

The logo features the text 'LASER-TEC' in a bold, orange, sans-serif font. Below it, the text 'REGIONAL CENTER FOR LASER & FIBER OPTICS EDUCATION' is written in a smaller, white, sans-serif font. At the bottom of the logo, the phone number '772.462.7179' and the website 'WWW.LASER-TEC.ORG' are displayed in white. The background of the logo is a dark blue gradient with abstract, glowing orange and white lines that suggest light or fiber optics. A thick orange vertical bar is on the left side of the page, and a blue square is at the bottom left corner.

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LASER-TEC 2015-2016 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. 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 startup 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 U.S. through a strong IAB.

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

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 evaluation plan which we currently execute. The evaluation plan is graphically represented in the logic model presented in this report. Continuous formative evaluations have been done during the first three years of operation. Part III lists the recommendations for changes or improvements. Part IV presents the conclusions of the evaluation team.

PART II

EVALUATION METHODOLOGY

A mixed evaluation methodology was used to assess and analyze the goals and objectives 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?

Additionally, goal number five focused on teachers' professional development, and the four-level Kirkpatrick and Kirkpatrick method was used, which asks the following questions:

- 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 every 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 the third year of operation of LASER-TEC. It analyzes and assesses the progress of the project and suggests changes or realignment of goals and objectives for the following year as needed.

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.	Knowing the industry needs in a number of technicians. Know the 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 having the needed workforce. 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, IEEE.	Create a dynamic Industrial Advisory Board 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 to creation of new courses and training	Strengthen and make US economy more competitive.
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?



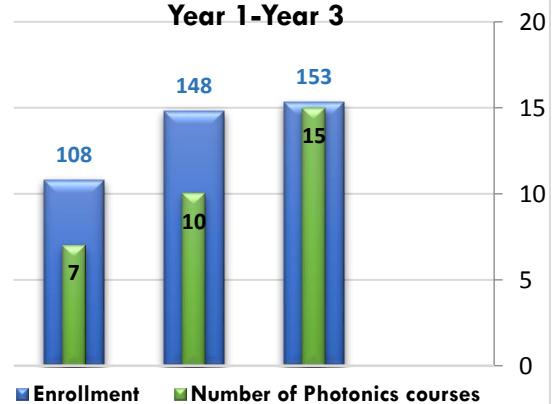
EXAMINED AREAS:

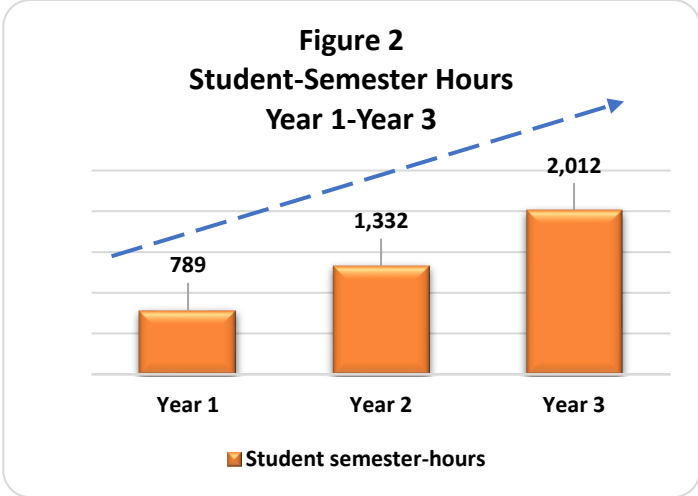
- Development, implementation, and dissemination of curriculum and instructional materials
- Efforts to enroll, retain, and graduate students from established LFO programs
- Development and improvement of LFO laboratories
- Faculty professional development
- Institutional Support
- Efforts to increase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

Findings:

The number of photonics courses offered and program enrollment has steadily grown over the three years of LASER-TEC. A sharp increase in enrollment was observed in years one and two when LASER-TEC was established and became fully operational. In year three the increase slowed down as the participating colleges reached the maximum in capacity of incoming students, available lab and classroom facilities, and personnel. The number of students increased consistently from the baseline of 108 in 2013 to 153 in 2015—an increase of 42%. The number of photonics courses available at the partner colleges increased from 7 in 2013 to 15 in 2015—an increase of 138%, as shown in figure 1.

