CREOL

A BRIEF HISTORY

1986 – 2006

CELEBRATING THE FIRST 20 YEARS

OF

CREATING THE FUTURE
OF OPTICS AND PHOTONICS

UNIVERSITY OF CENTRAL FLORIDA
COLLEGE OF OPTICS AND PHOTONICS
CREOL & FPCE

CREOL

The first 20 years
1986-2006

THE GENESIS

The history of CREOL began several years before it actually became a reality. The story starts with the energy and initiative of Bill Schwartz, who is viewed by many as the founder of Florida's laser industry. Coupled with Bill's leadership was the initiative by then-Governor Bob Graham in the mid-1980's to grow Florida's economy beyond its dependence on tourism and agriculture (mainly citrus) by fostering the development of high-technology, value-added, wealth-generating industry in the state.

Bill Schwartz

To lead the definition of what industries should be emphasized, the state formed the Florida High Technology and Industry Council (FHTIC). The FHTIC was made up of business, industry, and university leaders who were business and technology savvy, and were the type of people that elected leaders respected and would listen to. Bill Schwartz, along with Dr. Bill Oelfke of the UCF Physics Department, proposed a university-based program in 1984, which became one of the recommendations in a FHTIC report to the governor identifying seven technology areas that had high promise and were critical to Florida's economic future, one of which was "Lightwave Technology". Ron Phillips of the UCF Electrical Engineering Department, and chair of the Lightwave Technology Panel of the FHTIC, wrote the portion of the report that recommended the State University System (SUS) take action to "form the Center for Research in Electro-Optics and Lasers (CREOL)* to provide Florida's high-tech industries with access to research, students, and faculty in advanced areas of optical and laser sciences." The SUS Board of Regents approved such an action in 1985, and in 1986, the Florida legislature acted to provide $1.5M of permanent, recurring funds to the University of Central Florida (UCF) budget to support CREOL. It is this second milestone that has been chosen as the founding date of CREOL, even though the search for the first Director was not yet accomplished.

Establishment of CREOL was a bold action on the part of the state since in 1986, Florida typically invested the smallest amount per capita on education, and UCF was a very new university (founded in 1964) known primarily as a commuter school, had only 16,000 students (mostly undergraduates, the first of which graduated in 1970), very little technical research activity, limited graduate programs, including no PhD in physics, and only a handful of faculty who associated themselves with the optics field. Into this promising, but challenging environment came what the founding director, MJ Soileau, calls "The Texans" – MJ, Eric Van Stryland (now the Dean of the College), David Hagan (now the Associate Dean for Academic Studies for the College), and seven graduate students. MJ arrived on January 2, 1987 with the mission to build an internationally competitive academic unit in optics.

Why would a well-established group of academic scientists leave the known environment at North Texas State University to take on such a challenge? Maybe it was the "researcher's disease" that causes an irresistible urge "to go where no one has gone before." MJ has written a modified version of this: "I took the job because of the opportunity to build an academic unit

devoted to optics, to staff it with top scholars in the field of optics, and to attract excellent students. The simple idea was to build an academic unit that would be much better than I could ever be hired into, and then to become a member of it by the historical accident of being present at its birth!" Being in a new university like UCF also presented the opportunity to develop something new, without the hindrance of "tradition", the short version of what some call "the 7 last words of an organization" – "We've never done it that way before."

And so the journey began….

The "CREOL Period": 1986 - 1998

The CREOL period (1987-98) includes the formal appointment of the first director (MJ), the securing of facilities and additional base funding, recruitment of faculty, definition of the basic educational and research philosophy that would guide the new center, and solid accomplishments of the faculty that would lead to the next major period of development – status as a full academic unit.

The first challenge of finding suitable facilities was easily recognized by two situations: (1) The Texans were assigned office and lab space on the site where the CREOL building now stands consisting of a double-wide trailer. This would clearly not accommodate even the 10 Texans, never mind the 43,000 pounds of optical tables and equipment they brought with them, nor the 13 additional faculty that were to be hired.

