

Optical Engineering at Rose-Hulman Institute of Technology: ABET Accreditation with EC 2000

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Abstract: Rose-Hulman has a history of meeting the need for optical engineers via the Applied Optics Programs since 1983. We have changed our degree program to Optical Engineering and will seek ABET accreditation. The present paper will deal with the step taken to accomplish this and define the mission of the degree program.

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OCIS codes: (000.2060) Education, (350.4600) Optical Engineering

1. Introduction

Rose-Hulman has a long history of graduating optical engineers via the Applied Optics Programs and the name change to Optical Engineering will in fact reinforce the idea that we are educating our students in applications of optics to deal with real world problems and practice the profession optical engineering. Most of our students have expressed an interest in obtaining an optical engineering degree due to the level of optics education which is heavily lab and project oriented. Further the departmental advisory board that consists of top professionals from the optical industry and education strongly endorsed the name change to optical engineering. This science department is now optimally positioned to make this timely change to the degree name as well as seek ABET accreditation. In this paper we will discuss several steps that needs to be taken to fulfill the EC2000 criteria set by ABET.

2. EC2000 ABET Accreditation and the procedures adopted at Rose-Hulman

RHIT is an undergraduate science and engineering institution although we have an active masters level graduate program in many areas. The Department of Physics and Optical Engineering presently offers B. S. degrees in Optical Engineering, Engineering Physics, and Physics. Further, certificates in semiconductor materials as well as image processing enables the student to learn diverse topics. The multidisciplinary field of optics in the undergraduate curriculum is facing revolutionary changes, as optical techniques become the standard tools for industrial inspection and as optical components become standard items in consumer product. This necessitates the need to improve the curriculum from the traditional science course sequence and match the need for more applied and engineering nature of the courses. ABET's intent of criteria states that a curriculum in engineering should have to assure adequate foundation of *science, humanities and social sciences, engineering sciences, and engineering design methods*¹. This program is not intended as a supporting role in optical engineering but provides the basic practices of optical engineering. It also states that the specific program must have appropriate expertise, which we have, is further strengthened by the ECE department's hire in the optics area. There are various factors that need to be fulfilled as we look at the criteria of EC2000. We have highlighted all the major categories and its bulleted subsection and show the similarities between EC2000 and the optical engineering curricula at Rose-Hulman. We will also point out places where action needs to be taken to fulfill the criteria

3. The need for optical engineering:

The last two decades have seen a remarkable increase in the application of optics-based technology. The applications cover a very diverse list of areas and the demand for people with optical engineering

background in the industrial sector is very large and will most likely increase. Since most of the breakthroughs related to optical technologies have occurred relatively recently, the possibilities are practically endless.

Many industries are utilizing the principles of optical engineering in their industrial processes for the development of new products and component of new products. The developments in this area are occurring very quickly and companies need people with background in optical engineering in order for them to remain competitive. Some of the areas gaining the most publicity from this technology are medical diagnostic imaging, laser surgery, quality control devices, imaging, telecommunications, and fiber optics technology. These and many more areas require expertise in optical components as well as systems level understanding of these components.

Many journals (Laser Focus World, Photonics Spectra, Optoelectronics, Optics and Photonics News, etc.) dealing with optical technologies forecast a deficiency in the number of optical engineers in this country. As the potential benefits of optical technologies increase more optical engineers will be needed to bring about practical and useful devices.

Rose-Hulman Institute of Technology (RHIT) has a history of meeting the need for optical engineers via the Applied Optics (AO) Programs. In fact, many of our AO graduates have been employed as optical engineers. However, the name applied optics is not well understood in industry and has been regarded more as fundamental studies in optics as opposed to the applications of optics to technical problems. The name change to Optical Engineering will reinforce the idea that we are educating our students in applications of optics to deal with real world problems and practice the profession optical engineering. The AO idea does not carry the same connotations in industry as Optical Engineering. This has hindered some of our students from obtaining employment with some companies that are not aware of our program.

The AO program currently meets all of these goals. Most of our AO students have expressed an interest in obtaining an optical engineering degree. Further the departmental advisory board that consists of top professionals from the optical industry and education strongly endorsed the name change to optical engineering. The department is now optimally positioned to make this timely change. The change to optical engineering and the requisite changes in the curriculum would meet the desire of most of our AO students and the demand from industry. Therefore, we propose that the name of Applied Optics in the B.S. and M.S. be changed to Optical Engineering.

