td>
</tr>
<tr>
<td></td>
<td>Capstone Design, as specified by the department (not a minor requirement)</td>
</tr>
</tbody>
</table>

The existing or proposed course descriptions for all the above courses are given in Appendix A. The curriculum map shown in Table 2 indicates how courses meet the established learning outcomes.

Table 2. Curriculum map defining the link between curricular requirements in the core courses and established student learning outcomes.

<table>
<thead>
<tr>
<th>Student Learning Outcome</th>
<th>ENGI 120/220 or FWIS 188</th>
<th>ENGI 210</th>
<th>ENGI 350</th>
<th>ENGI 355 or MECH 403</th>
<th>2 required design projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students execute steps of the Engineering Design Process- including problem identification, needs assessment, context review, defining design criteria, idea generation, solution selection, iterative prototyping, and testing.</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2. Students demonstrate knowledge of the other steps of the engineering design process including market assessment, design for manufacturing, field testing, and implementation.</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Students apply technical knowledge from their major within the School of Engineering to solve a design challenge.</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. Students develop breadth in design by working on at least two different design projects.</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. Students work in multiple teams, filling the role of a team member and a team leader.</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Students apply project planning tools to guide design projects.</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
7. Students effectively communicate their design problems and solutions through written, oral and visual communication tools to a wide variety of audiences. X X X X

8. Students proficiently create low and high fidelity physical and digital-based prototyping. X X

Assessment Plan

In coordination with the Office of Institutional Effectiveness, we have developed an Engineering Design Minor Assessment Plan. Our assessment will be based on embedded work from the courses for the minor. Faculty who teach these courses will be responsible for assessing the outcomes via the work assigned in their classes. Course faculty will report to the Faculty Advisory Board (FAB) with de-identified student performance numbers to ensure that students are meeting established targets.

Grading rubrics that quantitatively and qualitatively measure the EDES Learning Outcomes will be used in EDES courses. These rubrics will be created in conjunction with the EDES FAB and will be verified to be compliant with the stated course and minor learning outcomes. Once per year the FAB will review rubrics and other graded work from these core courses by reviewing course materials that will be archived on OwlSpace or SVN. Revisions to course content may be suggested or required by the EDES FAB, to ensure that students are meeting established learning outcomes. Many members of the FAB are well versed in ABET and SACS accreditation, so methods and processes for assessment and continuous improvement are familiar.

Table 3 includes all the details of the assessment plan for the first 2 years of the minor. After that, we will evaluate 2 core courses each year. With this schedule, we will evaluate all the course courses associated with learning outcomes every three years.

The Office of Institutional Effectiveness has reviewed the proposal and has found the learning outcomes, the curriculum map and the assessment plan to be acceptable. See Appendix E for the emails containing is assurance.
Table 3. Detailed assessment plan for each of the 8 learning outcomes.

* Engineering faculty in this program typically grade so that a 70% is around a B grade.
* Only work that contains students in EDES minor will be evaluated.

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Embedded location</th>
<th>Materials</th>
<th>Measure</th>
<th>Standard*</th>
<th>Responsible</th>
<th>Timeline^</th>
<th>Who receives results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students execute steps of the Engineering Design Process- including problem identification, needs assessment, context review, defining design criteria, idea generation, solution selection, iterative prototyping, and testing.</td>
<td>ENGI 120/220 or FWIS 188; 2 design courses</td>
<td>Technical memos #1-7 in ENGI 120/220</td>
<td>Particular aspects of grading rubrics for technical memos that assess quality of completion of tasks</td>
<td>≥70% of students score 70% or higher</td>
<td>2 members of EDES FAB</td>
<td>2017, every 3 yrs following</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>2. Students demonstrate knowledge of the other steps of the engineering design process including market assessment, design for manufacturing, field testing, and implementation.</td>
<td>ENGI 210; ENGI 350</td>
<td>Technical memos in ENGI 350</td>
<td>Particular aspects of grading rubrics for technical memos that assess quality of completion of tasks</td>
<td>≥70% of students score 70% or higher</td>
<td>2 members of EDES FAB</td>
<td>2019, every 3 yrs following</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>3. Students apply technical knowledge from their major within the School of Engineering to solve a design challenge.</td>
<td>ENGI 350; 2 design courses</td>
<td>Final report and/or poster from design courses</td>
<td>Faculty-created rubric that tracks evidence of applied engineering knowledge in field.</td>
<td>80% of students apply two or more technical fields in design project including from their major</td>
<td>2 members of EDES FAB</td>
<td>Annually during degree audit-reviewed for all students completing minor</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>Learning Outcome</td>
<td>Embedded location</td>
<td>Materials</td>
<td>Measure</td>
<td>Standard*</td>
<td>Responsible</td>
<td>Timeline^</td>
<td>Who receives results</td>
</tr>
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</tr>
<tr>
<td>4. Students develop breadth in design by working on at least two different design projects.</td>
<td>ENGI 120/220 or FWIS 188; ENGI 350; 2 design courses</td>
<td>Students retain documents in a portfolio (e.g., reports, pictures) that demonstrate participate in two courses</td>
<td>Faculty-created rubric that confirms that student participated in 2 projects.</td>
<td>100% of students complete</td>
<td>2 members of EDES FAB</td>
<td>Every year - reviewed for all students completing minor during degree audit</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>5. Students work in multiple teams, filling the role of a team member and a team leader.</td>
<td>ENGI 120/220 or FWIS 188; ENGI 350</td>
<td>CATME results in ENGI 120/220 and ENGI 350</td>
<td>CATME results in ENGI 120/220 and ENGI 350</td>
<td>90% of students in minor score 0.8 or higher on CATME</td>
<td>2 members of EDES FAB</td>
<td>ENGI 120: 2017, every 3 yrs following: ENGI 350: 2019, every 3 yrs following</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>6. Students apply project planning tools to guide design projects.</td>
<td>ENGI 120/220 or FWIS 188; 2 design courses</td>
<td>Technical memo #8 in ENGI 120/220</td>
<td>Particular aspects of grading rubrics for technical memos that assess quality of completion of task</td>
<td>&gt;70% of students score 70% or higher</td>
<td>2 members of EDES FAB</td>
<td>2017, then every 3 yrs</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>7. Students effectively communicate their design problems and solutions through written, oral and visual communication tools to a wide variety of audiences.</td>
<td>ENGI 120/220 or FWIS 188; ENGI 210; ENGI 350; ENGI 355/MECH 403</td>
<td>Oral: Oral presentation in ENGI 350; Visual: Final CAD model in ENGI 355/MECH 403; Written: technical memo #9 in ENGI 120</td>
<td>Particular aspects of grading rubrics for written, oral and visual communication that assess quality of completion of task</td>
<td>&gt;70% of students score 70% or higher</td>
<td>2 members of EDES FAB</td>
<td>ENGI 120: 2017, then every 3 yrs; ENGI 350: 2019, then every 3 yrs; ENGI 355/MECH 403: 2019, every 3 yrs</td>
<td>Entire EDES FAB</td>
</tr>
<tr>
<td>Learning Outcome</td>
<td>Embedded location</td>
<td>Materials</td>
<td>Measure</td>
<td>Standard*</td>
<td>Responsible</td>
<td>Timeline(^{a})</td>
<td>Who receives results</td>
</tr>
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<tr>
<td>8. Students proficiently create low and high fidelity physical and digital-based prototyping.</td>
<td>ENGI 210; ENGI 355/MECH 403</td>
<td>Two physical prototypes in ENGI 210; Final CAD model in ENGI 355 or MECH 403</td>
<td>Particular aspects of grading rubrics for prototypes and models that assess quality of completion of task</td>
<td>≥70% of students score 70% or higher</td>
<td>2 members of EDES FAB</td>
<td>ENGI 210: 2018, then every 3 yrs; ENGI 355/MECH 403: 2019, then every 3 yrs</td>
<td>Entire EDES FAB</td>
</tr>
</tbody>
</table>
Minor Management & Administration

