

LASER-TEC

REGIONAL CENTER FOR LASER & FIBER OPTICS EDUCATION

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LASER-TEC 2016-2017 ANNUAL EVALUATION REPORT

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PART I

INTRODUCTION

LASER-TEC is the National Science Foundation Advanced Technological Education Center of Excellence in Lasers and Fiber Optics (the Center). It is an association of community and state colleges, universities, high schools and technical centers, trade associations, and laser and fiber-optic (LFO) companies in the following eight southeast states: Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Florida. LASER-TEC started its operation in September 2013 based at Indian River State College in Florida, with the following principal partners: Central Carolina Community College (North Carolina), Tri County Technical College (South Carolina), and CREOL (the College of Optics and Photonics at the University of Central Florida).

The mission of LASER-TEC is to develop a sustainable pipeline of qualified laser and fiber optics technicians to meet industry needs in the Southeastern United States. To accomplish this mission, the following goals were set:

1. Assist colleges with existing LFO programs by providing support, professional development, and equipment.
2. Assist colleges without LFO programs to create courses and programs by providing start-up support.
3. Provide professional development for K-12 STEM teachers to bring LFO career awareness to students to create a high school to college student pipeline.
4. Create awareness of LFO careers and a clear pathway for returning veterans to recruit them for participating regional college programs.
5. Develop, expand, and strengthen partnerships between LFO industries and all regional colleges.
6. Expand the membership of the Industrial Advisory Board (IAB) and monitor the supply, demand, and skillset needed by LFO technicians in the southeast region of the US through a strong IAB.

This report evaluates the progress, accomplishments, and challenges in achieving these goals in year 4 of LASER-TEC operation.

Part II of this report describes the evaluation model and methodology used for this project. The evaluation team started working with LASER-TEC during the proposal development period and created the current evaluation plan. The evaluation plan is graphically represented in the logic model presented on page 4 of this report. Continuous formative evaluations have been done during the four years of operation. Part III lists the recommendations for changes or improvements. Part IV of this report presents the conclusions of the evaluation team.

PART II

EVALUATION METHODOLOGY

A mixed evaluation methodology was used to assess and analyze the goals and their outcomes of this project. The following four questions were asked to facilitate the evaluation process:

- What was proposed to be done?
- How was it planned?
- Is it being done as planned?
- Is the program successful?

The four-level Kirkpatrick and Kirkpatrick method was used to evaluate results and outcomes of the fifth goal, which focused on teachers' professional development. The following questions were asked:

- To what degree are K-12 teachers, counselors, and administrators satisfied with the content and quality of LFO seminars and the center services? (Reaction Level)
- To what degree did K-12 teachers, counselors, and administrators understand the need to incorporate LFO modules in life sciences classes and career counseling? (Learning Level)
- To what degree are K-12 teachers, counselors, and administrators incorporating LFO modules in life sciences classes and career counseling? (Behavior Level)
- How many new LFO courses, modules, lessons, and career guidance sessions have been added in K-12 schools, and how many students have attended? (Results Level)

At the outset of the project, the PI met with the evaluator on four occasions and outlined the goals, objectives, and tasks of this project. An evaluation plan was drafted that includes the collection of data for a continuous formative evaluation during each year of the project and a summative evaluation at the end of each year of the project. Feedback from the formative evaluations was provided to the management team on a regular basis so that corrective actions are taken immediately for effective management. The evaluator was responsible for creating the evaluation instruments, scripts for telephone interviews, and other evaluation tools. The Center staff disseminated and collected the evaluation results from participants and presented them to the evaluator for analysis and report preparation.

This report represents the formal summative evaluation for year 4 of LASER-TEC operation.

LASER-TEC LOGIC MODEL

RESOURCES	ACTIVITIES	OUTPUTS	SHORT-TERM OUTCOMES	LONG-TERM OUTCOMES	IMPACT
In order to accomplish our set of activities, we will need the following:	In order to address our problem or asset, we will accomplish the following activities:	We expect that once accomplished, these activities will produce the following evidence or service delivery:	We expect that if accomplished, these activities will lead to the following changes in 1-3 years:	We expect that if accomplished, these activities will lead to the following changes in 4-6 years:	We expect that if accomplished, these activities will lead to the following changes in 7-10 years:
Funding from NSF.	Find industry needs in LFO technicians and training.	A list of training programs. A list of training strategies. A list of priorities and timelines for training.	Familiarity with industry needs in the number of required technicians. Familiarity with training needs of the industry.	Quicker responses to industry training needs.	Make US economy more responsive, efficient, and competitive in the global market.
Support from IRSC in infrastructure, offices, computer services, telecommunications, etc.	Establish specialty LFO training labs at each principal partner college.	A number and type of specialized LFO training programs at partner colleges.	A number of technicians trained at each college.	Industry satisfaction to demand in skilled workforce.	Increase the number of well-paid technicians. Strengthen industry by meeting workforce requirements. Strengthen the US economy.
Support from the industry in providing needed information on technician skills and needs.	Create training programs in colleges located close to industry.	A list of LFO training programs at colleges close to industry.	Increase the number of competent technicians available to the industry.	Further reduction in the gap between supply and demand for technicians.	Balance the supply and demand for technicians.
Endorsement from professional societies like SPIE, OSA, and IEEE.	Create a dynamic IAB to establish the direction of the Center.	Growing membership numbers in the IAB. A list of future directions.	Create courses and training needed by industry.	Reduce the response time in the creation of new courses and training	Strengthen and make US economy more competitive.
An action plan for year-to-year operations.	Provide outreach to K-12 teachers, counselors, and administrators.	A number of outreach programs for educators. A number of outreach participants.	Increase number of students studying LFO or related subjects.	Further increase the number of students that study LFO or related subjects.	Strengthen US economy and increase prosperity of graduates with LFO degrees.
Competent Center staff.	Recruit more veterans and minorities.	A number of veterans, minorities, and women in the industry.	Increase the standard of living of veterans and minority graduates.	Further increase the standard of living of veterans and minority graduates.	Strengthen US economy and increase prosperity for veterans and minorities.

