

CREOL, The College of Optics & Photonics

Strategic Plan

2013-2014

Executive Summary

The College of Optics and Photonics has been a world leader in education, research, scholarship, and partnership in optics and photonics. Our goal is to maintain this status and to further enhance our programs to become *the* world leader in all of these areas. New programs and some growth and expansion are envisioned for the next 5 years.

Education

- Complete the development of the new BS degree in photonic science and engineering.
- Increase the size of the doctoral program by 25%. This will support planned expansion in research.
- Improve the quality of the recruited students and enhance the curriculum to keep up with the rapid advances in the field.
- Double the number of terminal MS degrees awarded.

Research

A principal goal is to establish a stronger and more nationally visible presence in selected research areas, including *Biophotonics and medical applications of lasers*, sensing and *imaging*, *nanophotonics*, *lasers in manufacturing*, and *ultrafast optics*. This will be accomplished by adding several faculty positions with joint appointments in other UCF units. Another goal is to secure funding for centers and large projects with stable and continuing support, and benefit from new opportunities for federal and state funding. Our targets for the next 5 years are:

- Add 2–3 FTE faculty members in these areas.
- Get our first federally funded research center (with UCF as the lead institution).
- Increase our federal and industrial funding by 30% with a target of \$12M annually

Partnership and Outreach

- Enhance our partnership with the optics and photonics industry, particularly the Florida industry, for technology transfer by means of joint projects, licensing, spinoffs, and incubation.
- Enhance outreach programs directed to Florida's citizens and leaders, K-12 students, technician, and community-college students.

Resources

The targeted expansion will require resources, some of which will be provided by new external grants and gifts, and also revenue from tuition paid by new students. New recurring resources will be required to support the new faculty positions and one-time support for startups will also be necessary. Recurring funds for the administrative staff of the new BS program are required. New space will also be necessary.

1. Vision and Mission

1.1 Vision

Be the world's leader in education, research, scholarship, and partnership in optics and photonics.

2.2 Mission

- Provide our graduate students with the highest quality graduate education in optics and photonics, support the educational needs of undergraduate students in other programs, serve the continuing education needs of industry, and enhance optics and photonics education at all levels
- Create and disseminate new knowledge and innovations in optics and photonics by conducting, presenting, and publishing cutting-edge fundamental and applied research.
- Aid in the development of Florida and the nation's knowledge-based and technology-based industries, and create, foster, and sustain mutually beneficial research collaborations and partnerships with industry.

2. State of the College

CREOL, The College of Optics and Photonics, is the first of a few colleges in the US in this area of science and technology. Since its founding in 1987, the College has established itself as one of the top education and research institutions in optics and photonics in the world, educating and training the technology leaders of tomorrow and guiding the way optics is perceived in the US and abroad. Optics and photonics are enabling technologies that permeate many disciplines including physics, electrical engineering, mechanical engineering, chemistry, materials science, engineering, and computer science. Many of the college faculty members come from backgrounds in other science and engineering disciplines and some have joint appointments in other related departments. Although this inherently multidisciplinary field is now regarded within the technical community as a distinct discipline, the strong connections with other programs remain to be an important characteristic of the college.

Research Centers: The college has four research centers: Center for Research and Education in Optics and Lasers (**CREOL**), which is the original and primary research arm of the College, Florida Photonics Center of Excellence (**FPCE**), Townes Laser Institute (**TLI**), and Institute for the Frontier of Attosecond Science and Technology (**ifast**).

Scope: The faculty engage in research in a broad spectrum of programs covering materials, devices, and systems or applications, including photonic technologies such as lasers; optical fibers; semiconductor and integrated photonic devices; nonlinear and quantum optics; and imaging, sensing and display. These technologies have applications in industry, communication and information technology, biology and medicine, energy and lighting, aerospace, and homeland security and defense. Advanced topics such as nanophotonics, ultrafast optics, plasmonics, and biophotonics, are embraced as areas of strength and future growth. We are well positioned to take advantage of the revolution that is taking place in several fields enabled by optics and photonics.