Initial CREOL site with double-wide trailer. The truck in the photo is carrying some of the 43,000 pounds of optics stuff brought by the "Texans."

Research Pavilion, circa 1988

Exploration of options, including temporary use of space in the UCF Engineering Building, led quickly to a second move into the Research Pavilion, a new building in the new Central Florida Research Park adjacent to the UCF campus. By the summer of 1987, the buildup of laboratories in these new facilities was well under way, and the move into them was accomplished over the Christmas holidays.

The recruitment of faculty began in earnest once it was clear where they and their research labs would be housed. Since CREOL was not an academic unit, the tenure lines were held in the established academic departments such as physics, electrical engineering, etc. Table 1 shows the history of who joined CREOL and when. A total of 30 faculty members were hired during this period, 21 of whom are still part of CREOL. This early recruitment included a booth at the CLEO meeting in 1987 to get the word out about the new center and what it was all about.

MJ Soileau explaining the new CREOL at CLEO 1987

As the CREOL era began, there were a few fundamental principles that guided the new center:

- Hire top faculty, seeking the best scientist/engineer available, rather than a specific research topic, and create an environment in which they can be successful.
- Recruit the best students in the world and educate them in both fundamentals and applications of optics and photonics.
- Build solid research partnerships with industry worldwide, and with Florida industry in particular.
- Build a strong sense of community among the faculty and students of CREOL, including having some fun!

People sometimes ask which of the above principles have been most important in CREOL's rapid growth and success. The answer is "All of them!" They are all necessary, and none, or even 2 or 3 of them, are sufficient without the rest. Another important element in the early days was that the CREOL Director had control of the recurring financial resources that supported the faculty, even though CREOL was not yet an academic unit. This fact, coupled with the need for the faculty to have their academic appointment in one of the UCF college/department units, led to some occasional disagreements, but also demanded cooperation between CREOL and the other units. This helped encourage interdisciplinary research and promoted another dimension of partnership that is a fundamental value of CREOL and of UCF.

Although the guiding principle for recruiting faculty was to find the best scientist/engineer available, there were some topics identified to help guide the search. These are illustrated in the figure to the right, taken from the presentation to the Board of Regents before their vote on establishing CREOL in 1986.

CREOL

ORIGINAL UCF AY 86-87 Request to BOR

Funding is requested to "establish new initiatives in both instruction and research in the electro-optics and laser areas."

Proposed areas of emphasis of CREOL included:

1. Spectroscopy and Solid State Devices
2. Diode Pumped Lasers
3. Propagation
4. Optical microelectronics
5. Image understanding
6. Sensors
7. Metrology
8. IR systems
9. Medical uses of lasers
10. Undergraduate and graduate instruction

Center for Research in Electro-Optics and Lasers

The list of the faculty in Table 1 illustrates the rapid expansion of the CREOL faculty, and the success of the effort to attract the best and the brightest. Today, CREOL faculty members are recognized by their peers as leaders in their respective research areas. Some of the quantitative measures of their success include the following:

- 74% hold the rank of Fellow in at least one major technical society
- Collectively produce over 400 scholarly publications and 40 patent applications each year
- Serve in the leadership (boards, committees, officers) of all the major optics and photonics societies: SPIE, OSA, IEEE/LEOS
- Have received numerous honors and awards recognizing their achievements

The goal of attracting and educating the best students has also produced some great results. One of the critical elements of both attracting excellent students into the program, and of educating them to be significant contributors in their post-graduate career, was the CREOL commitment to a broad-based education in both the classroom and research, covering both fundamental and applied topics. A graphical representation of this philosophy is shown below. The lower axis is a typical physics curriculum, and the upper axis is a typical electrical engineering curriculum, each with optics as one of the components. The CREOL curriculum is a combination – ranging from the most fundamental physics aspects of optics and photonics to the more applied, engineering aspects.