**Figure 1
Photonics Courses and Program Enrollment
Year 1-Year 3**



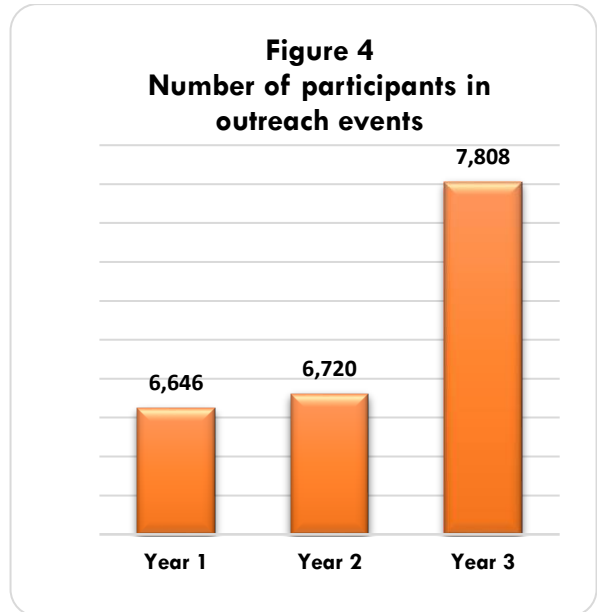
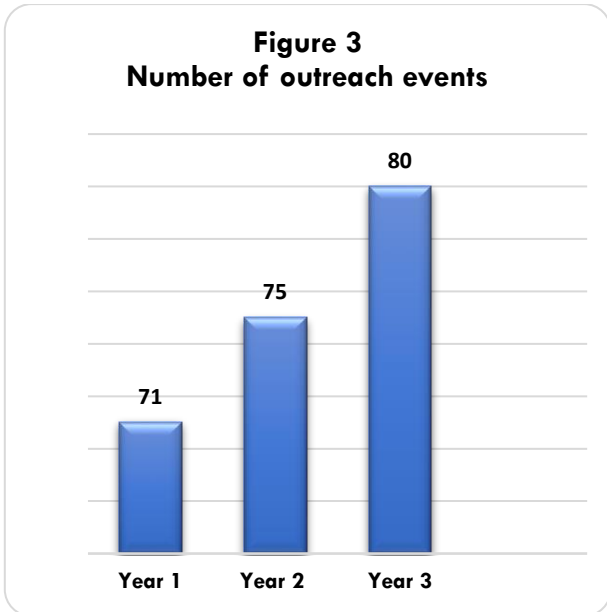


Since the length of courses in credit hours is different at each partner college, the student semester hours (SSH) were used as a metric to evaluate the increase in photonics enrollment at the participating colleges. The number of SSH has increased from 789 in 2013 to 2,012 in 2015. This represents the increase of 69% and 51% respectively, as shown in figure 2.

In the area of outreach and recruitment, LASER-TEC hired three part-time dedicated recruiters who have proven to be very effective, as demonstrated by the following results.

The Center’s diverse outreach efforts that feed the LFO college student pipeline are very significant. A lot of time and effort have been dedicated to accomplishing these tasks. The participants in the outreach events include teachers, parents, the general public, counselors, and advisors. LASER-TEC 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.

The numbers of outreach events has steadily increased to 80 in year three totaling 226 events since the establishment of the Center. The number of students impacted by the Center’s outreach activities increased to 7,808 in year three, totaling 21,174 since the establishment of the Center as shown in figures 3 and 4.



Activities under Goal 1 had the following long term impact:

Curriculum development:

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

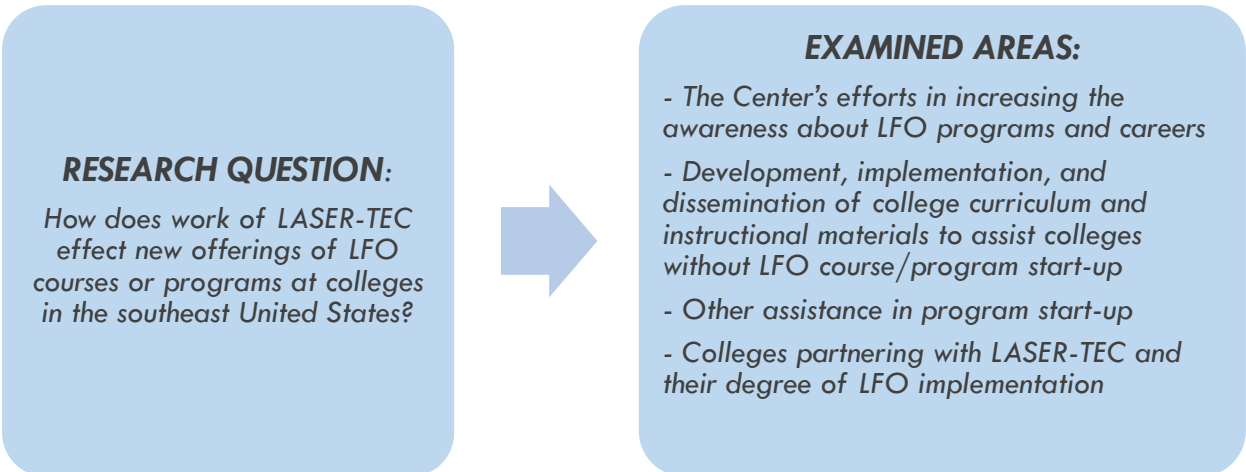
Enrollment, student success and placement:

- ✓ The number of students taking laser and photonics courses increased to 153 this year.
- ✓ The development of student cohorts, providing visits to industry, and career counseling has resulted in 100% retention from fall 2015 to spring 2016.
- ✓ 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 2015-2016 reached 49,875.
- ✓ The number of teachers who attended LASER-TEC outreach events and faculty development workshops is 7,808.

Goal 2. Assist colleges without LFO programs to create courses and programs by providing startup support.



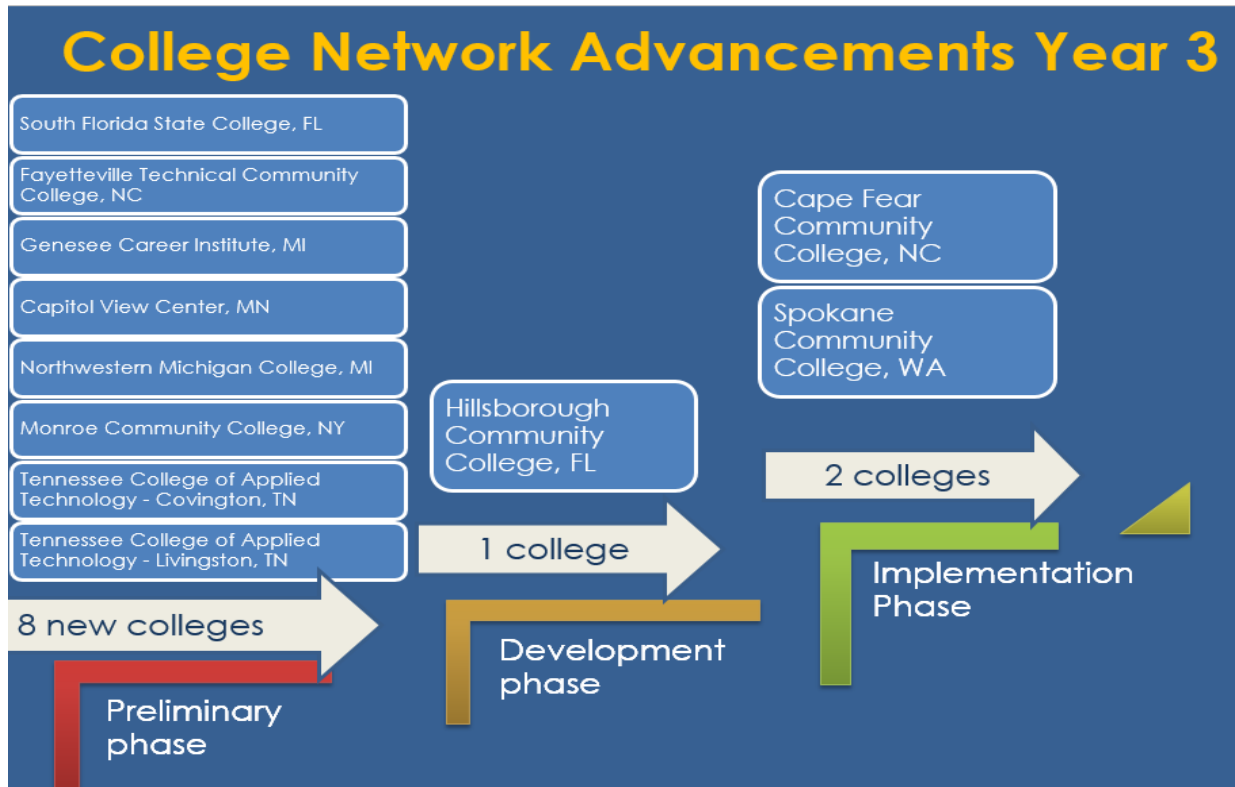
Findings:

LASER-TEC conducted 6 email campaigns to 236 southeast colleges and presented at 8 conferences for the purpose of bringing LFO awareness and attracting more colleges to the network. These efforts resulted in a balanced advancement of the LASER-TEC college network. Today, there are 24 colleges in the SE region in the process of offering LFO courses. 8 colleges expressed their interest in offering a course during year three. These colleges receive continuous support from the Center and have an access to the materials developed by LASER-TEC. This includes the new Lab Manual that accompanies the Light and Optics Experiment Kit which was specifically developed for two- year college use. Two colleges—Cape Fear Community College (CFCC) and Spokane Community College—advanced to the implementation phase of starting LFO courses.

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, a greater demand for laser-related curriculum is evident.

Figure 5 shows the new colleges and their phase in creating and offering LFO courses.

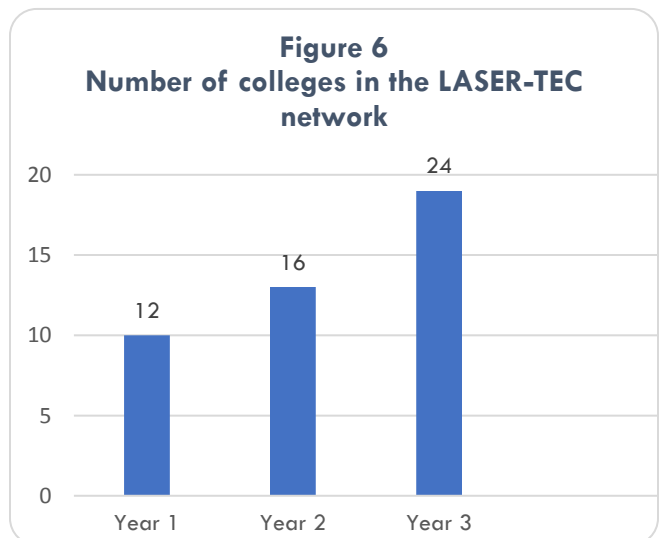
Figure 5



The network grew from 12 colleges in year one to 24 in year three, refer to figure 6. The level of engagement and support of the Center has advanced as well. Collaboration between the Center and the colleges' stakeholders enabled three colleges to launch LFO courses in the fall 2016. In year three, the number of colleges that received LASER-TEC support and offer LFO grew from 3 to 6: Indian River State College, Central Carolina Community College, Tri- County Technical College, Spokane Community College, Cape Fear Community College, and Hillsborough Community College.

LASER-TEC service package to its college network is inclusive and significant. It includes: local, state, regional, and nation-wide workforce