Faculty Size, ranks, and diversity: The size of the faculty in 2013 is 30 faculty members with the following FTE distribution:

2.5	FTE	Administration
2.7	FTE	Fractional appointment with other colleges
4	FTE	Research faculty (no teaching duties)
20.8	FTE	Tenure/tenure track with teaching & research duties

The rank distribution is:

7	Assistant Professor
4	Associate Professor
19	Professor

Two faculty members are women and one is from an under-represented group. In addition, there are 14 faculty with 0-FTE joint appointments and 100% appointment in other colleges. The numbers of research and administrative staff are:

36	Research scientists	3	Technical staff
6	Senior research scientists	15	Administrative staff
12	Post-doctoral researchers	25	Visiting Research Scientists

Faculty Eminence: Most of the senior faculty members are renowned in their fields of specialty. The following are the number of Fellows of the key professional societies:

22	Optical Society (OSA)	3	American Physical Society (APS)
6	SPIE	2	Laser Institute of America
12	IEEE Photonics	5	National Academy of Inventors

The senior faculty are winners of several prestigious awards from professional societies and international associations, including 2 honorary doctorates. They are also recipients of UCF awards and honors:

5	Pegasus professor	2	Trustee chairs
2	Endowed chairs	3	FPCE professorship

Junior faculty members have also received awards, including 6 NSF CAREER awards and 3 ONR Young Investigator awards. The faculty have also held key leadership positions in the professional community, including chief editors of key journals and president of professional society.

Educational Program: The College has a strong focus on education through research and course work. The 2013 total number of students in the graduate program is 123. As shown in Chart 1, this has remained approximately constant, but we are seeing a drop in the PhD enrollment and an increase in the MS enrollment. We provide a highly educated graduate for the modern-day workforce and our graduates continue to be highly sought after and demand high salaries in the competitive marketplace. As shown in Chart 2, 26 PhD degrees and 17 MS degrees were awarded in AY 2012-2013, which is a slight increase from prior years. The students receive a number of national scholarships, best-paper awards, and other honors.