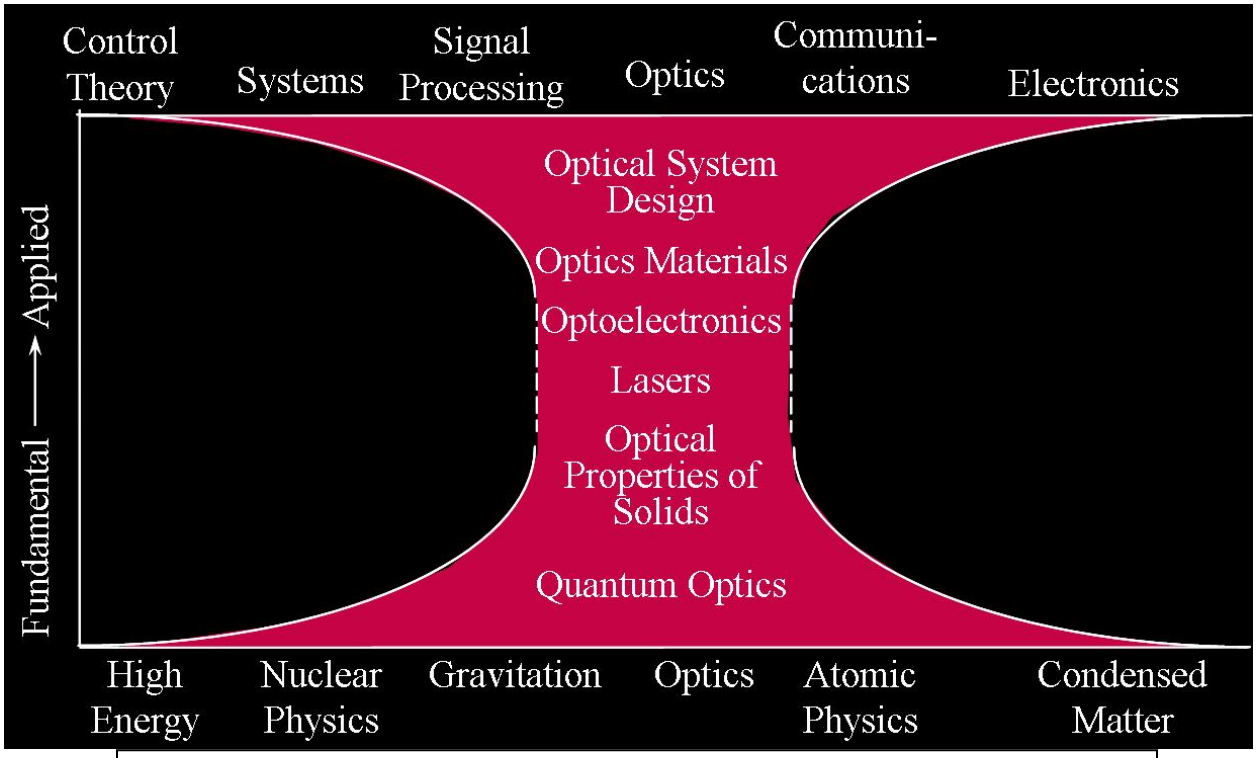


Illustration of the CREOL curriculum philosophy – to cover the full spectrum of topics from fundamental physics to engineering and design.

