A Jewel in the Crown II
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7. ABET Accreditation of The Institute’s Optical Engineering Degree

Andrew J. Berger

The BS degree in optics from The Institute of Optics has been a stamp of quality since the department’s founding. Why on earth, then, did the department recently feel the need to create a second undergraduate degree in optical engineering? It wasn’t as if our undergraduates were having any trouble getting industry jobs. And furthermore, why did the department take the (huge) extra step of getting the new degree accredited? After all, as a flagship undergraduate program in optics, the Rochester BS degree did not need the accreditation to bolster its credibility within academia or industry.

In the early 2000s, however, a number of forces started pushing The Institute of Optics in this unexpected direction. One nuisance was that undergraduate optics
majors were being excluded from awards and honors for which they had traditionally competed. Tau Beta Pi, the engineering honors society, adopted a rule requiring new inductees to have the word “engineering” in their degree titles. The Society of Women Engineers applied the same restrictions to its award offerings. Students raised these concerns to Institute director Wayne Knox—a well-chosen target, given that he had been inducted into TBP himself as an optics major.

In addition, the word “engineering” started gaining a lot more traction with Rochester students in the mid-2000s. UR alumnus Edmund Hajim made a major gift to create the Hajim School of Engineering and Applied Sciences (HSEAS). This development was paired with the hiring of a new dean of engineering and applied sciences, Robert Clark, from Duke University. The college began a targeted push to increase the percentage of engineering majors in its incoming classes. As the popularity of engineering rose, The Institute’s optics degree started to suffer in comparison to the other HSEAS departments, all of which had “engineering” in their degree titles (biomedical, chemical, electrical & computer, and mechanical). When first-year students at the annual HSEAS orientation session were shown a slide listing the school’s degrees, asterisks were placed next to all of the ABET-accredited degrees, making optics look like a possibly riskier path to employment. This took its toll on enrollment; at low ebb, the department graduated only seven majors in 2013.

Now, you might think that these concerns about the word “engineering” could have been fixed just by a cosmetic name change. Not so fast! New York State approval is required for any new degree names, and the state stipulated that any new degree containing the word “engineering” had to pursue ABET accreditation. ABET (Accreditation Board for Engineering and Technology) is an organization that accredits postsecondary degree programs in engineering and applied sciences. Certification indicates that there is a process in place for continuous assessment, evaluation, and revision of an educational program.

The push to pursue ABET accreditation didn’t just come from New York State. Not to be ignored, there was also some friendly pressure from our peer institutions. Several undergraduate programs, including the University of Arizona’s, had recently gone through the ABET accreditation process. Director Knox reported to the faculty that its counterparts were nudging him to pursue accreditation in order to show solidarity and strengthen the brand among optical engineering programs.

And so, when all was said and done, The Institute decided to create a new undergraduate degree called “optical engineering” and to get it accredited by ABET. Prof. Thomas Brown, the chair of the Optics Undergraduate Committee, led the department’s first step of designing an optical engineering track and getting it approved. Compared to the existing optics degree, the new program had three new features:

- A two-semester, team-based design project was added as a capstone course.
- The standard two-cluster requirement for college degrees was reduced to “cluster plus 1” (one cluster plus a single other class in the humanities or
social sciences), in line with the college’s other accredited engineering degrees.

- A breadth requirement of twelve technical-elective credits (the equivalent of three full classes) was added. These electives could be any nonintroductory course in science, technology, engineering, mathematics, or computer programming.

Rather than convert its existing optics degree into optical engineering, the department chose to retain optics as a separate degree option. This would allow interested students to pursue a senior thesis project (most likely research, but alternatively curriculum development or historical reviews) rather than the ABET-mandated team design project. The thesis was made mandatory, to parallel the optical engineering (OPE) design requirement.

Everything else about the new OPT and OPE degrees was identical: same technical elective requirement, same required core classes, and same cluster-plus-1. OPT thus became the only non-ABET degree in the college that does not require two clusters. While this was heresy to the Rochester Curriculum, it was deemed essential for the survival of the OPT degree (and thank goodness the college approved it). Undergraduates in The Institute, cursed with the inability to see ten years into the future, typically avoid as many writing classes as possible. Just think what would have befallen the OPT degree if it had retained the two-cluster requirement while the OPE degree lurked in the wings with its inviting cluster-plus-1!

After much heroic back-and-forth led by Tom Brown, the College Curriculum Committee approved the OPE degree near the end of the spring semester in 2010. This was in time for Hillary Maben (now Balonek) to be awarded the first OPE degree at graduation in May 2010. In anticipation of the degree being approved, Hillary had taken the required courses, including doing a senior design project.