PART III

EVALUATION FINDINGS

Goal 1. Assist colleges with existing LFO programs by providing support, professional development, and equipment.

RESEARCH QUESTION:

How do the efforts of LASER-TEC influence the development and strengthening of established LFO programs?



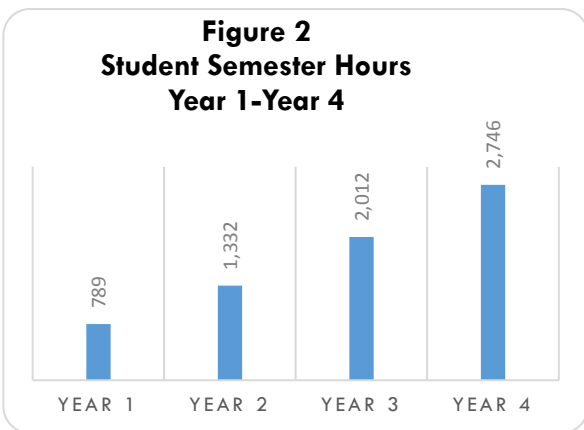
EXAMINED AREAS:

- *Development, implementation, and dissemination of curriculum and instructional materials*
- *Efforts to enroll, retain, and graduate students from established LFO programs*
- *Development and improvement of LFO laboratories*
- *Faculty professional development*
- *Institutional support*
- *Efforts to increase the number of students choosing LFO and STEM programs*

Findings:

The number of students in LASER-TEC photonics programs has increased consistently from the baseline of 108 in 2013 to 223 in 2017—an increase of 106%. This sustained growth of student enrollment is largely attributed to the diverse public outreach and recruitment campaign deployed by the Center.

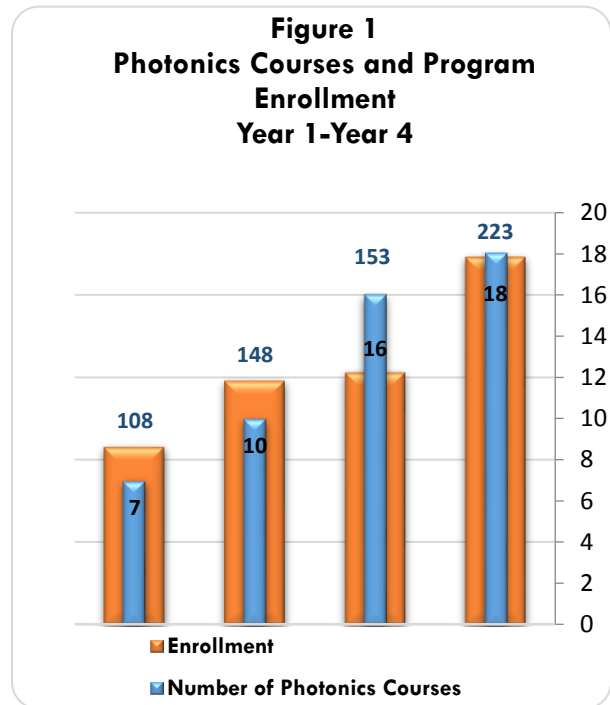
The number of photonics courses and program enrollment has steadily increased over the last four years. LASER-TEC has developed or updated ten photonics courses. During the 2016-2017 academic year, 18 photonics course sessions were offered by the partner colleges, which constitutes a substantial increase of 157%, as shown in figure 1. In addition, nine new modules have been developed and infused in photonics or photonics-related courses.



Since the length of courses in credit hours differ at each partner college, the student semester hours (SSH) were used as a metric to evaluate the

change in photonics enrollment at the participating colleges. The number of SSH has increased from 789 in 2013 to 2,746 in 2017. This represents the increase of almost 250% as shown in figure 2.

The overall increase in photonics course offerings is largely secured by faculty professional development and improvement of the laboratory facilities. In a short period of time, five new laboratories have been developed and now support the Center’s academic programs. A swift allocation of space and infrastructure for the new laboratories indicate a robust institutional support, which in turn reveals the high potential of program sustainability.