Table 1. History of hiring of CREOL Faculty

Faculty Member	Current Position	Hire Date
Soileau, MJ	VP for Research and Commercialization; Professor of Optics, ECE & Physics	12/1986
Lin, Jui-Teng	Associate Professor of Physics (departed)	01/1987
Van Stryland, Eric	Dean and Director, Professor of Optics, Physics & ECE	03/1987
Hagan, David	Assoc Dean of Academic Programs & Professor of Optics, Physics & ECE	05/1987
Bass, Michael	Emeritus Professor of Optics, Physics & ECE	11/1987
Guenther, Karl	Associate Professor of ECE & Physics (deceased)	12/1987
Moharam, Mohamed "Jim"	Professor of Optics & ECE	12/1987
Elias, Luis	Professor of Optics & Physics (departed)	06/1988
Kim, Jin	Professor of Physics & ECE (departed)	06/1988
Chai, Bruce	Professor of Optics Physics & MMAE & ECE (on leave)	01/1989
Miller, Alan	Professor of Physics & ECE (departed)	01/1989
Li Kam Wa, Patrick	Associate Professor of Optics & ECE	09/1989
Dixon, George	Assistant Professor of ECE (departed)	12/1989
Silfvast, William	Emeritus Professor of Optics	01/1990
Richardson, Martin	Professor of Optics, Physics & ECE	04/1990
Stickley, Martin	Assoc. Dir of Industrial & Governmental Rel. & Sr. Research Scientist (departed)	07/1990
Stegeman, George	Professor of Optics, Physics & ECE, Cobb Family Chair	07/1990
Boreman, Glenn*	Professor of Optics & ECE	08/1990
Harvey, James	Associate Professor of Optics & ECE	09/1990
Richardson, Kathleen	Associate Professor of Optics Chemistry & MMAE (departed)	08/1993
Delfyett, Peter	Professor of Optics & ECE	12/1993
Kar, Aravinda	Associate Professor of Optics, MMAE & ECE	03/1994
Zel'dovich, Boris	Professor of Optics & Physics	08/1994
Jenssen, Hans	Sr. Research Scientist (retired)	09/1994
Riza, Nabeel	Professor of Optics & ECE	02/1995
Glebov, Leon	Sr. Research Professor	09/1995
Rolland, Jannick**	Assoc. Professor of Optics, ECE & Computer Science	03/1996
Dogariu, Aristide	Associate Professor of Optics	08/1997
Li, Guifang	Professor of Optics, Physics & ECE	09/1997
Wolf, Emil	Provost's Distinguished Research Professor	01/1998
Johnson, Eric	Associate Professor of Optics	01/2000
Siders, Craig	Assistant Professor of Optics (departed)	08/2000
Wu, Shin-Tson	PREP Professor of Optics	07/2001
Christodoulides, Demetrios	PREP Professor of Optics	08/2002
Kuebler, Stephen	Assistant Professor of Chemistry & Optics	08/2003
Kik, Pieter	Assistant Professor of Optics	09/2003
Busch, Kurt	Associate Professor of Physics & Optics (departed)	12/2003
Schoenfeld, Winston	Assistant Professor of Optics	05/2004
Deppe, Dennis	Professor of Optics/FPCE Trustee Chair	06/2005

Another vital step to attract great students was the formation of student chapters of SPIE, OSA, and IEEE/LEOS, and the students quickly formed an umbrella organization – the CREOL Association of Optics Students (CAOS) – to coordinate and integrate their activities, and to qualify for funding from the UCF student government programs. They even built a float for an Orlando parade event! The CAOS group has also been instrumental in CREOL's outreach to the community, hosting tours for K-12 groups and other visitors, and developing clever displays to illustrate sophisticated optical concepts such as waveguiding and phase conjugation in tabletop displays that can be used in demonstrations at CREOL, or easily taken to other locations.

The CREOL – LASER Float, circa 1989

A CREOL grad student shows a visitor (Steve Guch – Litton Laser Systems) one of the tabletop demonstrations.

The research partnerships with industry have been built in a number of ways over the years. A Board of Visitors, or External Advisory Board, was developed early, expanding on an existing Industry Advisory Board by adding influential members of the community, including Mr. Charles Cobb (who later endowed the Cobb Family Chair at CREOL) and Joan Ruffier (former Chair of the Board of Regents of the State University System of Florida). And in 1989 the CREOL Industrial Affiliates program was inaugurated. Dr. Art Guenther was one of the first Life Members, and United Technologies Optical Systems (UTOS), led at the time by Dr. Jim Pearson (now CREOL Director, Research & Administration), was an early Affiliates member.