The EDES minor will be managed and overseen by the Engineering Design Minor Faculty Advisory Board (EDES FAB). The institutional home for the Engineering Design Minor is the School of Engineering.

The EDES FAB will make curricular decisions, including course content and emphasis, course elective options, and academic direction of the program. The EDES FAB will assess the strengths, weaknesses, and effectiveness of the program based on the following Student Learning Outcomes listed previously. EDES FAB membership represents a wide cross-section of departments in the School of Engineering and members have been active in engineering design education over the past 6+ years. A long-term goal is to have representation on the EDES FAB from at least six of the academic departments in the School of Engineering. The proposed EDES FAB is:

- Marcia O’Malley (Co-Chair), Professor MECH
- Joe Cavallaro, Professor ELEC
- Rafael Verduzco, Associate Professor CHBE
- Robert Griffin, Professor and Chair CEVE
- Jordan Miller, Ph.D, Asst. Prof, BIOE
- Rebecca Richards-Kortum, University Professor, BIOE
- Gary Woods, Professor in the Practice ELEC
- Ann Saterbak, Associate Dean of Engineering, Professor in the Practice BIOE
- Matthew Wettergreen, Lecturer OEDK
- Maria Oden (Co-Chair), Director of OEDK, Professor in Practice BIOE

A subset of the EDES FAB will serve on the Executive Committee. These faculty members will manage day-to-day administrative challenges, degree audits, and student advising in the minor. The proposed Executive Committee is:

- Marcia O’Malley (Co-Chair)
- Gary Woods
- Matthew Wettergreen
- Maria Oden (Co-Chair)

The OEDK will coordinate the administrative work for the minor. OEDK administrative personnel related to the minor currently consists of a 0.8 FTE administrative coordinator serving as the Engineering Design coordinator. This position exists and can take on these expanded duties although we may need to increase to 1.0 FTE. This increase will be funded by the OEDK.

Other Required Elements

The courses in the minor, course descriptions, as well as the names and rank of the faculty that are expected to teach the core and elective courses are listed in Appendix A.

Most of these classes are already in existence but two (ENGI 350 and ENGI 355) need to be
created or modified significantly from current offerings. Both proposed new courses are building on existing courses, specifically ENGI 350 will build on BIOE 392, and ENGI 355 will build on MECH 403 and BIOE 447. Faculty time to teach the both courses needs to be supported. OEDK is committing to 2 years of funding to teach these classes. After the 2 years, the School of Engineering dean’s office will work with OEDK to identify the resources needed to maintain these new courses.

Proposed Language for the General Announcements is contained in Appendix B. This minor meets all applicable rules specified in the General Announcements for minors. It is not possible to earn the minor simply by fulfilling degree requirements in any major or other minor.

**Answers to Expected Questions**
The engineering design minor proposing team has considered many issues in forming the plan presented in this document. We present here responses to questions that might be asked by the curriculum committee as they consider the proposal.

- **Who will take the minor?** We expect a modest number of students to complete this minor. We estimate 10-15 per year initially, perhaps growing to 20 per year. This is an important group of students who wish to have careers in engineering design. These students are taking many courses in design and/or are working though several years on design projects already. This minor is a deliberate way for us to develop their engineering design competencies rather than just having them take repeated independent study courses. The EDES minor should provide the appropriate breadth of knowledge and skills as well as a credential to move into industry.

- **How will busy engineering students have time to take this minor?** Students who will take the minor likely come to campus with some advanced placement credit in order to have time in their curriculum to take the courses. It is also possible for the students to take summer courses in order to meet general and departmental requirements and have room for the minor. Students may also use some of their free or technical electives within their degree program to complete the minor. This challenge is one of the reasons we expect to have a modest size minor. However, we also have a cadre of 5-10 students a year presently who are finding time in their schedule to do this work and would be obvious candidates for the EDES minor.

- **Does this overlap with Rice’s existing engineering degree programs?** None of the four core courses overlaps with any required core course in any department. Some of the elective courses in the minor may overlap with technical electives in a degree program or university distribution electives. Departments would need to consider whether these ENGI courses counted as technical electives; it is very unlikely that ENGI 120 and 210 would, as they are lower-level courses. This minimal overlap of courses is like other minors, such as the GLHT minor. It is not possible to obtain this minor by taking regular required and elective courses within any engineering degree program.