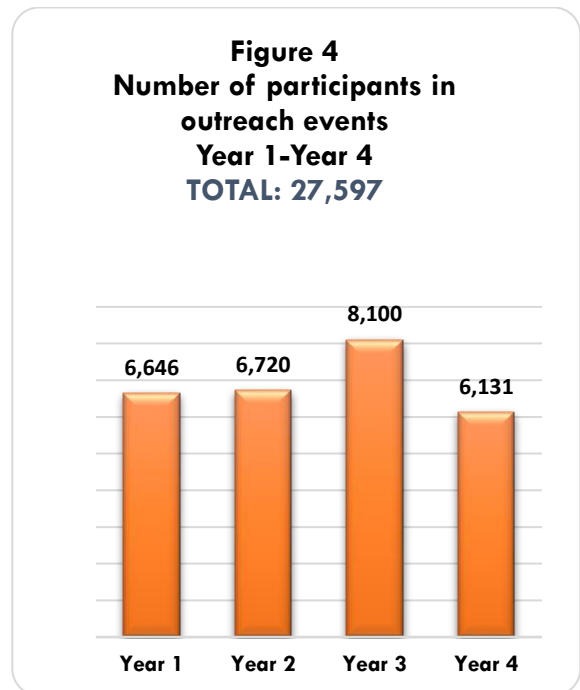
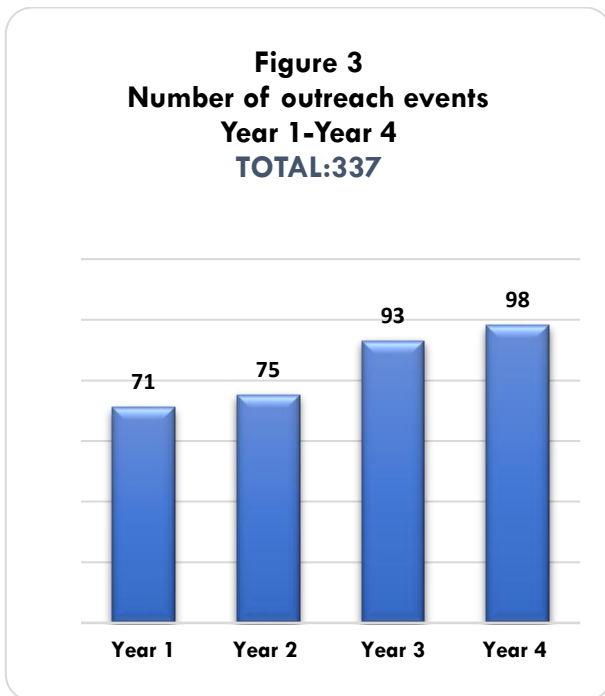


LASER-TEC has employed three part-time dedicated recruiters proven to be very effective in public outreach and student recruitment. The results are demonstrated by the large and continuously growing numbers of attendees as shown in figures 3 and 4. The number of outreach events has steadily increased, totaling 337 events since the establishment of the Center. The number of students impacted by the Center’s outreach activities reached almost 30,000.

The Center’s outreach efforts feed the LFO college student pipeline and are very significant. It is evident that the Center dedicates a lot of effort and time to accomplishing these tasks. The target

populations and groups include middle and high school students, teachers, parents, members of general public, counselors, advisors, unemployed, underemployed, veterans, and others. LASER-TEC has leveraged collaboration with the other NSF ATE centers, such as OP-TEC and MPEC, and reached out to the K-12 community outside the southeast region.

A close examination of the LASER-TEC outreach campaign has revealed that engagement of a large number of K-12 students in short-term events has not resulted in a projected growth of college programs' enrollment at the end of year 3. The Center management evaluated the results and adjusted its approach. During year 4, the Center concentrated on long-term events with multiple sessions throughout the whole academic year, focusing attention to individual students and building their fundamental knowledge and skills in LFO. The Center management considers that this change will have a higher impact on students' decision making to pursue LFO studies. During 2016-2017, LASER-TEC offered 18 camps with a minimum of 16 contact hours per camp for 214 middle and high school students. This change explains the drop in the number of participants in year 4, as the number of events continued to rise. The evaluation of this effort will be presented in later studies.



ACTIVITIES UNDER GOAL 1 HAD THE FOLLOWING LONG-TERM IMPACT:

Curriculum development:

- ✓ 10 new courses are now available to all US colleges.
- ✓ 9 new modules are available to all US colleges.
- ✓ Increased faculty knowledge.
- ✓ 5 new LFO laboratories have been established.

Enrollment and placement:

- ✓ The number of students taking laser and photonics courses increased to 223 in year 4.
- ✓ Job placement is at 95% with several students receiving more than one job offer.

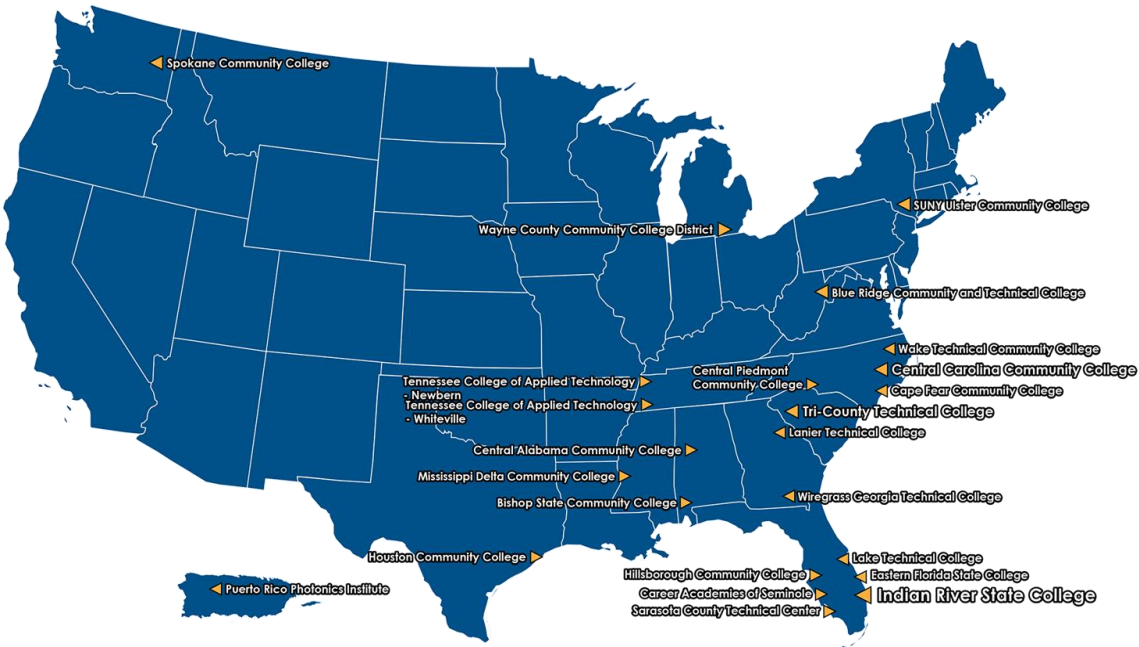
STEM awareness:

- ✓ The total number of all middle and high school students who attended LASER-TEC events in 2013-2017 reached 27,597.

Goal 2. Assist colleges without LFO programs to create courses and programs by providing start-up support.

Findings:

During year 1 to year 4, LASER-TEC conducted 10 email campaigns that reached out to more than 700 southeast college faculty and administrators, presented at nearly 30 conferences for the purpose of bringing LFO awareness, and invited more colleges to the network. At the same time, college members received continuous support in establishing or sustaining LFO programs. These efforts resulted in a balanced advancement of the LASER-TEC college network. Today, there are 24 colleges in the southeast region that are in the process of offering LFO courses.

Figure 5. LASER-TEC College Network

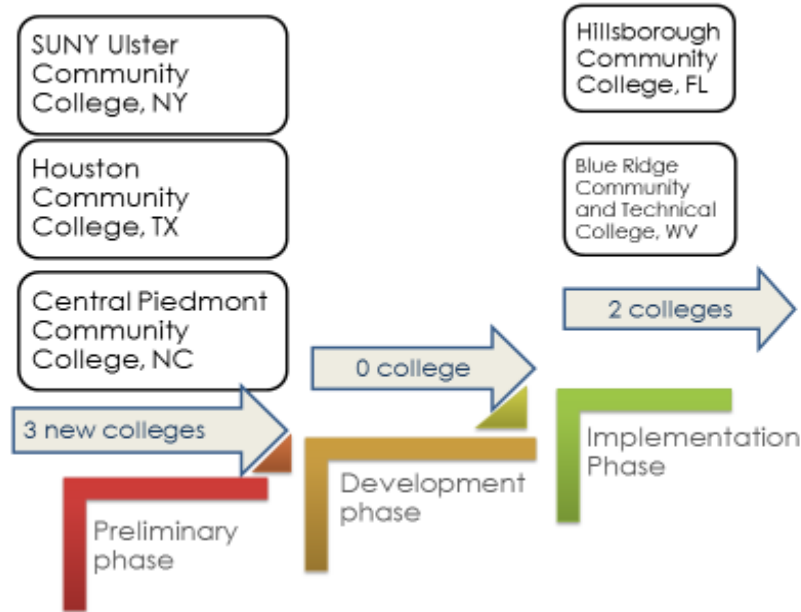
These colleges are at different stages of LFO program development. To track the advancements of colleges within the network, the evaluator and the Center's management team developed a three-phase classification system which includes preliminary, development, and implementation phases. In 2017, eight colleges are classified to be in the implementation phase (IRSC, CCCC, TCTC, SCC, PRPI, BRCTC, HCC, and WGTC), one in the development phase (WCCCD), and the rest are in the preliminary phase.

As it was identified in the previous Evaluation Report, under favorable conditions a college two to three years to progress between the preliminary and implementation phases. A relatively slow advancement is associated with the required faculty development, facility establishment, and necessary processes and policies within each institution.

During year 4, three colleges—SUNY Ulster Community College (NY), Houston Community College (TX), and Central Piedmont Community College (NC)—expressed their interest in offering an LFO course. These colleges receive continuous support from the Center and have a full access to the materials developed by LASER-TEC. This includes the new Experiment Manual that accompanies the Light and Optics Kit specifically developed for use by two-year colleges. During this period, Hillsborough Community College (FL) and Blue Ridge Community and Technical College (WV) advanced to the implementation phase of starting LFO courses and modules. See figure 6.