MJ thanking Jim Pearson for UTOS Industrial Affiliates membership

MJ and Eric help Art Guenther place his plaque on the "Wall of Honor" as a Life Member of the CREOL Industrial Affiliates

From the beginning, the partnership between CREOL and industry was not just a "connection", but a true research partnership. Industry found CREOL to be a great place to get research accomplished that was relevant to their needs, and accomplished on a time scale that met industry needs. As a result, for most of the last 20 years, CREOL has had approximately 25% of its funding coming directly from industry – just over $5M in 2005.

The final foundational element of community and fun is the "soft" element, but an essential one. Since in the early days, there were no decent restaurants within 10km of UCF, so CREOL began the tradition of entertaining faculty candidates and other visitors in the homes of faculty. This practice, plus ad hoc get-togethers at the office, holiday parties, and others helped connect

L-R: Jim Pearson, MJ, Jim Breckinridge, Henry Arsenault, and Joe Houston help carve the gator tail at the CREOL Spring Thing

CREOL students help Prof. Nicholaas Bloembergen celebrate his birthday at the CREOL Spring thing

everyone personally through fun events where the Director served everyone, literally. One of the parties has been "institutionalized" as the CREOL "Spring Thing," held each year after the SPIE Orlando meeting at MJ's home on the shore of alligator-infested Lake Jessup.

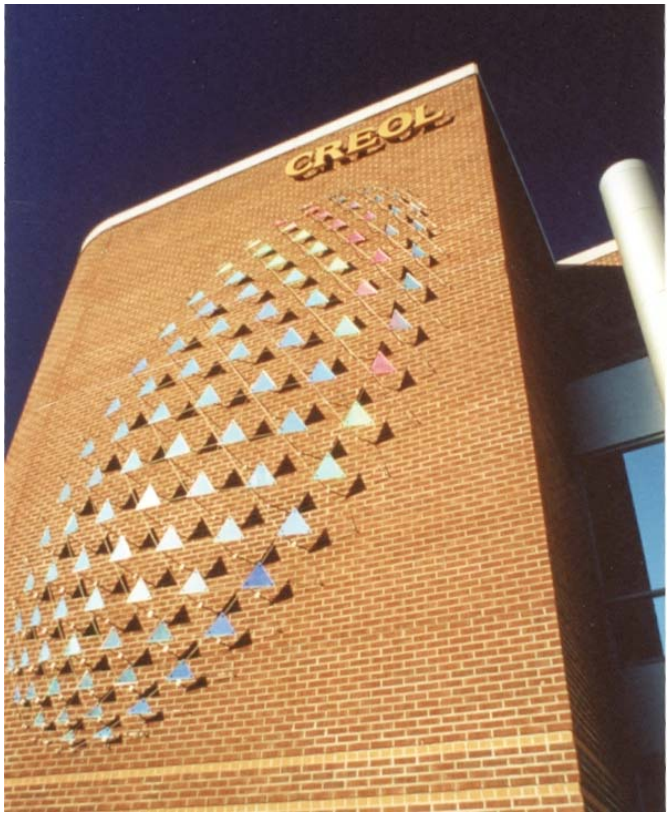
As the research progressed, and the new faculty arrived, CREOL rapidly outgrew the available space in the Research Pavilion and had several labs in another building near the UCF Institute for Simulation and Training (IST). In addition to the operational difficulties this situation presented, everyone really wanted to be on the main UCF campus, both for proximity to colleagues in other units, as well as to be perceived as an integral part of the university. And so a new facility was designed (it was actually promised at the outset, but it took 7 years to get everything in place), and construction began on the site of the original double-wide trailer.

View of the CREOL site cleared for the start of construction. The UCF Engineering building is visible in the far right of the picture. The double-wide trailer is at the far left.