- **Are there too many non-tenure track faculty involved in this minor?** The faculty co-chair of the EDES FAB is a tenured professor in mechanical engineering. Several NTT faculty members in
a leadership role for the EDES minor are long-term members of the Rice University faculty. Many of these professors are locally and nationally recognized as leaders in teaching, pedagogy, and design education (e.g., Maria Oden, Ann Saterbak). Others in the group have substantial industry experience in the field of product and process design (e.g., Gary Woods, Matt Elliot). Teaching design is a very time-intensive endeavor and is well suited to faculty whose primary role is education.

• **Who has the academic and intellectual management of ENGI courses?** The School of Engineering School Course Review Committee will carefully review new courses for their academic rigor as well as appropriate content, assignments and assessments. Also, all ENGI courses within the minor will be reviewed on a yearly basis by the multi-disciplinary EDES FAB. This standard is more rigorous that most courses in ABET-accredited departments, which are reviewed every three to six years.

• **Is this a departmental or interdisciplinary minor?** We believe this should be evaluated as a departmental minor with the ‘department’ as the School of Engineering. As Dean, Ned Thomas serves as the supervising authority for the minor. We sought advice on this matter from Susan Macintosh as chair of the CUC in this matter.

**Conclusion**
The purpose of the proposed EDES minor is to support the intellectual development of students who seek in-depth knowledge and experience in the design process. Eight learning outcomes are fulfilled by the completion of 18 credit hours. The EDES minor requires four core courses (ENGI 120, ENGI 210, ENGI 350, ENGI 355) and two elective courses. Students must also participate in two separate design projects to ensure some breadth of engineering design practice. The EDES FAB is a diverse, talented group of engineering professionals who can ably steer the minor and advise students. In summary, the EDES minor is a unique opportunity for Rice to distinguish its graduates with the knowledge and skills of modern engineering design.
Appendices
## Appendix A

### Table A1: Minor in Engineering Design- Core Courses, 4 required

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
<th>Course Instructor and title:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 120 or ENGI 220 or FWIS 188</td>
<td>Students learn the engineering design process and use it to solve meaningful problems drawn from the community and around the world. Teams of students evaluate design requirements and construct innovative solutions in the Oshman Engineering Design Kitchen. Students develop teaming and communication skills.</td>
<td>Saterbak, Prof. in the Practice, Wettergreen, Lecturer and/or Loyo, Lecturer and/or Volz, Prof. in the Practice</td>
</tr>
</tbody>
</table>

**Pre-requisites:** None  
**Credit Hours:** 3  
**Enrollment Cap:** 40-45  
**Course Frequency:** Fall and Spring

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
<th>Course Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 210 - Prototyping and Fabrication</td>
<td>Students in ENGI 210 will learn and practice advanced prototyping and fabrication skills useful in the construction of physical objects for engineering design projects. The course is structured as lecture and demonstration of basic and advanced prototyping techniques and out-of-class work practicing and honing the application of these techniques. Example techniques include low fidelity prototyping, 2D and 3D Computer Aided Design, electronics, foam cutting, laser cutting, plasma cutting, 3D printing, and molding/casting methods. Students will individually apply these techniques to create physical objects. The course description and content of ENGI 210 will be altered to include design for manufacturing.</td>
<td>Wettergreen, Lecturer</td>
</tr>
</tbody>
</table>

**Pre-requisites:** ENGI 120 or 220 or instructor permission  
**Credit Hours:** 3  
**Enrollment Cap:** 12  
**Course Frequency:** Fall and Spring

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
<th>Course Instructor TBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG I 350* - Problem Identification and Implementation</td>
<td>Students in this course will identify needs situated in two or more environments. Students learn to ask questions that elucidate the problem, needed features and criteria for success. Students also develop testing and implementation plans for a refined design product that may include completion of an IRB protocol, bench-scale testing, and/or design of experiments.</td>
<td></td>
</tr>
</tbody>
</table>

**Pre-requisites:** ENGI 120 or 220 or instructor permission  
**Credit Hours:** 3  
**Enrollment Cap:** 20  
**Course Frequency:** TBD
**Course Number and Title**
ENGI 355* – Digital and Computer Aided Design

**Course Instructor TBD**

**Course Description:** Students will acquire basic to intermediate digital design proficiency for engineering-related design applications. Programs for the design of engineering prototypes include reverse engineering of physical objects, computer-aided design, and parametric modeling to create virtual models. Students will create CAD models for machining purposes, visualization of designs, and advanced manufacturing.

**Pre-requisites:** ENGI 120 or 220 or instructor permission

**Credit Hours:** 3  
**Enrollment Cap:** 20  
**Course Frequency:** TBD

---

**Table A2: Minor in Engineering Design- Elective Courses, 6 credits in at least 2 courses required**

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description: Seminar-style introductory design course covering epidemiology, pathophysiology, health systems, health economics, medical ethics, humanitarian emergencies, scientific and engineering design methods, and appropriate health technology case studies. To register, you must be enrolled in the GLHT minor and submit a 250 statement to <a href="mailto:beyondtraditionalborders@rice.edu">beyondtraditionalborders@rice.edu</a> by Monday of preregistration. The minor and course prerequisite is waived for students majoring in Bioengineering. Instructor Permission Required. Cross-list: GLHT 360.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Number and Title</strong></td>
<td>BIOE 360 – Appropriate Design for Global Health</td>
</tr>
<tr>
<td><strong>Course Instructor</strong></td>
<td>Richards-Kortum, Professor</td>
</tr>
<tr>
<td><strong>Pre-requisites:</strong></td>
<td>GLHT 201 and instructor permission</td>
</tr>
</tbody>
</table>
| **Credit Hours:** | 3  
**Enrollment Cap:** 40  
**Course Frequency:** Spring |