Approval from New York State followed swiftly; a letter was sent to President Joel Seligman by the state on October 8, 2010, with the initial registration lasting only until September 1, 2011. As forewarned, extension beyond this date was explicitly tied to evidence that the department was working toward obtaining ABET accreditation. The die was cast.

The Institute’s decision to pursue ABET accreditation came into focus at an interesting time for optical engineering programs. In 2010, a few other optical engineering programs in the country had ABET certification, including those of the University of Arizona, University of Alabama in Huntsville, Rose-Hulman Institute of Technology, and Norfolk State University. There was no distinct category for optical engineering; however, these programs were all certified under the “Other” category, an umbrella that included, for instance, sanitation engineering.

Convinced that the field of optics needed its own space, IEEE and SPIE jointly sponsored a new ABET category in the area of optical engineering. The curricular part of the accreditation effort was led by Dr. Barry Shoop from West Point. In January 2011, Institute of Optics professors Wayne Knox, Jannick Rolland,
and Andrew Berger attended a first planning meeting at Photonics West. After more than two years, the new category of Optical, Photonic, and Similarly Named Engineering Programs was approved at the fall 2013 ABET board of directors meeting in Baltimore. Thanks to this timing, the University of Rochester was placed in position to be the first school to apply for ABET accreditation in this new category. (The program criteria that define ABET’s Optical Engineering category are provided as an appendix.)

The Hajim School had its next ABET reaccreditation visit for its other programs (ECE, ME, BME, CHE) coming up in Fall 2015. This was chosen as target time for the OPE application, since an earlier off-cycle accreditation would have required reaccreditation in 2015 anyway.
At the request of the new Institute director, Xi-Cheng Zhang, Prof. Andrew Berger stepped down as Undergraduate Committee chair and took the lead on both undergraduate recruitment and the ABET accreditation process. Berger mapped out a path with Wayne Knox (at that point the new associate dean of education for the Hajim School) and Barbara Masi, UR’s new director of education innovation and assessment initiatives, who had recently worked on ABET assessment at MIT. After a sabbatical year for Berger in 2013–14, the effort began in earnest in Fall 2014.

With help from Masi, Berger implemented reviews of the undergraduate curriculum. These have since been conducted every semester since Fall 2014. They consist of a standardized form that is filled out by every instructor, called a Course Reflection Memo. This gives the instructor a chance to reflect on what needs improvement and what steps should be taken the next time the class is taught. Starting with Fall 2015, the instructor could also mention how well the revisions had worked. This creates a cycle of continuous improvement (assessment/evaluation/revision), which is the core of ABET’s philosophy.

The curriculum review includes short reports from each instructor and discussion by those present. This is a chance for instructors to share information and discuss the undergraduate educational process with a bird’s-eye view: for example, which topics come up in multiple classes, and which prerequisites need to be added for certain classes. Notes are taken (generally by the undergraduate coordinator) and become part of the record submitted to ABET.

ABET requires a process that is guided by a set of Program Objectives. These are aspirations for what the program’s graduates will be accomplishing a few years after they have left the university. ABET also requires Student Outcomes, which are measurable accomplishments that the students have attained upon graduation. Program Objectives and Educational Outcomes were developed by the Undergraduate Committee and then discussed and voted on by the full faculty. They are revised periodically. The current ones are listed publicly, per ABET rules, on the departmental website (and are also included here as an appendix).

The ABET application itself, called a Self-Study, required a large amount of documentation. No part was generated without effort, but some elements were at least straightforward, such as syllabi for every undergraduate course, faculty CVs, a history of the department, and a summary of the findings from curriculum reviews.

More substantially, the Self-Study required assessment of the Student Outcomes. Andrew Berger created a spreadsheet that mapped the Outcomes onto the OPE classes required for the degree. Each class thus became responsible for occasional assessment of one or more Outcomes. This became part of the Course Reflection Memo that instructors submitted for curriculum reviews.

In addition, the year immediately prior to an ABET accreditation required a fine-grained snapshot of student work. For every class, three anonymized examples (good/medium/poor) of every graded written assessment (homework, quiz, exam) were acquired. This made lots of work for the instructors and their
teaching assistants! Charlotte DeBossu, an undergraduate optics major working in the department front office, helped out enormously by redacting the names from the homework assignments and tests.

Lastly, the department assembled an external advisory board. For this purpose, it leveraged the Director’s Advisory Council (DAC), a subset of the Industrial Associates roster. Every spring since 2015, the department’s ABET team has made a presentation about the status of the undergraduate program to the DAC and has stimulated either full-room or small-group discussion, with notes taken to preserve the feedback.