Figure 6

College Network Advancements Year 4



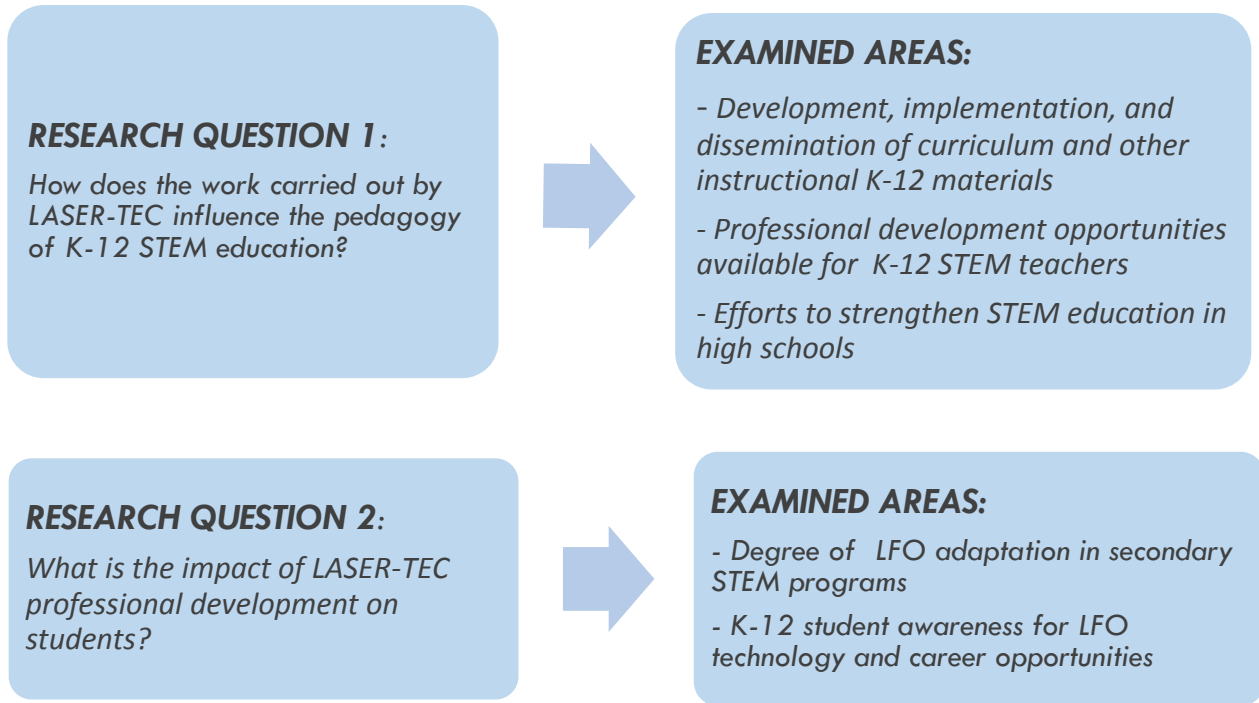
The college course offerings are found to reflect the local industry presence. For example, in Florida and Georgia, where there is large number of fiber optics companies, colleges are mostly interested in offering fiber-optics-related courses. In North Carolina, where there is a large number of laser companies located in the Research Triangle, there is a greater demand for laser-related curriculum.

In summary, the college network doubled from 12 colleges in year 1 to 24 in year 4. The level of engagement and support of the Center has advanced as well.

ACTIVITIES UNDER GOAL 2 HAD THE FOLLOWING LONG-TERM IMPACT:

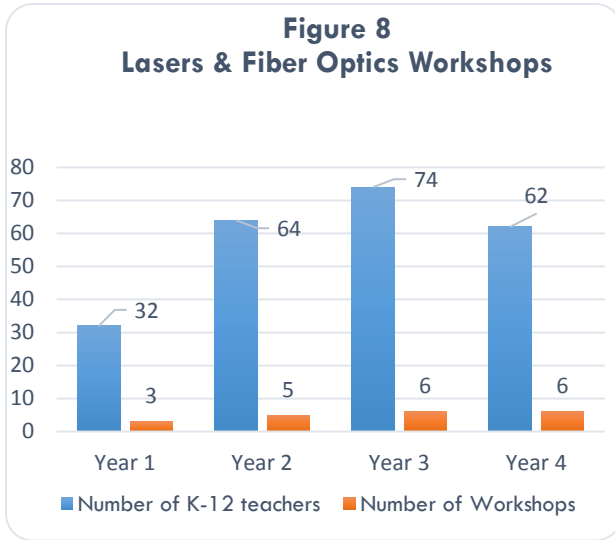
- ✓ Increased number of colleges that are aware about LFO.
- ✓ Increased number of colleges developing LFO courses and programs.
- ✓ Increased number of colleges offering LFO courses and programs.
- ✓ Increased output of graduates from southeast colleges.
- ✓ Reduced the supply/demand gap for LFO technicians in the southeast.

Goal 3. Provide professional development for K-12 STEM teachers to bring LFO career awareness to students to create a high school to college student pipeline.

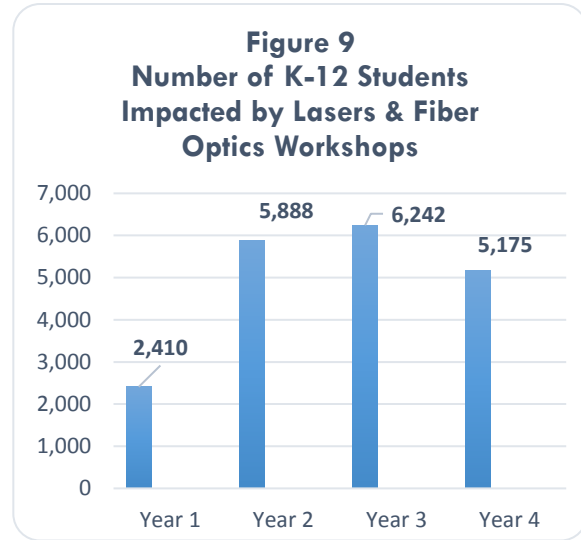


Findings:

LASER-TEC workshops offer rich content and various hands-on activities, and they are profoundly supported by teacher materials. The workshop content and delivery format are continuously adjusted based on participants' evaluations as well as internal evaluation by the Center. One of the main workshop goals is to teach educators and counselors to achieve a multiplier effect in student LFO awareness. Typically, every teacher has on average 125 students under their tutelage every year, and a counselor has more than 500 students annually. Workshops are one day in length, typically seven hours with a combination of lectures, demonstrations, and hands-on sessions. These workshops were conducted in fall, spring, or summer semesters, based on teacher availability. In year 4, a total of six workshops have been hosted to advance technical knowledge in LFO to 62 K-12 teachers and counselors as shown in figure 8. The total number of students impacted by LASER-TEC workshops is 19,715, also shown in figure 8.



Total number of workshop: 20
Total number of K-12 teachers 198



Total number of students impacted: 19,715

A two-step workshop evaluation is conducted in accordance with the Kirkpatrick and Kirkpatrick model. The first evaluation is conducted at the end of each workshop to measure participants' Reaction Level and Learning Level. In general, workshop attendees found the workshop useful and informative, as indicated below.

- Overall, how would you rate this professional development event? *Excellent, 95%*
- Overall, how valuable was the content presented at this workshop? *Excellent, 98%,*
- How likely are you to implement some of the classroom demonstrations into your lessons? *Very likely, 80%*
- How likely are you to start a laser and fiber optics course at your school? *Very likely, 20%,*

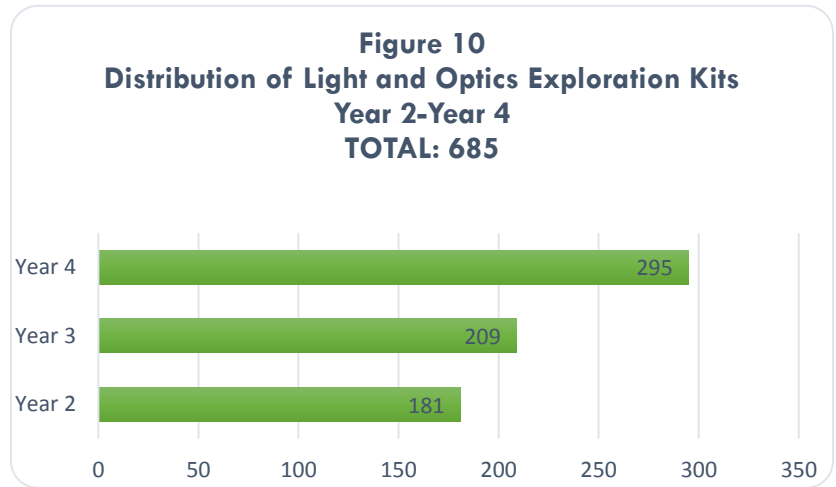
Six months after each workshop, a second evaluation is conducted in a form of an electronic survey to assess the degree of implementation. This survey is designed to measure behavior and result levels according to the Kirkpatrick and Kirkpatrick model. The findings related to the six-month follow-up survey are summarized below:

- Percent of received responses: 38%.
- 76 % of responders used the kit and the lesson plans in their STEM lessons.
- All 15 lesson plans have been used by responders for their lessons.
- 76% of responders who used the kit and lesson plans stated that the kit and lesson plans are useful and contain all necessary information to help them prepare for the lesson.

A relatively high content implementation level of the workshop content in K-12 STEM classes is sustained by the availability and quality of the teachers' resources developed by LASER-TEC. During each workshop, all participants are provided with the Light and Optics Exploration Kit accompanied with detailed lesson plans. This approach has been found to be the most immediate and efficient way to impact students and get them interested in STEM and LFO.

During the past three years, LASER-TEC has distributed 685 Light and Optics Exploration Kits in more than 25 different states, as shown in figure 10.

In addition to the Exploration Kits, LASER-TEC has also developed Laser-Enabled Security System Kits (59 distributed) as well as Arduino 1 and 2 Kits (65 distributed). The Center is currently working on developing teacher supplementary resources such as lesson plans, videos, power point presentations, and other resources.



ACTIVITIES UNDER GOAL 3 HAD THE FOLLOWING LONG-TERM IMPACT:

- ✓ Increased infusion of LFO knowledge into K-12 STEM disciplines.
- ✓ Increased number of students interested in LFO careers.
- ✓ LASER-TEC kits create an affordable way to teach photonics in K-12 schools.
- ✓ Mapping National Standards to lesson plans makes demonstration book useful to all STEM disciplines.

Goal 4. Create awareness of LFO careers and a clear pathway for returning veterans to recruit them for participating regional college programs.

RESEARCH QUESTION 1:
What is the Center's impact on veterans' enrollment to LFO programs?