Figure 6
Number of colleges in the LASER-TEC network

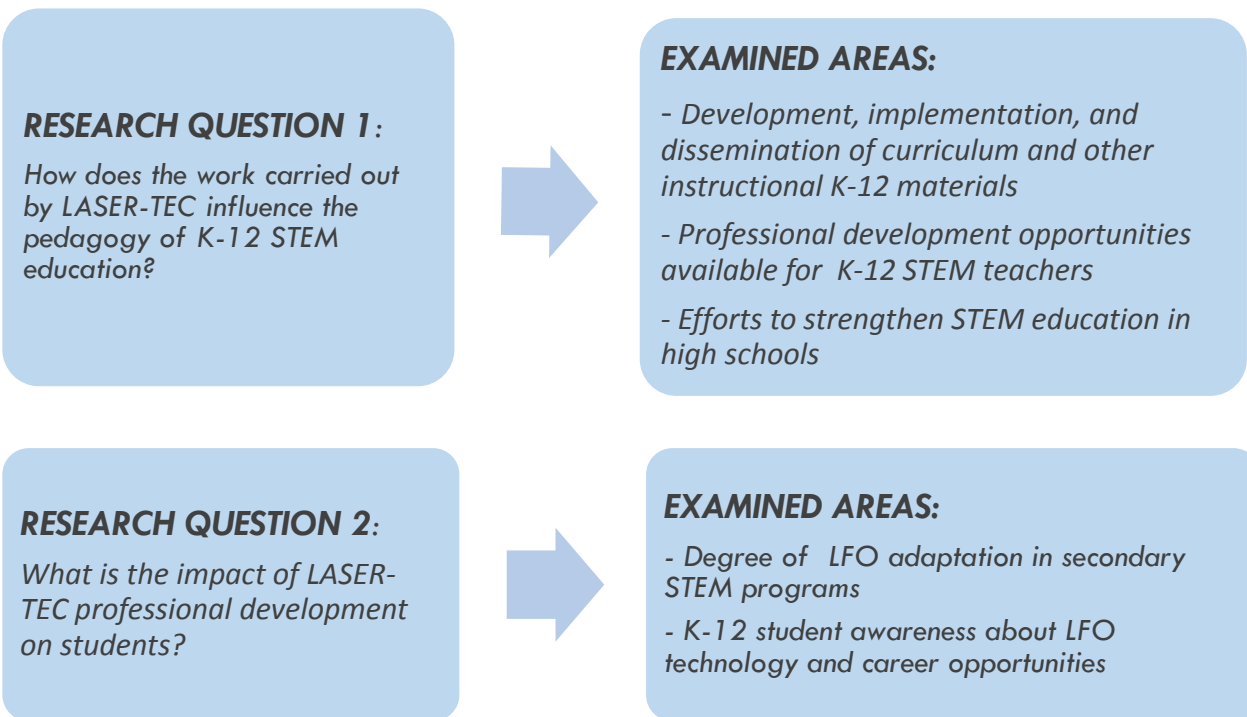


supply/demand for LFO technicians, industry distribution, faculty professional development, curriculum development, new curriculum approval processes, funding opportunities, LFO laboratory start-up and enhancement. In average, an integration of a course in a two-year college consists of multiple stages and engages a wide pool of stakeholders. It takes 2-3 years for a college to advance from the preliminary phase to the implementation phase. Therefore, the LASER-TEC’s effort to double the number of colleges that offer LFO courses is found to be substantial.

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 course/program.
- ✓ Increased number of colleges offering LFO.
- ✓ Increased outputs of graduates from southeast colleges.
- ✓ Reduced the supply/demand gap for LFO technicians in the southeast.

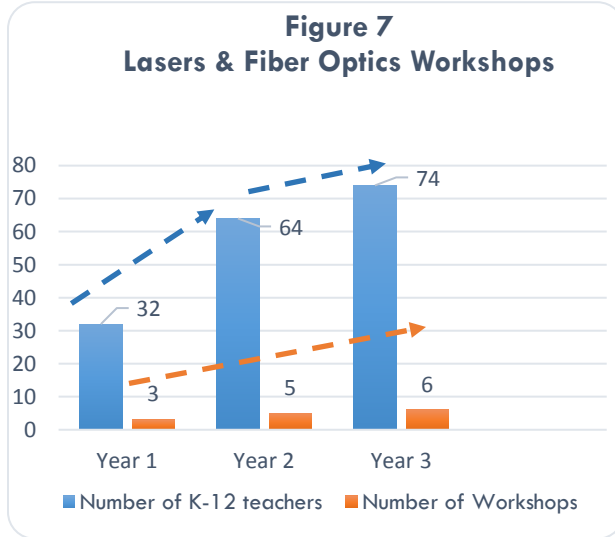
Goal 3. Provide professional development for K-12 STEM teachers to bring LFO career awareness to students to create a high school to college student pipeline.



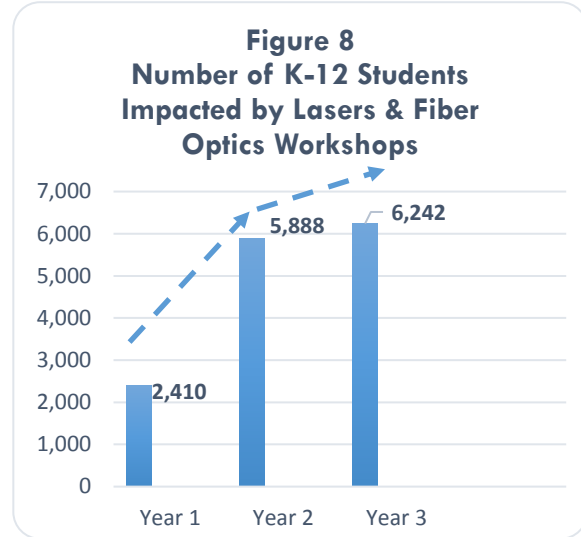
Findings:

Ultimately, this goal has the overarching objective of teaching teachers and counselors to get the multiplier effect. 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 6-8 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 three, a total of 6 workshops have been hosted to advance technical knowledge in LFO to 74 K-12 teachers and counselors as shown in figure 6. The workshops

provide tools that enable teachers to integrate workshop content immediately (i.e. the Light and Optics Exploration Kit with detailed lesson plans has been found to be the most immediate and efficient way to impact students and get them interested in STEM and LFO). The number of students impacted by these workshops is 6,242, as shown in figure 7, bringing the total for the last three years to 13,940 students.



Total number of workshop: 14
Total number of K-12 teachers 170



Total number of students impacted: 13,940

Workshop evaluations are conducted at the end of each workshop to measure Reaction and Learning Levels according to Kirkpatrick and Kirkpatrick model.

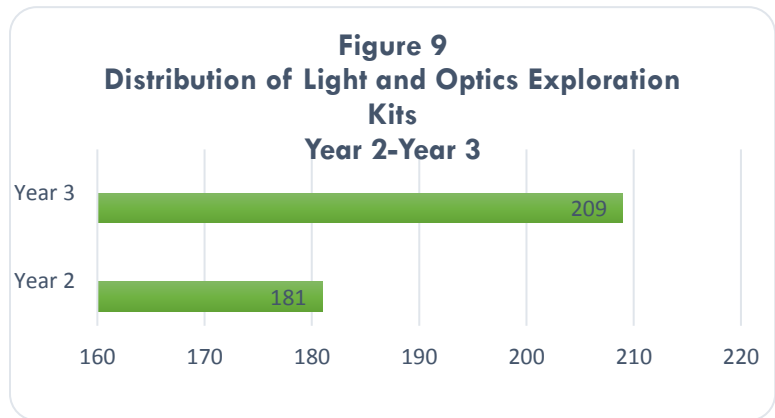
Some of the evaluation results are summarized below:

- 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 survey was conducted to evaluate the degree of implementation. This survey is designed to measure behavior and result levels according to Kirkpatrick and Kirkpatrick model. The findings related to the 6-month follow up survey are summarized below:

- Percent of received responses: 40%
- 75 % of responders used the kit and the lesson plans in their STEM lessons
- 15 Lesson plans have been used by responders for their lessons
- 75% 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

LASER-TEC has distributed 390 Light and Optics Exploration Kits to this day in more than 25 different states, as shown in figure 8.



Activities under Goal 3 had the following long term impact:

- ✓ Increased infusion of LFO knowledge in K-12 STEM disciplines.
- ✓ Increased number of students interested in LFO careers.
- ✓ LOE kit creates 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 veteran's enrollment to LFO programs?

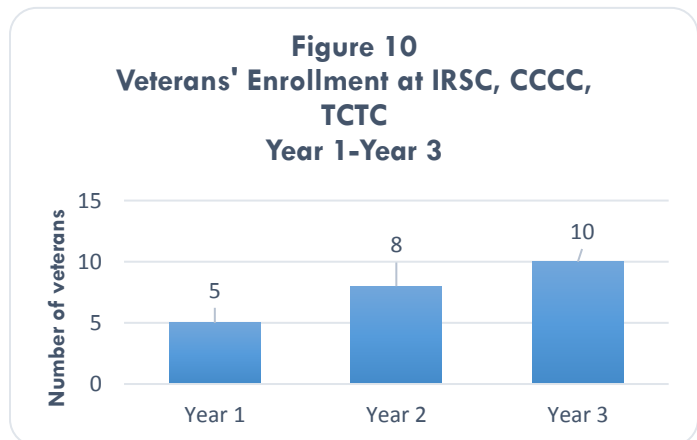


EXAMINED AREAS:

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

Findings:

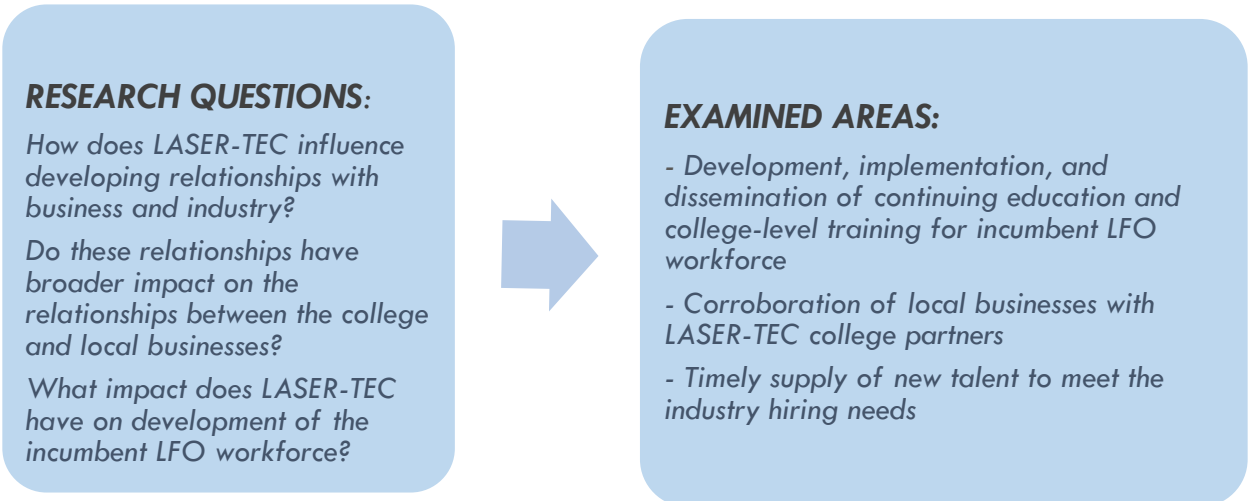
The Center initiated email and telephone campaigns to 25 veteran Transition Assistance Program offices in the southeast United States. Also, similar campaigns were conducted at military bases in the southeast region. The number of veterans enrolling in LFO programs has increased but at a slower than anticipated rate, as shown in figure 9. However, the number of enrolled veterans has double in year 3 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>

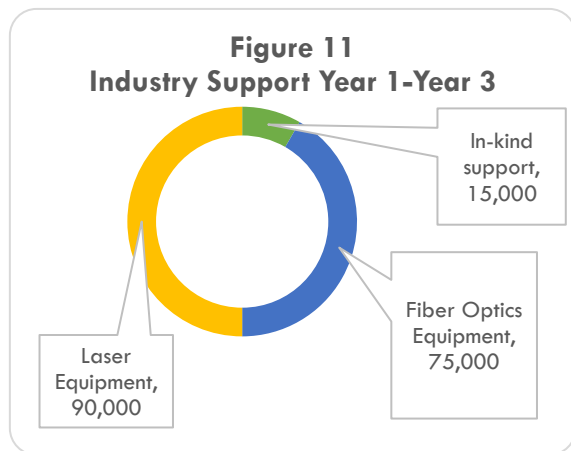
Goal 5. Develop, expand, and strengthen partnerships between LFO industries and all regional colleges.



Findings:

The industry contribution to LASER-TEC has been growing throughout the three years of LASER-TEC operation, with estimated contributions of about \$120,000 as shown in figure 10.

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:

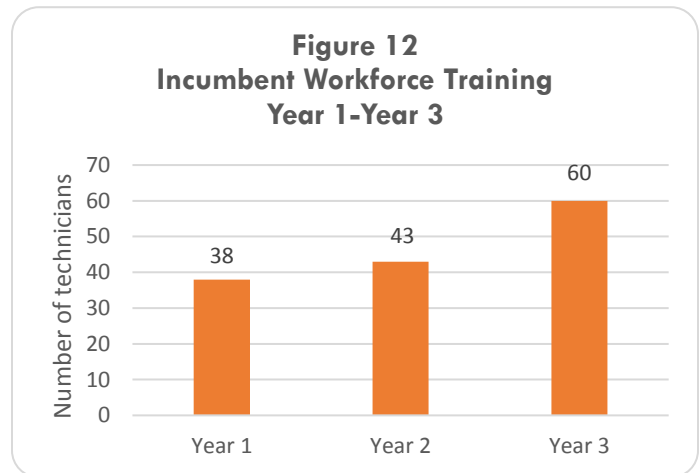
- Spectroscopy: Watsatch Photonics, Ocean Optics
- Laser Applications: MegaWatt Lasers, Synoptics, IPG Photonics
- Fiber Optics: PCS (Florida), Corning Optical Systems, Anixter, Transition Networks

The following industry partners have also provided student employment:

Laser Components (Florida), Boomerang (Florida), SW Florida Waste Water Management (Florida), Watsatch Photonics (North Carolina), MegaWatt Lasers, Synoptics (North Carolina), Aqueti (North Carolina), Photonics (North Carolina), Lawrence Livermore National Laboratory (California), DISCO USA (North Carolina), Bosch (South Carolina), and BMW (South Carolina).