Prof. James Zavislan, now serving as the new Hajim School associate dean (and yes, it has been very convenient to have Optics faculty occupying this slot continuously) worked to centralize the ABET Self-Study process for all UR engineering programs. Material common to all applications (e.g., details about the Hajim School and the University of Rochester) were generated by Hajim staff members. This allowed The Institute to focus on the most optics-centric parts. Zavislan strategically deployed high-quality box lunches at ABET meetings to maintain morale.

The Institute’s Self-Study was finally completed and submitted at the end of June 2015. The department received pre–site visit feedback from ABET and addressed the organization’s questions in writing in advance of the all-important site visit later that year.

On Monday, October 12, 2015, the site visit took place. The University of Rochester was visited by a team of ABET evaluators led by Prof. Frank Croft from Ohio State University. The program evaluator for optical engineering was Prof. Robert Bunch from Rose-Hulman Institute of Technology. Predictably, Professor Bunch was assigned a busy schedule on his first day: he met with the Hajim School dean, the Optics Undergraduate Committee, the senior design instructor, selected OPE juniors and seniors, the undergraduate coordinator (Dan Smith), the all-important lab guru (Per Adamson), and representative instructional faculty.

Bunch was given full access to all the materials that had been assembled, either electronically (on a dedicated laptop) or physically (course binders). With great help from Gina Kern (assistant to The Institute director), all of this was set up in the Goergen 417 conference room for Bunch to do with as he pleased. The scenario was vaguely evocative of the Rumpelstiltskin story, in which a young lady is locked in a room with hay (course binders) and required to spin it into gold (program assessment). The professor finished his work on the following day and departed cordially, without revealing whether the assessment was glowing or not.

Thankfully, the OPE proposal was indeed given a mostly positive review. The program itself earned flying colors; the requested changes focused on a few rookie mistakes. For example, we accidentally wrote our Program Objectives to describe students at the moment of graduation. We were told to revise them to reflect expectations for students who were three to five years past receiving their degrees. We also had to rewrite our Student Outcomes to ensure closer adherence to general
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ABET standards. At the end of the day, the true sign of having been through the ABET accreditation process is that you no longer have to pause for ten seconds to remember the difference between an Objective and an Outcome.

We sent in our corrections and settled in to wait for ABET’s decision. Finally, The Institute got the good news on August 19, 2016, when a letter was sent to President Seligman by Lawrence Jones, president of ABET: the OPE degree was accredited, retroactively to October 1, 2014. Hoorah!

Our initial accreditation lasts until September 30, 2022. A newly formed departmental ABET committee, consisting of Knox (chair), Zhang, and Berger, will oversee the next application cycle. In the meantime, the Undergraduate Committee is considering several additional changes to the curriculum, including different tracks for majors, greater distinction between OPE and OPT degrees, and a new BA in optics. There’s discussion about a degree in photonic engineering, and another in optical sciences. There’s even talk about The Institute helping to establish new programs in optics at other universities. Stay tuned! The commitment to the best in undergraduate optics education never rests.

Appendix

ABET’s Program Criteria for Optical, Photonic, and Similarly Named Engineering Programs are as follows:

**Curriculum**

- The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program.
- The curriculum must prepare students to have knowledge of and appropriate laboratory experience in: geometrical optics, physical optics, optical materials, and optical and/or photonic devices and systems.
- The curriculum must prepare students to apply principles of engineering, basic sciences, and mathematics (such as multivariable calculus, differential equations, linear algebra, complex variables, and probability and statistics) to modeling, analyzing, designing, and realizing optical and/or photonic devices and systems.

**Faculty**

- For primarily design courses, faculty members must be qualified by virtue of design experience as well as subject matter knowledge.

As of this writing, The Institute’s Objectives and Outcomes for its optical engineering degree are as follows:
**Program Objectives**

- Graduates of the University of Rochester’s bachelor of science degree in optical engineering will, after a few years, be assuming leadership roles in commercial and governmental jobs, or be progressing toward advanced degrees.
- Our graduates will have a track record of continued education, trainability, and adaptability within their workplaces.
- Our graduates will be valued for their innovativeness, technical proficiency, teamwork, and excellence in conveying information.
- Our graduates will have gained awareness of the many ways engineering skills are used, allowing them to select paths that align with their interests and maximize their contributions.
- Our graduates will know how to act ethically and will appreciate the relationship of engineering and science to their society, their economy, and their environment.

**Student Outcomes**

ABET recently revised its Outcomes; they will be in effect for the 2019–20 application cycle. They are:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**Note**