4. Impact statement:

At RHIT there are 10 departments consisting of four science departments (mathematics, chemistry, biology, and physics & optical engineering), four engineering departments (Mechanical, chemical, civil , electrical & computer), computer science, and humanities & social science department. As these 10 academic departments are closely tied in their teaching and course development activity we have a policy of developing impact statement that indicates how a new or modified program affects other departments. It is necessary that an impact statement be written that addresses the staffing of the program and how it affects other departments, in terms of teaching and student enrollment. We generated such impact statements and found minimal influence of the degree name change on other departments

5: Background

It is well understood that optics education in the undergraduate curriculum is multidisciplinary and

involves more engineering in its education than science/physics degree. We are faced with the task of designing a curriculum to meet not only the growing needs of market trend but also to make the students learn the essentials. The students need to gain knowledge in a broad range of fields from pure physics to almost every discipline of engineering but appropriately staggered by designing courses that have specific outcomes. This should not essentially be focused on the methodology of teaching but on a broader level of evenly distributed but reinforced learning styles for the students. This task is significantly difficult in the optics curriculum because optics courses are usually a blend of new technology, engineering and physics. At RHIT, this concept has geared us to evaluate the traditional sequence in a course with laboratory in terms of information content and student outcomes. Overall, laboratory experiments are designed to reinforce concepts for understanding the basic scientific ideas of a particular course along with the necessary experimental skills. RHIT's optics program has evolved gradually to mix the two worlds with the introduction of project-based courses that awaken the scientific curiosity as well as the engineering creativity [1-3]. There has also been a focus to enable the students to employ their optics and scientific knowledge to build products as well. We are in a process of constantly restructuring the program to meet the challenges of tomorrow by carefully assessing the needs of the students, the engineering community and the market place.

6: ABET accreditation for the Optical Engineering program

The multidisciplinary field of optics in the undergraduate curriculum is facing revolutionary changes, as optical techniques become the standard tools for industrial inspection and as optical components become standard items in consumer product. This necessitates the need to improve the curriculum from the traditional science course sequence and match the need for more applied and engineering nature of the courses. As educators, we are faced with a task of designing a curriculum to meet the growing needs of market trend. In that regard we have proposed the name change along with appropriate curriculum to meet the market requirement.

ABET stands for Accreditation Board for Engineering and Technology. ABET's intent of criteria states that a curriculum in engineering should have to assure adequate foundation of science, humanities and social sciences, engineering sciences, and engineering design methods. The intent is to prepare students for the practice of engineering at a professional level. This program is not intended as a supporting role in optical engineering but provides the basic practices of optical engineering. It also states that the specific program must have appropriate expertise, which we have, is further strengthened by the ECE department's hire in the optics area. There are various factors that need to be fulfilled as we look at the criteria of EC2000. We have highlighted all the major categories and its bulleted subsection and show the amount of similarities between EC2000 and the optical engineering curricula. We will also point out places where action needs to be taken to fulfill the criteria

In EC2000, specialty programs like optical engineering fall under the program criterion as nontraditional programs. In the nontraditional programs few examples are Engineering sciences, Material science, Mechatronic engineering, Engineering physics, Engineering and public policy, and Optical engineering as well. There is only one school in US that has an accredited program in optical engineering and one that is in the process of getting accreditation even though there are couple of them that do not have accreditation. We in the Physics and Optical Engineering (PHOE) department are fortunate to have the Electrical and Computer Engineering (ECE) department as our collaborator in this direction. We propose to offer the Optical Engineering course from the PHOE department along with suitable courses from the ECE and other engineering departments. ABET has presently modified the accreditation policy for all nontraditional engineering program and they all fall under one umbrella as engineering program in their EC2001-2002 document. There is no special classification of a nontraditional engineering program anymore.

The restrictions such as having faculty advisors from engineering departments and courses needed to taken from engineering departments for a classified nontraditional program has been lifted. The documents with bullets in this paper are generated from EC2000 and is identical to EC2001-2002 criteria [4] except that the section on nontraditional program criteria has been removed. We show in the highlighted sections how we satisfy each of the criteria and also methods that will be taken to fulfill them as we get the program into full swing. It should be noted that as far as optical engineering program was concerned prior to EC2001-2001, we had to satisfy two criteria under non traditional engineering program. The two criteria were: i) In institutions with a substantial number of faculty members educated as engineers and teaching in other departments, one or two faculty members should be responsible for guidance as coordination of the non traditional program and ii) must have at least one year of course taught by engineering faculty. These two criteria were addressed in our first response to faculty members in the institute. However since then we have modified our documents. We still believe that it will help the program to have one or two faculty from the engineering department be advisors to the program and therefore we have included advisors from the ECE department.

We present a broad overview of the ABET criteria as applicable to optical engineering program at Rose-Hulman.

ABET CRITERIA:

I.C.1 faculty:

- a. Faculty that can give overall scholarly atmosphere
- b. Level of academic training, diversity of its background, effective teaching, degree of participation in professional and scientific societies
- c. Must have at least three full time faculty
The definition of an engineering faculty is broad and there are various criteria that are used to judge optical engineering faculty. The overall competence of faculty is judged by factors such as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation of professional societies, and registration as professional engineers. A large number of the OE faculty members have engineering, design, and industrial experience. In addition we have faculty advisors from the electrical and computer engineering department (ECE) who will also collaborate in developing courses jointly as well.
- d. Stability, continuity and morale of the faculty
- e. Teaching load must be consistent
- f. Curriculum and career advising

All the departments at RHIT meet criteria d-f.