Construction began in 1994, and was completed in time for a move-in over the Christmas holiday in December of 1995. By this time, the center had a total of over 150 students, staff, and faculty. The new 83,000 ft^2 facility was beautiful, functional, and graced by a wonderful sculpture of an artificial (holographic) rainbow on the outside of the building shows different colors depending on the time of day and angle of the sun with respect to the observer (see pictures below).

CREOL building during construction in 1995

The completed CREOL building – early 1996



With the new facilities, great faculty, outstanding students, strong partnerships, and a bit of fun to leaven the hard work, there was still one milestone left to achieve in the "CREOL Period" – although UCF, was granting degrees in optical science and engineering through the Electrical Engineering Department, it was time to consider a new degree program. So in the spring of 1996, an external review panel (Art Guenther, University of New Mexico; Bob Shannon, University of Arizona; and Brian Thompson, University of Rochester) was convened to review CREOL's progress, structure, plans, and programs. One of the recommendations of this panel was that CREOL should be made into an academic unit with its own degree programs, tenure of faculty, etc. The rationale for this recommendation was straightforward: optics had become a discipline unto itself; the CREOL faculty did all the functions of an academic unit: recruited the students, taught the classes, secured the funding for student stipends and research; supervised the student dissertations, and helped place students in jobs upon graduation.

With the panel's recommendation as support, UCF Provost Gary Whitehouse announced approval of the School of Optics in February of 1998, and on September 11, 1998, the Florida Board of Regents gave its formal approval of the school. To celebrate this significant milestone,

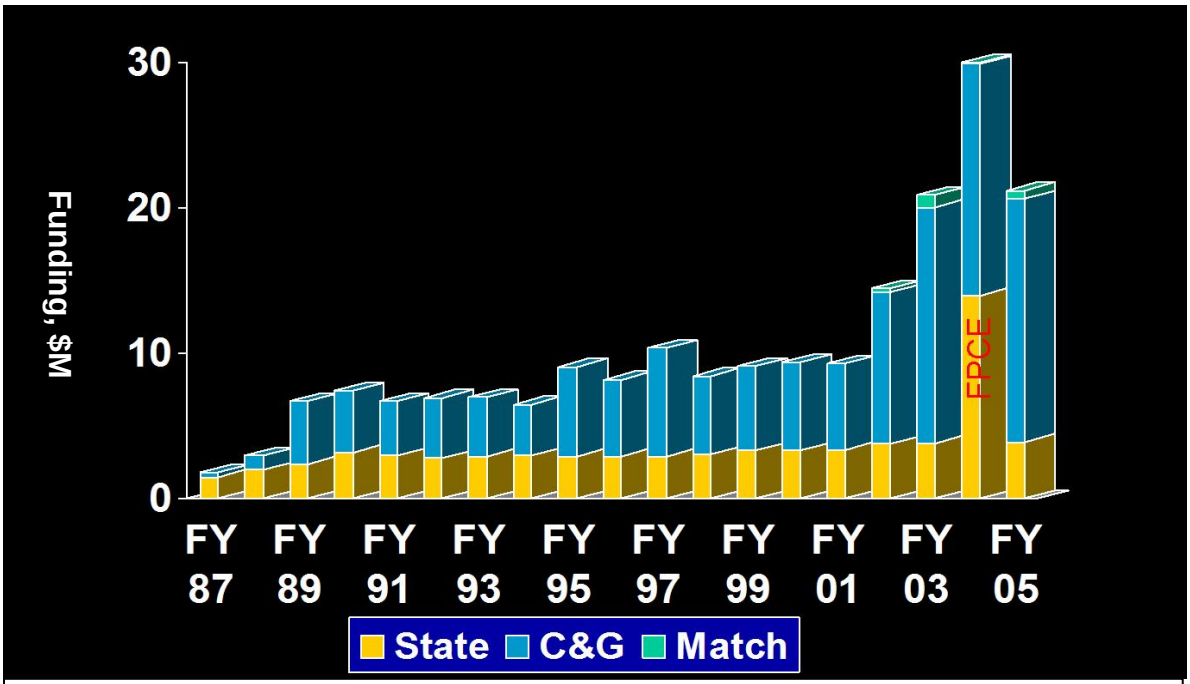
the School of Optics Inaugural Conference was held 11-12 January 1999, and was attended by many leaders from the optics community, including three Nobel laureates – Nicolaas Bloembergen (who also chaired the conference), Charles Townes, and Steven Chu. Even MJ's 8th grade teacher, Pete Antie, was there to help celebrate!