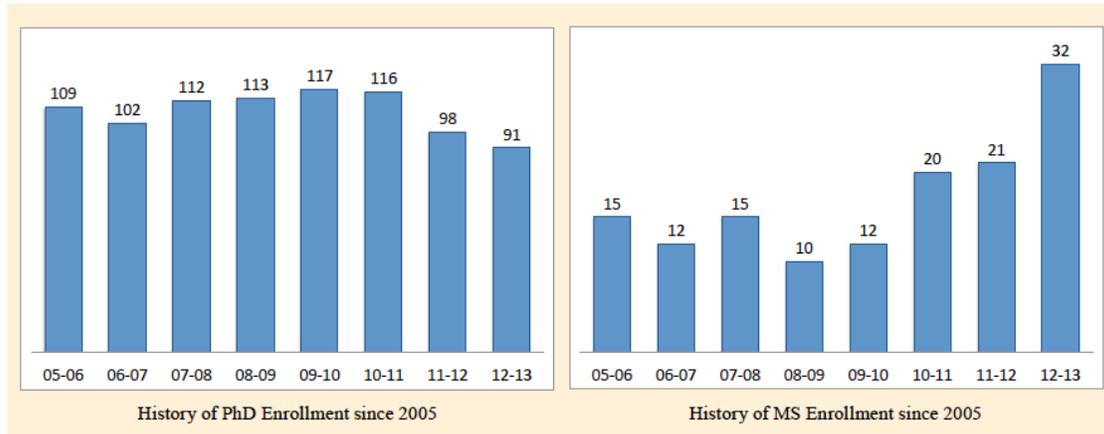


Chart 1. Eight-year history of Ph.D. and MS enrollment

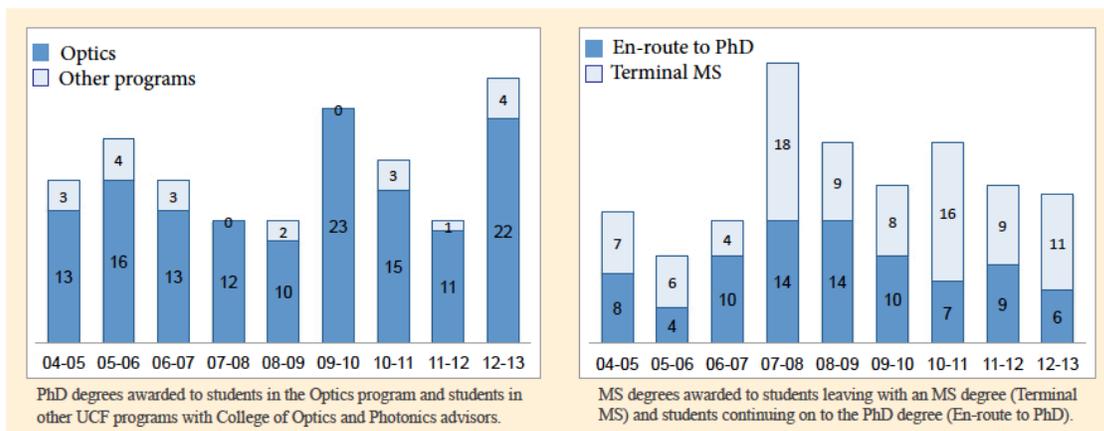


Chart 2. Eight-year history of Ph.D. and MS degrees awarded

In 2013, a new BS degree in Photonic Science and Engineering was established. This is a joint program with the College of Engineering and Computer Science designed to fill the growing need for photonics engineers. The first class was offered in Fall 2013, along with a companion laboratory. Other classes and labs are being developed. Unfortunately, as a result of budget constraints, the new program relied totally on college resources and gifts from industrial partners, and received no additional resources or new faculty lines from the university. In addition to this new undergraduate degree program, we continue to teach undergraduate courses in optics to students in other colleges.

Research and Scholarship: The research performed by the faculty, students, and scientists has been disseminated nationally and internationally over the years. The list of scholarly works in 2013 includes 5 book chapters, 192 journal papers, 263 conference papers and presentations, and 34 invited lectures. This year, nine papers were published in *Nature* journals. Our tradition of innovation has also continued. In 2013, the faculty were inventors or co-inventors of 19 issued patents. UCF has been ranked among the top 25 universities in the world for the number of patents awarded in 2012. The ranking, by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO), is based on data from the U.S. Patent and Trademark Office. UCF researchers received 72 patents and were ranked 21st on the list of 100. The rich IP portfolio in optics and photonics has contributed significantly to this ranking (see Chart 3).

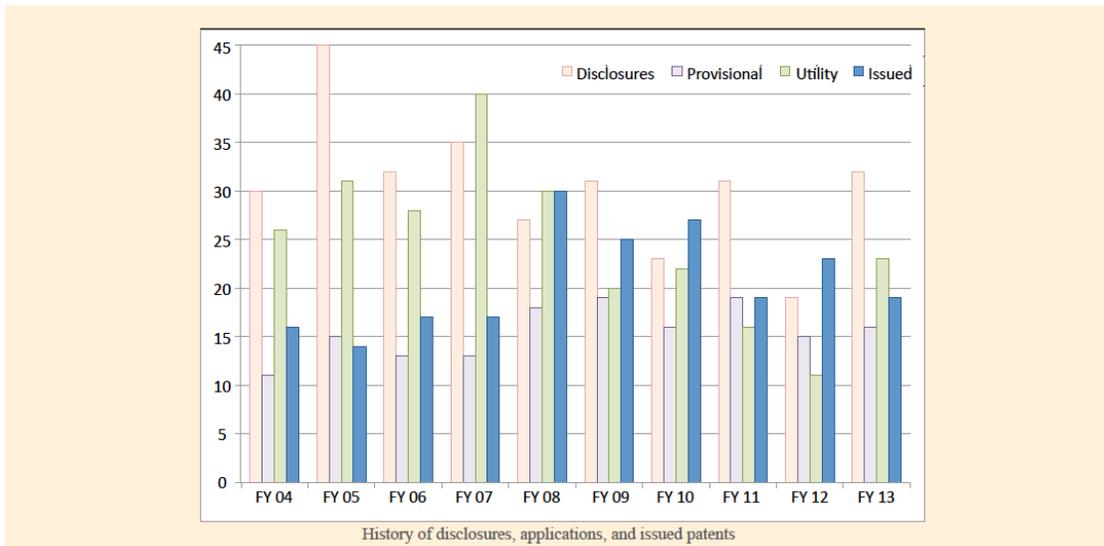


Chart 3. Patents generated by the faculty, scientists, and students

External Funding: The faculty, scientists, and students conduct state-of-the-art research funded by contracts and grants (~\$9M in FY 2013 year). These grants provide the infrastructure and assistantships for the students. This level of funding has been sustained in the last 7 years as shown in the Chart 4.