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Vertically Integrated Projects (VIP) teams include students from multiple years working on one larger, multi-year project defined by the instructor. Students participating in VIP for 3 or more semesters may be eligible for the Distinction in Research and Creative Work graduation award. Instructor Permission Required. Graduate/Undergraduate Equivalency: ELEC 591. Repeatable for Credit.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Number and Title</strong></td>
<td>ELEC 491 – UG Electrical Engineering Research Projects- Vertically Integrated Projects</td>
</tr>
<tr>
<td><strong>Course Instructor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-requisites:</strong></td>
<td>(Note: Instructor permission required for enrollment)</td>
</tr>
</tbody>
</table>
| **Credit Hours:** | 1-6  
**Enrollment Cap:** |
<p>| <strong>Course Frequency:</strong> | Fall and Spring |</p>
<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHBE 490 – Chem Car Eng and Design</td>
<td>An engineering design course focused on the design and fabrication of a car powered by a chemical reaction</td>
</tr>
<tr>
<td>Pre-requisites:</td>
<td>(Note: Instructor permission required for enrollment)</td>
</tr>
<tr>
<td>Credit Hours:</td>
<td>3</td>
</tr>
<tr>
<td>Enrollment Cap:</td>
<td></td>
</tr>
<tr>
<td>Course Frequency:</td>
<td>Fall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 200 – Engineering Design Studio</td>
<td>Graduates of ENGI 120 and ENGI 220 will have the opportunity to gain a more in-depth knowledge of the engineering design process by furthering progress on specific engineering design projects. Students may extend their project work by completing advanced prototyping for their designs and conduct testing. Students will be held accountable through technical mentorship, weekly meetings, and prototype evaluations. Students will only work in design teams. Student teams wishing to continue their projects from ENGI 120/220 may apply. For application contact the instructor. Instructor Permission Required.</td>
</tr>
<tr>
<td>Pre-requisites:</td>
<td>ENGI 120</td>
</tr>
<tr>
<td>Credit Hours:</td>
<td>2-3</td>
</tr>
<tr>
<td>Enrollment Cap:</td>
<td></td>
</tr>
<tr>
<td>Course Frequency:</td>
<td>Fall and Spring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGI 300 – Engineering Design Workshop</td>
<td>Advanced design students will have the opportunity to further their design projects in an independent study course. Students will work with faculty to develop their own schedule, set their own deadlines, goals, and expectations to be met for grading purposes. Students may complete advanced prototyping for their designs, conduct tests, perform safety evaluations with external committee and/or write up their work for publication. The specific tasks that will be completed are dependent on the project needs. Students will be held accountable through technical mentorship, weekly meetings, and prototype evaluations. To be eligible for ENGI 300 students must have taken ENGI 120 (or equivalent), ENGI 210, and ENGI 200. Instructor Permission Required. Repeatable for Credit.</td>
</tr>
<tr>
<td>Pre-requisites:</td>
<td>(Note: Instructor permission required for enrollment)</td>
</tr>
<tr>
<td>Credit Hours:</td>
<td>3</td>
</tr>
<tr>
<td>Enrollment Cap:</td>
<td></td>
</tr>
<tr>
<td>Course Frequency:</td>
<td>Fall and Spring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Course Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Application of principles of psychology and human performance to the design of modern systems.</td>
</tr>
<tr>
<td><strong>Course Number and Title</strong></td>
<td><strong>Course Description</strong></td>
</tr>
<tr>
<td>----------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>PSYC 370 – Introduction to Human Factors and Ergonomics</td>
<td>Students learn the principles of engineering leadership, strategies for launching and leading engineering teams, and methods for utilizing creativity and innovation in engineering environments. Learning methods include case studies, simulations, group projects, and interactions with industry professionals. Graduate/Undergraduate</td>
</tr>
<tr>
<td>ENGI 315 – Leading Teams and Innovation</td>
<td></td>
</tr>
<tr>
<td>BUSI 462 - Foundations of Entrepreneurship: Toolkit</td>
<td>In this course, students will learn about a process for new technology venture development. Through experiential learning, students form teams and develop a plan for a new venture. Objectives include  1. identifying the customer,  2. performing effective primary market research,  3. clarifying a value proposition,  4. developing a customer acquisition strategy,  5. crafting a business model. At the end of this course, a student should know  1. how to translate a business model and the assumptions they make about their business into a bottoms up financial model that tells them about their cash flows, revenues, and EBITDA,  2. how to use that model to track performance and identify errors in the underlying assumptions, and adjust accordingly, and  3. how to update the model based on actual performance.</td>
</tr>
</tbody>
</table>
**Course Number and Title**
BUSI 463- Foundations of Entrepreneurship: Strategy and Financing

**Course Instructor**
Hochberg, Assoc. Professor

**Course Description:** This course provides an integrated strategy framework for entrepreneurs. The course is structured to provide a deep understanding of the core strategic challenges facing start-up innovators, and a synthetic framework for choosing and implementing entrepreneurial strategy in dynamic environments, as well as a general understanding of the financing options for early stage startups, including angel investment, accelerators, crowdfunding and the venture capital industry. A central theme of the course is that, to achieve competitive advantage, technology entrepreneurs must balance the process of experimentation and learning inherent to entrepreneurship with the selection and implementation of a strategy that establishes competitive advantage. The course identifies the types of choices that entrepreneurs must make to take advantage of a novel opportunity and the logic of particular strategic commitments and positions that allow entrepreneurs to establish competitive advantage. The course includes an in-depth overview of the organization, operation and economics of different funding sources; venture capital and angel investment term sheets and deal structures; startup investment methodology – deal sourcing, monitoring and liquidation; the role of VCs as key advisors and board members; and current issues in early stage financing as a result of a changing global and economic environment. The course combines interactive lectures, speakers and case analyses. The cases and assignments offer an opportunity to integrate and apply the principles taught in the course in a practical way, and draws from a diverse range of industries and settings.