At the end of the CREOL Period (December 1998), CREOL had 21 faculty, 5 associate faculty with joint appointments in CREOL, 29 research associates, 18 staff, and 104 students.

The end of this Period was marked by a leadership transition. Dr. MJ Soileau stepped down as Director of CREOL to take on the duties of UCF Vice President for Research (to be precise, MJ handed over the directorship in July 1999). Dr. Eric Van Stryland, another of the original "Texans", became Interim Director while a search for a permanent director was conducted, with the caveat that he did not want the permanent job. During subsequent history "periods" below, the search for a better director was fruitless, and Eric became the de facto permanent director, in spite of his protests!

THE "SCHOOL OF OPTICS PERIOD": 1999 – 2004

The establishment of The School of Optics was a defining event in the history of CREOL, even though the momentum continued with great research, outstanding education, growth in faculty, etc. The new governance structure gave CREOL full control of its degree programs and tenure-granting and hiring decisions, and removed a source of conflict between CREOL and other UCF departments. Recruitment of faculty slowed down a bit, but 8 new people were added to the CREOL faculty through 2004, although some faculty also left or retired. Research continued strong, with funding taking a marked upturn beginning in FY2002 (July 1, 2001 to June 30, 2002) – see the figure below. The first optics degrees were awarded in 1999, and recruitment of students expanded.



CREOL funding history. The baseline state funding has slowly increased, with the effect of the one-time FPCE creation grant shown in FY2004. Contract and Grant (C&G) funding includes funding from both industry and government sources,

One of the more notable events during this period was the creation of the Florida Photonics Center of Excellence (FPCE). The FPCE was established with a $10 million grant from the State of Florida to create a new center of excellence within the School of Optics. The program began in July, 2003 (FY2004) with three primary goals:

- Advance excellence in research and graduate education chosen to serve existing and emerging industry clusters in the state (photonics, optics, lasers)
- Leverage state resources via partnerships with industry and government
- Work in partnership with local, state and regional economic development organizations to attract, retain and grow knowledge-based, wealth producing industry to Florida.

The focus of the FPCE research and education work is on the technologies of nanophotonics, biophotonics, advanced imaging and 3D displays, and ultra-high bandwidth communications, all of which have forecasts of rapid market growth. The $10M state grant is being used for three purposes:

(1) To develop infrastructure ($6M for new faculty, new facilities, new equipment)
(2) To fund competitive R&D Partnership Projects at Florida universities in partnership with Florida industry ($3.1M)
(3) To pursue commercialization and outreach (0.9M) with the help of the FPCE Industrial Advisory Board, the UCF Technology Incubator, and the Florida Photonics Cluster.

By the end of the School of Optics Period, CREOL/School of Optics had grown to a total of 234 people: 25 faculty, 11 associate faculty, 35 research staff, 18 staff, and 145 students. This growth had fully utilized the CREOL building lab and office space, and even with an office trailer added for graduate student offices, more space was desperately needed. The next period of evolution would address this need.