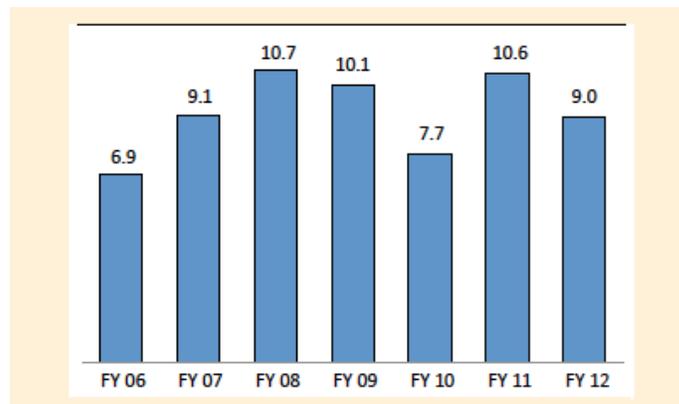


Chart 4. External research funding (\$M)

Partnership: Since its early years, CREOL has instituted a strong partnership with industry and established a large industrial affiliates program (with current membership of 69 companies, sustained over many years). Our *Industrial Affiliates Day* brings in optics companies from around the country to learn about the ongoing research, recruit students, and identify new partnering opportunities. In 2013, approximately \$2.1M was received from industry or from federal grants flow through industrial partners, a connection that gives our students experience and a leg up on industry positions after they graduate. Several companies donated equipment for the new undergraduate laboratories. Events of the *Annual Industrial Affiliates Day* were attended by about 200 guests. This year we offered four short courses with 200 attendees.

4. Goals and Action Plans

4.1 Education

BS Program

- Complete the development of the new BS degree program, which started in Fall 2013, including new courses, laboratories, and senior design capstone courses. Graduate the first class.
- Maintain and enhance the marketing effort with the goal of reaching a steady class size of 40 in the next two years
- Receive ABET Accreditation.
- Re-establish the national and international REU program, which has recently ended.

MS Program

- Establish a two-track program: 1) Optics, and 2) Photonics.
- Add a new 12-month MS program, in addition to the existing 18-months program.
- Build upon our interdisciplinary strengths and the resources of other UCF colleges and centers to offer new programs in cross-cutting areas (e.g., MS in Biophotonics, MS in Photonic Materials, etc).

The above actions aim at making the MS degree more attractive for industry-supported tuition-paying MS students.

Our goal is to double the number of terminal MS degrees awarded per year, while maintaining the number of MS degrees offered to students en-route to the PhD degree.

Doctoral Program

- In order to support the growing research program we need to increase the size of the doctoral program.

Our goal is to increase the total number of doctoral students in the program to a steady number of 125 and to offer 25 PhD degrees annually.

These numerical goals can be achieved by increasing external funding to generate support for more doctoral students, and by reducing the average number of years for the doctoral degree to 5 years.

- Improve recruitment methods to attract doctoral students from better schools, students with external fellowships, and more domestic doctoral students
- Improve the curriculum (integrate the content of core courses, offer richer choice of advanced courses, and include new courses in emerging areas).
- Maintain and improve instructional laboratories and facilities.
- Continue to seek federal funding to support students (e.g., NSF IGERT program), and interdisciplinary and international programs.

4.2 Research

A principal goal of the college is to maintain strong and nationally visible presence in a number of thrust research areas of excellence that have applications of relevance and societal impact. Our vision is to further strengthen the already strong research areas, while expanding into new applications of current interest. Because of the inherent cross-disciplinary nature of optics & photonics, coordination with other UCF units can yield win-win results and accelerate overall research in science and technology at UCF. We should also be cognizant of

the instructional needs of our undergraduate program. For example, a 2012 external review of our program noted some deficiency in the area of optical engineering (optical system design), which we have been addressing.

- Guided by these principles, we have identified the following areas for faculty additions:
 - *Biophotonics and medical applications of lasers*. This area has been emphasized by the FPCE and a Chaired position has recently been filled by an expert in lasers in medicine. Further growth in this area in coordination with the **College of Medicine** would be very advantageous, particularly if we identify an expert in translational medicine.
 - *Sensing and imaging*. Optical sensors and image acquisition systems is an area of strong current relevance. We have an excellent infrastructure and a strong and well-funded activity in the optical fiber sensors and sensor networks area, as well as the integrated-optic area. Mechanical, electrical, and microfluidic sensors are also areas of interest to the **College of Engineering & Computer Science (CECS)**, in both ECE and MAE Departments. The **Center for Research in Computer Vision** is also active in image understanding. The addition of joint faculty to our two colleges would be of mutual benefit and would enhance cross-disciplinary programs.
 - *Nanophotonics*. Existing activities in nanophotonics, including fabrication of nano particles and plasmonic devices for medical applications, complement research at the UCF **Nanoscience Technology Center** as well in nanoelectronics at the CECS. The addition of a faculty member in this area will strengthen research in all these units and will also help with meeting undergraduate instructional needs. Growing in this area will make us more competitive as we pursue IMI funding.
 - *Lasers in manufacturing*. The Townes Laser Institute at CREOL has developed some expertise in laser applications to manufacturing, including additive manufacturing or 3D printing. Other groups are also involved in the fabrication of photonic integrated circuits. In collaboration with faculty in the **College of Engineering & Computer Science**, MAE and MSE Departments, funding for a national IMI center was recently sought, but the effort was not successful. Growing in this are will make us more competitive.
 - *Ultrafast Optics*. The Institute for the Frontier of Attosecond Science and Technology, a joint effort of CREOL and the **College of Sciences** Physics Department has garnered considerable external funding and national recognition. The addition of another faculty position, 50% with Physics, would provide the center with the critical mass for external funding, and hopefully the creation of a national center in this critical area.