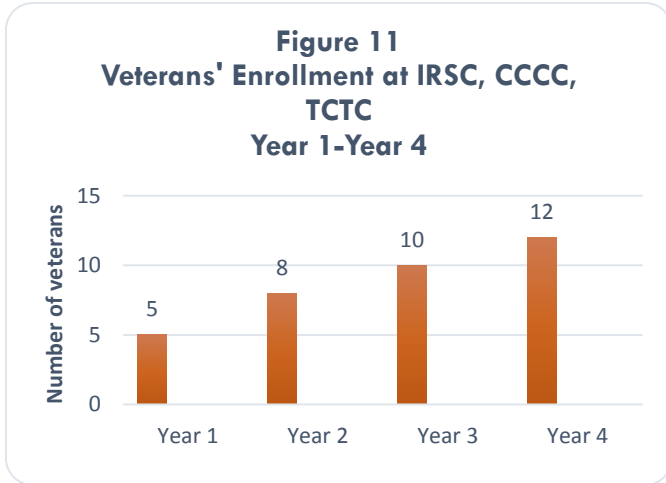


EXAMINED AREAS:

- Awareness strategies to veteran community employed by LASER-TEC
- Veteran enrollment in partnering colleges

Findings:

The Center initiated email and telephone campaigns to 25 veteran Transition Assistance Program offices in the southeast United States. Also, similar campaigns were conducted at military bases in the southeast region. The number of veterans enrolling in LFO programs has increased but at a slower than anticipated rate, as shown in figure 11. However, the number of enrolled veterans more than doubled in year 4 from that of year 1. Similar results are reported by other NSF Centers.



A possible explanation for this is the aggressive marketing of for-profit colleges attracting the majority of veterans. An excerpt from the *Tampa Bay Tribune* states “For-profit schools received \$1.7 billion in veterans’ benefits during the 2012-13 academic year, 41 percent of all G.I. Bill dollars and almost as much as the cost of the entire program just four years earlier, according to the majority report of the Senate Health, Education, Labor and Pensions Committee released July 30.” See the links below for relevant articles in the US press.

- <http://www.tbo.com/news/education/colleges-gouge-vets-report-says-20140818/>
- <http://www.latimes.com/business/la-fi-university-of-phoenix-military-20151009-story.html>
- <http://chronicle.com/article/For-Profit-Colleges-Still-Cash/147977>

Goal 5. Develop, expand, and strengthen partnerships between LFO industries and all regional colleges.

RESEARCH QUESTIONS:

How does LASER-TEC influence developing relationships with business and industry?

Do these relationships have broader impact on the relationships between the college and local businesses?

What impact does LASER-TEC have on development of the incumbent LFO workforce?



EXAMINED AREAS:

- Development, implementation, and dissemination of continuing education and college-level training for incumbent LFO workforce

- Corroboration of local businesses with LASER-TEC college partners

- Timely supply of new talent to meet the industry hiring needs

Findings:

The industry contribution to LASER-TEC has been growing throughout the three years of LASER-TEC operation. Estimated contributions came to \$120,000, as shown in figure 12.

The LASER-TEC industry partners advised on the program design and course content as well as contributed equipment for course development.

The major contributors of the course development effort are:

- Spectroscopy: Watsatch Photonics, Ocean Optics
- Laser Applications: MegaWatt Lasers, Synoptics, IPG Photonics
- Fiber Optics: PCS Fiber, Corning Optical Systems, Anixter, Transition Networks

The LASER-TEC industry training has enabled the advancement of technical knowledge and skills in 141 of the LFO incumbent workforce. Furthermore, the exposure of the college faculty to the new technologies and techniques facilitated development of the curriculum which is better aligned to the industry needs.

The Center has organized and facilitated 43 on-campus or on-site hiring sessions for 15 LFO companies. This effort enabled industry to acquire qualified workforce, while providing graduates with opportunities of gainful employment. By the end of year 4, 31 LFO companies have hired LASER-TEC graduates.

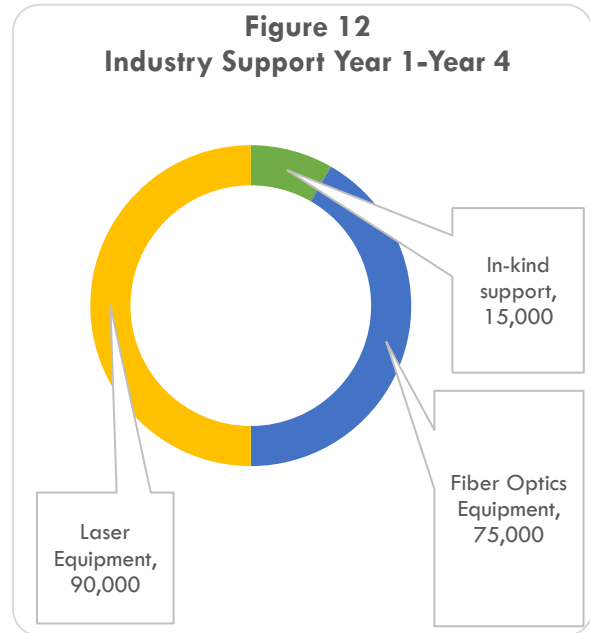
It is evident that the Center conducts a wide-spectrum approach in engaging the industry and building college/industry partnerships that enable strengthening of the nation's LFO workforce.

ACTIVITIES UNDER GOAL 5 HAD THE FOLLOWING LONG-TERM IMPACT:*Impact on the incoming workforce:*

- ✓ Increased number of companies hiring LASER-TEC graduates.
- ✓ 15 companies routinely recruit LASER-TEC graduates before their graduation.
- ✓ Supplied qualified LFO technicians to 31 SE companies.

Impact on the existing workforce:

- ✓ Increased number of trained incumbent workers.
- ✓ Companies have trained workforce to the latest industrial standards.