**Pre-requisites:**

**Credit Hours:** 3  \hspace{1cm} **Enrollment Cap:** 60

**Course Frequency:** Spring
Tab 1: Department Info:

Co-Chairs
Maria Oden, Bioengineering
Marcia O’Malley, Mechanical Engineering

Executive Committee
Maria Oden, Bioengineering
Gary Woods, Electrical and Computer Engineering
Marcia O’Malley, Mechanical Engineering
Matthew Wettergreen, Oshman Engineering Design Kitchen

Minor Advisors
Maria Oden, Bioengineering
Ann Saterbak, Bioengineering
Gary Woods, Electrical and Computer Engineering
Marcia O’Malley, Mechanical Engineering
Matthew Wettergreen, Oshman Engineering Design Kitchen

Faculty Advisory Board
Jordan Miller, Bioengineering
Maria Oden, Bioengineering
Rebecca Richards-Kortum, Bioengineering
Ann Saterbak, Bioengineering
Robert Griffin, Civil and Environmental Engineering
Rafael Verduzco, Chemical and Biomolecular Engineering
Joe Cavallaro, Electrical and Computer Engineering
Gary Woods, Electrical and Computer Engineering
Marcia O’Malley, Mechanical Engineering
Matthew Wettergreen, Oshman Engineering Design Kitchen

Program (Undergraduate): Minor

Program (Graduate): N/A

Defined simply, engineering design is the process of creating a new product or process to meet a defined need while taking into account constraints such as cost, practicality, and safety. The design process begins with creating an open-ended problem statement to address an unmet need. Through careful consideration of existing solutions and other research, students establish goals that the design should meet. Following a period of brainstorming, students select ideas that best meet the design goals. Building and testing technologies is challenging and forces students to apply their ‘book knowledge’ (e.g., equations) to develop a physical or computational solution. A proof-of-concept prototype usually needs extensive revision and testing before it can be manufactured at scale. Throughout the design process, project planning and communication are essential. Because solving engineering challenges is often open-ended, it is very important to give students many opportunities to experience the steps in the process.

The minor in Engineering Design capitalizes on strengths in engineering design at Rice—both innovative and successful engineering design courses and unsurpassed facilities that are available for undergraduate engineering students starting in their freshman year. Students may begin the minor in their freshman year and take courses throughout their duration of undergraduate studies. The skills they gain will complement their academic major and provide a deep understanding and skill set to successfully embark in engineering design careers.

As of September 9, 2016
Program Learning Outcomes for Minor in Engineering Design

Upon completing the minor in Engineering Design, students will be able to:

1. Execute steps of the engineering design process including problem identification, needs assessment, context review, defining design criteria, idea generation, solution selection, iterative prototyping, and testing.
2. Become familiar with other steps of the engineering design process including market assessment, design for manufacturing, field testing, and implementation.
3. Apply technical knowledge from their major within the School of Engineering to solve a design challenge.
4. Develop breadth in design by working on at least two different design projects.
5. Work in multiple teams, filling the role of a team member and a team leader.
6. Apply project planning tools to guide design projects.
7. Effectively communicate their design problems and solutions through written, oral and visual communication tools to a wide variety of audiences.
8. Become proficient in low and high fidelity physical and digital-based prototyping.

Requirements for the Minor in Engineering Design

Students pursuing the minor in Engineering Design (EDES) must complete:

- A minimum of 6 courses (18 credit hours) to satisfy minor requirements.

Students are encouraged to begin taking courses in the minor their freshman year and are encouraged to declare the minor no later the beginning of their fifth semester.

CORE REQUIREMENTS

Students must complete the following 4 courses (12 credit hours) to satisfy the Core Requirements for the minor in Engineering Design.

- ENGI 120 Introduction to Engineering Design [ 3 credit hours ]
  or ENGI 220 Introduction to Engineering Design II [ 3 credit hours ]
  or FWIS 188 Introduction to Engineering Design and Communication II [ 3 credit hours ]
- ENGI 210 Prototyping and Fabrication [ 3 credit hours ]
- ENGI 350 Problem Identification and Implementation [ 3 credit hours ]
- ENGI 355 Digital and Computer Aided Design [ 3 credit hours ]
  or MECH 403 Computer Aided Design [ 3 credit hours ]

ELECTIVES

To fulfill the remaining requirements for the minor in Engineering Design, students must complete a minimum of 2 additional courses (minimum of 6 credit hours). Please note: The courses listed below are approved to satisfy the requirements for the EDES minor for the 2017-2018 academic year only. Courses not on this official list may be substituted upon approval of the minor’s academic advisor. Students and their academic advisors should identify and clearly document the courses to be taken.

- BIOE 360/GLHT 360 Appropriate Design for Global Health [ 3 credit hours ]

As of September 9, 2016
GENERAL ANNOUNCEMENTS 2017-2018 (Proposed)

Engineering Design

The George R. Brown School of Engineering

- BUSI 221: New Enterprises [3 credit hours]
- CEVE 314/BIOE 365/GLHT 314 Sustainable Water Purification for the Developing World [3 credit hours]
- CHBE 490 Chemical Car Engineering and Design [3 credit hours]
- ELEC 342 Analog Electronic Circuits [3 credit hours]
- ELEC 491 Undergraduate Electrical Engineering Research Projects – Vertically Integrated Projects [1-6 credit hours]
- ENGI 200 Engineering Design Studio [2-3 credit hours]
- ENGI 300 Engineering Design Workshop [2-3 credit hours]
- ENGI 315 Leading Teams and Innovation [3 credit hours]
- MECH 488 Design of Mechatronic Systems [3 credit hours]
- PSYC 370 Introduction to Human Factors and Ergonomics [3 credit hours]
- Departmental design or project-based courses, excluding capstone or final-year design, with approval.

ADDITIONAL REQUIREMENT

One additional requirement is that students must participate in at least two different design projects during their undergraduate experience. This requirement is in place to ensure that students have some breadth in their practice of design. This can be satisfied by taking the courses above and/or capstone design. Note that while in-major, departmental capstone design courses (e.g., BIOE 451 and BIOE 452, MECH 407 and MECH 408, ELEC 494, etc.) may NOT count as an elective, a project in these courses may count as a second design project. For example, a student may work on one project in ENGI 120 and 200 and then a different project in their capstone CHBE 404 course.