THE COLLEGE OF OPTICS AND PHOTONICS PERIOD: 2004 – PRESENT

In early 2004, UCF Provost Terry Hickey recognized that with the continuing growth and expansion of CREOL/School of Optics, and of the field of optics and photonics and its increasing importance to the state of Florida, the time had come to elevate the School of Optics to a full college, with a Dean to address not only the needs of the college, but also its place as a full partner with the other colleges at the University of Central Florida. The provost also wanted to try to infuse some of the successful "CREOL Culture" into the rest of the university. Consequently, in May of 2004, Provost Hickey announced the formation of CREOL & FPCE, The College of Optics and Photonics. This event marked the first time an optics program in the United States had achieved the status of a full college in its host institution, a milestone for CREOL, and also an indication that optics and photonics was at last being recognized as a distinct, independent discipline. We had a great time for the next 9 months of being the only college of optics in the US, even while being the youngest of the “Big 3” institutions among our colleagues at the University of Arizona and the University of Rochester. The next spring, the University of Arizona “saw the light” and promoted the Optical Sciences Center to the College of Optical Science. CREOL thus retains the distinction of being the first college in the field, and is glad to see other institutions following its lead.

Although we are only 2 years into the current “period”, a number of new things have been accomplished. Several of the accomplishments are associated with the FPCE. The results of the FPCE to date include the following:

- Support of 5 new start-up companies
- Establishment of 3 endowed chair faculty positions
- Hiring of one senior chaired faculty member (Dennis Deppe) and 4 junior faculty members
- Addition of a unique nanophotonics fabrication facility.
- Significant technical and product development results from ongoing Partnership Projects with industry. Use of $3.1M from FPCE to fund 24 projects at 5 universities and involving 20 company partners who have contributed $5.3M, several of which will enable new commercial products.
- Construction start of a 21,000 ft^2 lab/office building addition, supported in part by a $1.5M grant from the US Department of Commerce, Economic Development Administration, a $750K grant from the Florida High Tech Corridor Council, private donations, and UCF matching support. It includes space for an extension of the UCF Incubator, and will be occupied in December, 2006.

Elevation drawing of 3-story addition to CREOL Building, to be completed in Dec 2006

THE NEXT 20 YEARS

Of course, this chapter has yet to be written. As the next 20 years begins, CREOL & FPCE, The College of Optics and Photonics has a population of 277 people: 28 faculty, 16 research and associate faculty, 54 research associates or post-docs, 19 staff, and 160 students. Some of the things that are in process or on the possibility horizon include the following:

- Addition of a Bachelor's degree in optics. This would complement a relatively new UCF program, started in 2003 by a CREOL graduate, Dr. Al Ducharme, that provides a BSEET-Photonics undergraduate degree. The BSEET (Bachelor of Science in Engineering Technology) degree is designed as a terminal bachelor's degree, with more hands-on

course/lab work and less math and physics content than is found in a Bachelor of Optics curriculum.

- Expansion of the biophotonics research activities. A search for a chaired professor in biophotonics is currently underway.
- Expansion of the optics courses offered via distance learning, particularly web-based courses. The technical capability at CREOL to enable such course delivery was enhanced in 2005 and will continue to increase, both at CREOL and at UCF, as resources allow.
- Completion of the current 21,000 ft^2 expansion of the CREOL building facilities, and addition of a final expansion phase, completing the use of the available land on the CREOL site.

The future of CREOL & FPCE, The College of Optics and Photonics is clearly a bright one, full of opportunities and challenges to be met and realized. The philosophy of partnership with industry and of attracting the best and brightest faculty and students will continue to be central to the College's operation, and will continue to serve as a model for the continued development of the University of Central Florida into a 1^{st}-tier research university. The growth and development of UCF research capabilities is providing CREOL with many opportunities to team with colleagues in such diverse disciplines as human-factor psychology, augmented reality for simulation and training, materials science and engineering, biomolecular and medical sciences, information technology, digital media, and many others.

The Central Florida region has recognized the economic importance of optics and photonics, both as an industry and as an enabler to many other industries. With CREOL & FPCE, The College of Optics and Photonics as the academic and research hub, central Florida is poised to be an international center of excellence, technically and economically, in the 21^{st} century – the Century of the Photon!