60 incumbent workers were trained in year three. The increasing numbers of incumbent technicians trained by LASER-TEC during year one through year three are shown on the figure 11.

The LASER-TEC industry training has enabled the advancement of technical knowledge and skills among the LFO incumbent workforce. 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. Students' familiarity with new technologies and techniques will better prepare them for their future employment.



Activities under Goal 5 had the following long term impact:

- ✓ Increased number of courses available for technicians.
- ✓ Increased number of trained workers.
- ✓ Increased industry contributions.

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 Industrial Advisory Board.

RESEARCH QUESTION:

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



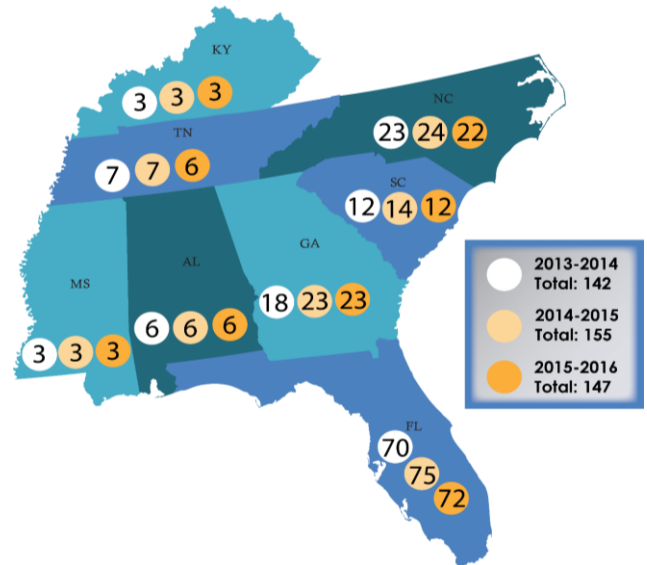
EXAMINED AREAS:

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

Figure 13

Findings:

LASER-TEC has a strong IAB consisting of 147 companies in the southeast US. 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 in appropriate courses and labs. All partner colleges in collaboration with the IAB facilitated on campus, or on-site interviews for this year's graduates. Up to the writing of this report, 95% of graduates received job offers, with several of them receiving multiple employment opportunities.



Activities under Goal 6 had the following impact:

Mid-Term

- ✓ Active Industry Advisory Board.
- ✓ 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.

PART IV

RECOMMENDATIONS

In light of recent changes in policies of the Federal Department of Education, especially the “gainful employment” rule, LASER-TEC should revisit its strategies and approaches for veteran recruitment.

It is recommended for the Center to diversify the strategies for recruitment of the underrepresented populations in the fields of lasers and fiber optics.

The evaluation team also recommends to consider creating a series of short demonstration videos to supplement the Light and Optics Exploration Lesson Plans, as requested by many K-12 teachers.

PART V

CONCLUSIONS

LASER-TEC’s efforts show evidence of growing the number of students, faculty, courses being offered, and lab facilities in all participating colleges. Indeed, it was found that the number of photonics courses offered and program enrollment has steadily grown over the three years of LASER-TEC, therefore, strengthening the existing LFO program.

The Center has met its goal of expanding the college network offering LFO courses by attracting 19 new colleges in the planning phase and advancing 2 institutions to the implementation phase.

LASER-TEC shows impressive outcomes in the area of professional development for K-12 teachers and counselors by providing 74 workshops to 170 individuals. Surveys conducted 6 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 209 kits that were distributed this year. Mapping the lesson plans to the National Science 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 industry’s monetary and in-kind contributions to LASER-TEC has 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 Industrial Advisory Board (IAB), consisting of members from many southeast states. The Center’s management team is responsive to recommendations from the IAB, particularly in aligning training and college-acquired skillsets with industry needs.