Admission

Students who are pursuing a B.A. or B.S. degree in the School of Engineering are best prepared to pursue the minor in Engineering Design. Many courses that can be applied towards the minor requirements are open to all Rice students, including those not pursuing the minor in Engineering Design. For ENGI 200 and ENGI 300, students must explain their interest and reasons for taking the course in order to gain instructor permission. Preferential admission will be given to students who indicate they are seeking to complete the minor in Engineering Design. For information on EDES minor declaration, visit oedk.rice.edu/minor.

Descriptions and Codes Legend

Note: Internally, the university the following abbreviations (4-digit codes) to identify the undergraduate minor in Engineering Design. The following is a quick reference:

Course Catalog/Schedule
- Course offerings/subject code: Courses from various subjects may apply toward the minor.

Department Description and Code
- Oshman Engineering Design Kitchen: OEDK

Minor Description and Code
- Minor in Engineering Design: EDES

As of September 9, 2016
Engineering Design

The George R. Brown School of Engineering

**Tab 3: Graduate Requirements**

Graduate Requirements

The Minor in Engineering Design does not currently offer an academic program at the graduate-level.

**Tab 4: Graduate Requirements**

Course Listings

The official course offerings, including course descriptions, listed in the Engineering Design Undergraduate Requirements section can be found in [Rice's Course Catalog](#).

To view the most recent course schedule for the 2016-2017 academic year, see [Rice's Course Schedule](#).

For additional information regarding engineering design at Rice, see the department's website: [oedk.rice.edu](#).
Appendix C: Examples of long-term successful design teams

**R-ARM: Robotic Assistive Reaching Mechanism (sponsor: Shriners Hospital)**

This team developed a two-joint robotic arm (R-ARM) that attaches to the back of a wheelchair. The R-ARM offers a means to grab objects up to 4.5 feet beyond the edge of the wheelchair and return the object back to the user. The R-ARM include a quick attach/disconnect mechanism, a foot pedal to release objects, and safety features. Material costs for the R-ARM are less than $1,000. The team filed a provisional patent filed, and worked with patients and physicians in the Texas Medical Center to receive feedback.

*Publications*


*Awards and Grants*

- National Collegiate Inventors and Innovators Alliance Stage 1 Grant, $5,000 (11/13-6/14)
- “Cure it!” Lemelson-MIT Student Prize – UG Student Team, finalist (1 of 5, 2014)
- BMEStart TREAT award (2014)
- NIH Debut Honorable Mention (2014)

*Key videos and media*

- [http://www.youtube.com/watch?v=N1jbEvhFzQM](http://www.youtube.com/watch?v=N1jbEvhFzQM)

**IV-DRIP: Dehydration Relief in Pediatrics (sponsor: Rice U Beyond Traditional Borders)**

This team developed the IV DRIP, a simple, low-cost, mechanical automatic volume regulator to deliver fluid from 1-L bags. The device stops the flow of fluid after the target volume has been dispensed, preventing over-hydration. Tests have shown that IV DRIP can deliver fluid volumes from 50 mL to 800 mL in 50 mL increments within 2.5% accuracy. This device solved the problem of the risk of over-hydration in intravenous therapy, which can lead to severe complications and death in the developing world. This project can completed a design for manufacturer and will soon begin clinical trials in Malawi.
Publications


Key videos and media

- [http://www.youtube.com/watch?v=VlED86BWPcE&feature=player_detailpage&list=PL0373A23703CA92AA](http://www.youtube.com/watch?v=VlED86BWPcE&feature=player_detailpage&list=PL0373A23703CA92AA)

Awards and Grants

- National Collegiate Inventors and Innovators Alliance Stage 2 Grant, $20,000 (2/13-10/14)
- National Collegiate Inventors and Innovators Alliance Stage 1 Grant, $5,000 (11/12-6/13)
- NIH Biomedical Undergraduate Teams (DEBUT) challenge, recipients of Technology to Aid Underserved Populations Award (2013)

**Modified Wheelchair for Individual with Arthrogryposis (sponsor: Shriners Hospital)**

This team created a modified wheelchair for Pedro, a teenager with severe arthrogryposis. The team modified an existing wheelchair by adding Wijit Wheels as the internal hubs. Lap bars and paddle shifters allow for Pedro to interact with the chair. The spring return and braking system were also customized for Pedro. Two years after delivery, Pedro uses his wheelchair daily. It has significantly improved his independence, allowing him mobility without assistance of a family member or friend.

Publications


Key videos and media

Appendix D: Letters of Support
April 19, 2016

Dear Committee on the Undergraduate Curriculum:

The creation of an Engineering Design Minor as a departmental minor within the George R. Brown School of Engineering is a very good idea and I am fully supportive. I have worked with Drs. Oden, O’Malley, Saterbak and Wettergreen to make sure the proposal fulfills many of the long term goals of the school. The creation of this minor would constitute an additional growth of our commitment to engineering design, preparing our students for employment as engineers, particularly in the areas of design and innovation. Companies interested in hiring our students are definitively looking for the learning experiences that this minor will provide.

This minor will be a very valuable addition to the academic options for Rice engineering. Indeed, many students are already seeking these opportunities on their own. The minor will provide additional credentials to those students along with a course framework that will broaden their knowledge and experience in engineering design.

The George R. Brown School of Engineering is the ideal home for this minor. The minor is similar to a departmental minor as it is a focus area within engineering. We envision that it will be of interest to students across many of the departments within the school. There are only a few engineering design minors offered at other academic institutions. With this minor, Rice Engineering will be one of the leading institutions in a larger group of schools that will ultimately offer a minor. For example, University of California- Berkeley is currently conducting surveys and focus groups to evaluate the creation of a minor in engineering design. The School of Engineering and the Oshman Engineering Design Kitchen are committed to offering the required courses with sufficient frequency to fulfill the requirements within a four-year period. The four core courses in the minor are offered either every semester (in the case of ENGI 120 and ENGI 210) or every year (ENGI 350 and ENGI 355.) The OEDK is committing to fund faculty to teach the two new courses- ENGI 350 and 355) for the next 3 years. This commitment is for funding individual lecturers to teach individual courses. More ideally, the OEDK and the Deans Office would like to hire one full time lecturer who can fully integrate into the engineering design teaching faculty group. Our plan is to prioritize the addition on one permanently funded lecturer to be added to the OEDK A1 budget. The Deans office is committed to working with the OEDK and Rice Administration to solidify this funding for the long term.