Our target is to add 5 new faculty members in these areas jointly with other UCF units. This will give us 2–3 new FTEs and would support our emerging undergraduate program in photonic science and engineering.

- Strong and nationally visible presence in these research areas can be enabled by the establishment of well-funded centers and large projects with stable funding. It is essential to position the college to benefit from new opportunities for federal funding (e.g., new centers) and state funding. The college must be ready with a number of possible large initiatives in the aforementioned areas. We must also continue to pursue other out-of-the-box innovative ideas for collaborative research centers matching the faculty expertise and leveraging the resources available at other UCF colleges and centers.

Our goal is to get our first federally funded research center (with UCF as the lead institution) within the next 5 years.

- Single-PI or few-PI federal and industrial funding will remain to be the main source of

research funding. We must therefore continue to encourage aggressive pursuit of such funding. Our external funding, which has an annual average of \$9.2M over the last seven years, tends to be generated mostly by a small fraction of the faculty. Our goal is for almost every faculty member to contribute significantly to the generation of research funding

Our target is to increase our federal and industrial funding by 30% to a sustained \$12M annually in the next 5 years. This increase will be enabled by the addition of new faculty and will support our goal of enlarging our doctoral student body by 25%.

4.3 Partnership

- Continue to transfer the innovations developed by the CREOL faculty, scientists, and students to our industrial partners
- Continue to assist in forming, recruiting, and retaining optics and optics-related industries in Florida.
- Continue to pursue outreach programs to raise the level of appreciation of the impact of optics and photonics on the state and the national economy. This includes playing a strong role in the National Photonics Initiative. A number of outreach activities are planned for 2015, which has been declared by the United Nation as the International Year of Light.
- Continue to pursue outreach programs aimed at K-12 students, and technical and community college students.

4.4 Visibility

Our goal is for the College to be, and to be viewed as, the leading optics and photonics institution.

- We would like to be viewed by industry and academia as the leader in producing well-educated students in optics and photonics, and in conducting cutting-edge research.
- We would like to be viewed by students as the first choice for applicants to graduate school in the field.

In order to achieve this goal, we need to:

- Make continuous improvements in the quality of our education, research, and partnership programs, and to generate some new spectacular innovations and receive highly visible awards and recognitions for our faculty.
- Enhance our marketing effort via the web and social media, brochures and posters, visits to key academic and industrial institutions, and exhibits at key technical conferences.

5. Resources

Expanding the doctoral program by 25% and the MS program by 100%, and completing the development of the new BS program will require additional resources, and so will the planned expansion of the research programs by adding new faculty.

The targeted 30% increase of research funding will provide full support for the new doctoral students, and the overhead generated by external grants will provide some resources for supporting the research expansion. The tuition generated by the new MS and BS students will provide some recurring revenue in the long term, but some resources will be needed in the initial phase of this expansion. Recurring funds in support the new faculty and one-time funds for startups are necessary.

Some of the needed financial resources may be obtained by fund raising from private sources.

Endowed chairs secured through development effort would provide us with a tremendous advantage in the recruitment of senior faculty.

New Staff

With the targeted expansion in education, research, and partnership programs, especially the development of the new undergraduate program, additional staff support has been necessary. We have recently added a new administrative staff using college resources. We are expecting that recurring funds will become available for this position.

New Space

The college has now outgrown its existing building. It is essential that the unfinished space in the third floor of the CREOL building addition be finished as soon as possible. This will provide us with some laboratory space. The targeted expansion in research and education, including the creation of new centers, will require additional space. Possibilities include a new addition, a new building, and lab space in Lake Nona for the biophotonics program.