Goal 6. Expand the membership of the Industrial Advisory Board (IAB) and monitor the supply, demand, and skillset needed by LFO technicians in the Southeast region through a strong IAB.

RESEARCH QUESTION:

How does LASER-TEC leverage the Industry Advisory Board to monitor the workforce supply and demand in the southeast?



EXAMINED AREAS:

- Communication effectiveness with IAB and the Industrial Network
- Dissemination of information among the stakeholders
- Implementation of IAB recommendations

Findings:

LASER-TEC has a strong industry network consisting of 147 companies in the southeast US. Additionally, six other companies joined the network this year from the following states: California, Michigan, Ohio, Massachusetts, Delaware, and Washington. From the annual survey of technician skills and from industry meetings, the Center identified and forwarded to its members the new recommended skills. Partner colleges added these skills to appropriate courses and labs.

ACTIVITIES UNDER GOAL 6 HAD THE FOLLOWING IMPACT:

Mid-term

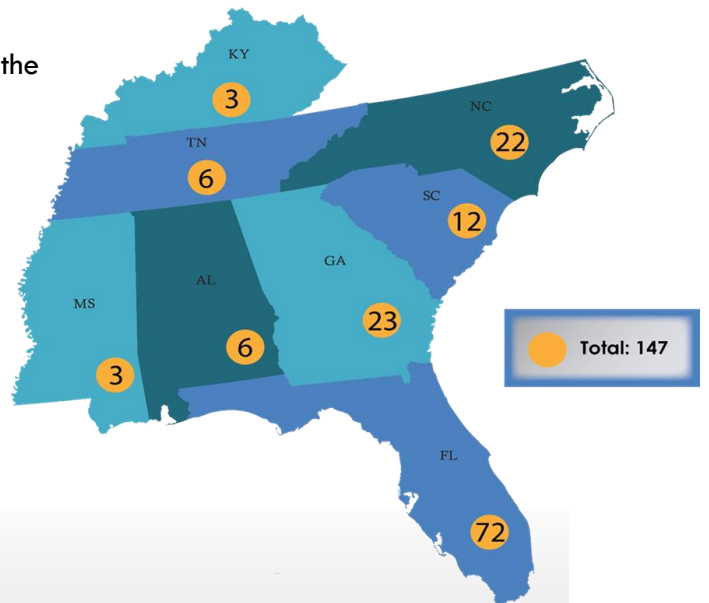
- ✓ Active IAB.
- ✓ Improved LFO programs reflecting IAB recommendations.
- ✓ Improved quality of LFO graduates.
- ✓ Increased number of companies hiring LASER-TEC graduates.

Long-term

- ✓ Aligned skillset for LFO technicians with the industry needs.
- ✓ Reduced the supply and demand gap of trained LFO workforce.

Figure 13

Industry Network, Regional Cluster



PART IV

RECOMMENDATIONS

The impact of the Tech Like a Girl initiative has been significant. Consider its expansion with the Center's college network members.

It is evident that LASER-TEC's cost-friendly kits accompanied with the teacher support package are prevalent among teachers as they enable educators to easily integrate LFO and introduce a large number of students to this growing field. Currently, the new Arduino 1 and 2 kits are not yet supported with comprehensive teacher's resources. Consider developing teacher's guides for the two Arduino kits and make them available to K-12 and college instructors.

To strengthen college/industry partnerships and facilitate robust graduate employment, consider participating with UCF/CREOL at the SPIE Conference Defense and Commercial Sensing which will take place in Orlando in April 2018. This local Florida conference provides a great opportunity in establishing partnership with multiple photonics companies.

PART V

CONCLUSIONS

LASER-TEC has successfully improved on all of its six goals with outcomes and impacts measured according to the logic model evaluation methodology.

It did increase the number of students, faculty, offered courses, and lab facilities in all participating colleges. It has also grown the number of photonics courses offered, and program enrollment has steadily increased over the four years of LASER-TEC existence.

The Center expanded the college network that is offering and preparing to offer LFO courses at 24 new colleges. In year 4, three new colleges entered the preliminary phase and two institutions advanced to the implementation phase.

In the area of professional development for K-12 teachers and counselors, between year 1 and year 4, LASER-TEC conducted 20 workshops to 198 educators. Surveys conducted six months after the workshops show 100% utilization of the Light and Optics Exploration Kit and lesson plans in K-12 classes. Teachers and administrators commended LASER-TEC for the affordability of the kits. Mapping the lesson plans to the National Science Education standards makes the demonstration book valuable to all STEM disciplines.

Reaching out to veterans remains one of the most challenging tasks. Despite expending considerable amount of time and effort to increase the veteran enrollment, LASER-TEC has achieved only a slight increase in numbers. However, similar results are reported by other NSF centers. It is recommended that LASER-TEC revisits the methods used to recruit veterans and create a new plan of action.

The ongoing industry support is very strong, as evidenced by the monetary and in-kind contributions to LASER-TEC, which have been growing throughout the duration of the Center's operation and reached an estimated amount of \$120,000. LASER-TEC has been effective in fostering industry partnerships and leveraging it for the LFO program design, course content, and updating technician skillsets.

The Center has a strong IAB, consisting of members from not only southeast states, but other states such as California, Michigan, Ohio, Massachusetts, Delaware, and Washington. The Center's management team is responsive to recommendations from the IAB, particularly in aligning training and college-acquired skillsets with industry needs.