Sincerely,

Edwin L. (Ned) Thomas, NAE
Dean of Engineering
May 20, 2016

Dear Committee on the Undergraduate Curriculum,

As the Chairs of Bioengineering, Chemical and Biomolecular Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering, Materials Science and Nanoengineering, and Mechanical Engineering we are pleased to support the development of a new minor in Engineering Design (EDES) based in the George R. Brown School of Engineering. The proposed minor offers Rice engineering undergraduates an exciting opportunity to deepen their knowledge and practical experience in engineering design. We expect this minor to be of interest to a subset of students in our departmental majors who would like to have careers in product development and engineering design.

The minor builds on the success of the Oshman Engineering Design Kitchen and efforts in the School of Engineering to engage freshmen in solving real-world design challenges early in their academic careers. We believe this minor will be a positive offering for the undergraduate curriculum. Nothing like this currently exists at Rice. There are students in our major programs who have demonstrated a significant interest in this minor through their efforts in ongoing, multi-semester design projects and who have already begun to take some of the courses that would form the minor. Faculty in our departments have served as mentors for design teams such as those in the proposed minor. We expect these faculty members to continue serving as mentors for teams as the need arises for their specific technical expertise.

We have reviewed the courses included in the minor and can confirm that students in our departments would not be able to earn the minor simply through careful selection of courses within our major degree programs.

By signing this letter we provide our support for the creation of the minor in Engineering Design.

Sincerely,

Michael Deem, Ph.D.
Bioengineering

Michael Wong, Ph.D.
Chemical and Biomolecular Engineering

Robert Griffin, Ph.D.
Civil and Environmental Engineering

Edward Knightly, Ph.D.
Electrical and Computer Engineering

Pulickel Ajayan, Ph.D.
Materials Science and Nanoengineering

Laura Schaefer, Ph.D.
Mechanical Engineering
Dear Committee on the Undergraduate Curriculum,

My name is Michaela Dimoff, and I am writing this letter to voice my support of the Engineering Design (EDES) minor currently being proposed.

I will begin by establishing myself as credible. I will graduate from Rice in May with a BS in bioengineering. I have been enrolled in engineering design classes for seven out of my eight semesters as an undergraduate. Moreover, I have TAed three semesters of ENGI 120, one semester of ENGI 200, and two summer sessions of the engineering design module that is taught during the Rice Emerging Scholars Program. At graduation, I will receive a Distinction in Creative Works for a project that was sponsored by the OEDK and was completed in conjunction with ENGI 300. I have also been the recipient of awards at both the 2016 and 2014 Engineering Design Showcases and presented two posters, both on engineering design projects, at the Biomedical Engineering Society national conference. I have accepted a position at General Electric’s Healthcare Division, in the Edison Engineering Development Program. My first rotation will be in a design engineering position on the Computed Topography hardware team and will begin in July 2016.

My support of the EDES minor can be best understood as a contrast to my typical attitude about minors and credentials at Rice. I hold the belief that Rice students tend to assume, incorrectly, that additional credentials will help them meet their long-term goals. When advising students about taking on additional minors or certificates, I challenge them to think deeply about the cost/benefit relationship for these credentials. For instance, will getting a business minor really make you a better MBA applicant, or would you be better served by taking those 10 hours a week and putting them towards a management position at a student run business? However, I think the EDES minor provides significant benefit at little additional cost (in terms of time and effort), particularly to Rice students who are intrinsically motivated to complete and deliver engineering design projects.

I applied for three positions at GE Healthcare, one each in my sophomore, junior, and senior years. I was rejected the first two times. I talked extensively with my interviewer (a Rice alumna) after my rejection junior year, and she stated that despite the wealth of engineering
design projects on my resume, GE was concerned that, as a bioengineering graduate from a traditionally theoretical engineering program, I would be unable to successfully complete mechanical engineering design projects. She even went as far as to state that if I had been able to say that I was working towards a official credential in engineering design, instead of just working on independent projects, I probably would have been selected for the position.

Finally, as our institution moves further into the twenty-first century, we must continue to ask ourselves what we provide students that they could not obtain through another platform, such as a massively open online course (MOOC.) By codifying and officially recognizing the work that is completed by Rice students engaged in engineering design, the EDES minor will further distinguish itself among its peer institutions as a leader in engineering design.

In conclusion, I fully support the EDES minor, because it would have added significant value to my Rice experience and because I believe it will add value to present and future Rice students. If you have any questions about my support of the EDES minor, please do not hesitate to contact me through the means listed below.

Regards,

Michaela Dimoff

Rice University, Class of 2016
Bioengineering, B.S.
Recipient, Distinction in Creative Works
Recipient, Graham C. Stubbins College Service Award
michaeladimoff@alumni.rice.edu
336.601.3862
May 16, 2016

The Committee on Undergraduate Curriculum  
c/o Dr. Z. Maria Oden  
Director, Oshman Engineering Design Kitchen  
6100 Main St.  
Houston, TX 77005

To Whom It May Concern:

I am writing this letter in support of a Minor in Engineering Design. Having graduated this May 2016 with a BA in Statistics, Distinction in Research and Creative Works, and eight semesters of work at the OEDK and in engineering design, I feel that I bring a thoroughly qualified student perspective to the conversation about a Minor in Engineering Design (MED).

Instead of addressing the facets of work necessary for a MED or the scope of such a program of study—these are covered in full in the proposal from the sponsoring faculty—this letter will address the myriad benefits and opportunities a MED would provide students.

During my time at Rice, I participated in freshman design, independent design continuing from ENGI 120, an internship at the OEDK, writing mentorship for ENGI 120 students, senior design, and an independent senior project. In each of these, I was faced with unique challenges: freshman year, the challenges were often team-based, groups of 18-year-olds often struggle to work together effectively and maturely, whereas senior year, many of my challenges were technical, discovering the best way to manufacture, machine or engineering a solution.