I.C.2 Curricula Objective:

- a. Capability to delineate and solve in a practical way of society that are acceptable to engineering treatment.
- b. Sensitivity to the socially-related technical problems
- c. Understanding of the ethical characteristics of the engineering profession and practice
- d. Understanding of the engineer's responsibility
- e. An ability to maintain professional competence

We have shown that we were and are fulfilling all the above requirements with the change in the curriculum. This is documented in the through several of the report published by the department.

I.C.3. Curricula content:

- I.C.3.d.(1).* One year of appropriate combination of mathematical and basic sciences
- I.C.3.d.(2).* One-half year of humanities and social sciences

I.C.3.d.(3). One and one-half year of engineering topics

The Optical engineering curricula provides this integrated educational experience that identifies with the I.C.3 of the Accreditation commission. It is very well documented that at RHIT the first two bullets in the Optical Engineering curricula are accomplished and the requirement is to show that we will fulfill the third requirement in engineering topics. Therefore we will omit the sections I.C.3.d.(1) involving science and math requirements and I.C.d.3.(2) involving humanity and social science requirements . Our curriculum has a strong foundation in engineering and from the content and breadth standpoint it compares well with other accredited optical engineering degree program. Presently ABET has accredited two optical engineering degree programs in the nation.

Engineering topics include engineering sciences and design.

I.C.3.d.(3) Engineering sciences:

I.C.3.d.(3) Engineering design:

- a. Engineering sciences should be developed with the mathematics and basic sciences as it roots.
All the optical engineering courses are developed with mathematics and science as foundation courses.
- b. Process of devising a system, component, or process to meet demand
We have developed several courses which meet this requirement.
- c. Design experiences should be taught in section sizes that are small enough
We have shown that there are over seven courses that have very strong design components. Some of the courses are already accepted as design for some engineering departments as well. The Optical engineering design course is well documented from some of our publications in OPN as well as in SPIE proceedings [1-3].
- d. Self study questionnaire should be able to discern the goals of the program and the logic of the selection of the topics
We plan to initiate this process once we have OE degree program.
- e. Drafting skills
OE students will get this from graphical communication course.
- f. Appropriate laboratory experiences
All OE courses are very lab intensive and have 4 to 8 labs in a course.
- g. Knowledge of probability and statistics to engineering problems
We are thinking of including one such course but some of these topics and concepts are already covered in our laboratory courses.
- h. Competence in written and communication skills
The OE students already take technical communication.
- i. Ethical, social, economic, and safety considerations in engineering practice.
The Humanities and Social Science requirement at RHIT fulfills some of these requirements. These issues are also covered in the project courses and laser related courses. Every laboratory course has laser safety component associated with it.

I.C.4. Student Body

- a. Quality of the students
- b. Policies for accepting transfer of credits
- c. Example works of exams, homework problems, laboratory exercises, design, and reports
- d. Record of what the graduates are doing after graduation
We have started the several of the procedure in the department as in the other engineering departments at RHIT including assessment of several of the soft skills. We have looked into several of the self-study books and will generate a standard procedure

for keeping records of class activities and alumni survey.

I.C.5. Administration:

- a. Capable faculty
- b. Selection, supervision, support of faculty, and supervision of students
- c. Constructive leadership

We meet this entire requirement.

I.C.6. Institutional facilities:

- a. Adequate physical facility
- b. Library support
- c. Computer facility
- d. Laboratory facility

We meet this entire requirement.

I.C.7. Institutional Commitments:

- a. Organizational structure of the University should support the engineering mission
- b. Sound physical policy
- c. Provide facilities to support engineering program

We have received endorsement from several of our constituencies such as Alumni, the departmental advisory board, and the administration. The program was approved by the highest body, the curriculum committee in the school that approves all curriculum issues. Several soft core criteria for the program have been assessed and all the course materials are being documented. We will be sending surveys to graduated optical engineering alumni in 2004-2005. Several of the assessment of student learning is being done through e-portfolio at Rose-Hulman. The students submit several of their work on a specific outcome and during the summer faculty raters then evaluate the student submission. The student is then given a response as to whether he met the criteria or not. The results are then sent to the department which then used to close the loop on several of the learning objectives.

7: Acknowledgement

The paper presented here has been reviewed by the department faculty on many occasions and the authors would like to thank the PHOE department faculty for their suggestions and input in the preparation of this article. Further all these developments in education in optics is not possible without the input and feedback from our optics students. They have inspired us as faculty and provided the energy to work on the process of improving optics education and we thank all of them.

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