Though these experiences were diverse, each taught me valuable lessons, lessons that I wouldn’t have had the chance to learn without engineering design.\(^1\) Though my case is rather uniquely positioned to succeed with the independent projects later in my engineering design career at Rice—I built strong relationships with friends and mentors on the faculty and staff—that opportunity is not currently available to many of the undergraduates who would benefit from it.

A MED would provide continuous engagement for engineering undergraduates. It would provide a place for the development of skills that freshmen are excited but do not have the course structure to learn about. It would provide a course of study for innovative development on multi-year projects, the existence of which is currently rare.\(^2\)

A MED would provide deep understanding of the engineering design process. In ENGI 120, students are introduced to the engineering design process—an interactive cycle of design, building and revising—but that theme is then abandoned until senior year when students engage in senior design. This two-year gap is a critical flaw in the development of excellence in applied engineering.

---

1 Engineering design broadly, since there currently is not a formal program.
2 For instance, a multi-year project for a robotic arm for disabled patients created by Sergio Gonzalez, Nimish Mittal and Matthew Nojoomi earned national acclaim, but was only possible due to their unique motivation.
engineering. If engineering students are supposed to go and fix the world, but lack any sort of sensible design process how can we expect them to do this? Adding coursework and structure during the critical sophomore and junior years will allow for increased productivity and impact of projects across students’ four years.

Finally, a MED would allow students to solve unsolved problems. Across the engineering curriculum, students work on problems sets, tests and many group projects. These assignments have known solutions—and rightly so. However, equally productive is providing a pathway for students to do something no one else has, to solve an as-of-yet unsolved problem. The value of engineering design is that it allows the application of fundamental engineering principles (learned in the classroom) to problems students encounter in the real world. By working through multiple solutions to the problem, they learn the underlying fundamentals, but they also learn the soft skills (project management, team-building, etc.) that are critical to future success.

In each of these above points, you have read about gaps in the current undergraduate engineering curriculum. By offering a MED, the School of Engineering would take a step towards ensuring that our engineers of 2020 are prepared not just for the mental and theoretical challenges of an evolving workplace (or lab), but that they are ready to design innovative solutions to those problems from day one.

As I look back on my Rice experience, my most valuable developmental opportunities came from engineering design. I learned to be accountable; I learned to think differently; and I learned to work with all sorts of different people. Engineering design has taught me and many of my classmates the value of applied engineering.

In summary, engineering design has played a critical part of my and many of my classmates’ undergraduate experiences. A MED would provide and avenue for continuous engagement, deep understanding, and solve unsolved problems. I believe the MED to be the best avenue to increase these opportunities in the undergraduate engineering curriculum and such a minor would benefit students’ learning outcomes while cementing Rice’s place as a leader in engineering design.

Respectfully submitted,

Colin C. Shaw
B.A., Statistics
Certificate, Engineering Leadership
Class of 2016

\[3\text{ A summary of various speeches from President Leebron and Dean Thomas.}\]
Appendix E: Review by the Office of Institutional Effectiveness

From: John Cornwell [mailto:jmc4@rice.edu]
Sent: Tuesday, May 17, 2016 2:18 PM
To: Maria Oden
Cc: Stephanie Post
Subject: Re: minor in EDES

Maria,

We don’t issue formal letters.

You may affirm in your submission that OIE has reviewed the three components and found them acceptable.

best,

John Cornwell

On May 17, 2016, at 2:15 PM, Maria Oden <moden@rice.edu> wrote:

Thank you. Do we need a formal letter from you or should we use this in our submission?

On May 17, 2016, at 8:57 PM, Stephanie Post <post@rice.edu> wrote:

Maria,

The OIE components of the proposal look good. The OIE is satisfied with the learning outcomes, the curriculum map, and the assessment plan.

Good luck with the proposal.

Stephanie

On May 15, 2016, at 10:45 AM, Maria Oden <moden@rice.edu> wrote:

Thank you. The body of the proposal is there. We are literally awaiting one more faculty member to agree to serve on the FAB and a letter signed by dept chairs. This is not a letter that is required per the guidelines but is desired to show interest. I look forward to hearing from you.

Maria

Z. Maria Oden, Ph.D.
Professor in the Practice, Department of Bioengineering
Director, Oshman Engineering Design Kitchen,
George R. Brown School of Engineering
Maria,

Sounds like you all are almost ready. I am copying John Cornwell on this email. We will talk tomorrow and let you know if we need anything else for the OIE review of the application.

I hope you are doing well.

Stephanie

Sent from my iPhone

On May 15, 2016, at 4:50 AM, Maria Oden <moden@rice.edu> wrote:

Stephanie-

Thank you for your previous feedback on the Engineering Design Minor proposal. We have incorporated your requested changes and have included a learning outcomes/assessment plans table in the body of the application.

We are getting very close to being ready to submit this proposal to the CUC for a minor in engineering design. We are waiting for comments and acceptance of the role in the EDES-FAB (our faculty advisory board from one person. All have reviewed and suggested edits. We have our letter from Dean Thomas and are getting signatures on a letter from 6 department chairs. We also need the letter from your office. After that we will be ready to submit.

I think it is time for your office to do its formal review unless you tell us you need something more. The latest proposal is attached. Thanks so much.

Maria

Z. Maria Oden, Ph.D.
Professor in the Practice, Department of Bioengineering
Director, Oshman Engineering Design Kitchen,
George R. Brown School of Engineering
Rice University
The table is included with your proposal.

Stephanie

On Apr 14, 2016, at 10:46 AM, Maria Oden <moden@rice.edu> wrote:

Quick question Stephanie-

Do we embed this table into our plan or just fill it out for your office?

Z. Maria Oden, Ph.D.
Professor in the Practice, Department of Bioengineering
Director, Oshman Engineering Design Kitchen,
George R. Brown School of Engineering
Rice University

Maria,

Attached is the assessment plan template that we discussed on the phone yesterday. I shared the proposal with John Cornwell, so he can give you feedback on the proposal.

Best,

Stephanie

<EDES Minor_17.docx>