

Leading Owls toward the light: Advances in optics and precision manufacturing educational pathways at Keene State College

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ABSTRACT

Keene State College (KSC) is excited to share new pathways, curricular offerings, and outreach focused on workforce development in the areas of optics and precision manufacturing. KSC is a primarily undergraduate institution with a liberal arts focused mission, uniquely located in southern New Hampshire within a strong industrial New England network in precision optics.

After collaborative identification of workforce needs, KSC created a series of courses focused on hands-on, technical, and conceptual optics education: Introduction to Optics, Thin Films, Laser Optics, and Ultra-Precision Manufacturing. The Introduction to Optics and Laser Optics courses place practical and conceptual understanding in the foreground so that mathematical representations are integrated with student understanding. The Ultra-Precision Manufacturing and Thin Films courses focus on hands-on education using diamond turning ultra-precision machining and thin film deposition techniques respectively to provide students the necessary technical skills. All courses are designed to be accessible individually or are stackable as multicourse microcredentials.

The creation of educational pathways relies on the convergence, collaboration, and engagement from education, industry, and community partners. KSC is working with local industry professionals to explore tailored apprenticeship offerings and intensive bootcamp workshops to deliver key skills outcomes as alternatives to semester-based offerings. Outreach with high schools and career and technical education centers offers increased opportunities to raise awareness regarding careers in optics and the ways KSC educational pathways connect students to this rapidly growing sector. This presentation will highlight key stages of development and challenges toward future growth of optics education at KSC.

Keywords: optics education, workforce development, diamond turning

1. OPTICS AND PRECISION MANUFACTURING EDUCATION AT KEENE STATE COLLEGE

1.1 Background

KSC is a primarily undergraduate institution with a liberal arts focused mission, uniquely located in southern New Hampshire within a strong industrial New England network in precision optics. KSC offers an ideal community for students to learn in, with dedicated faculty who support students through hands-on learning experiences and close mentoring. The shared college-wide learning outcomes rooted in the liberal arts translate to students who graduate with collaborative problem-solving skills, which we find are increasingly valued by their future employers in the industrial network. Keene State College (KSC) is excited to share new pathways, curricular offerings, and outreach focused on workforce development in the areas of optics and precision manufacturing

Precision Optics requires problem solving with multiple perspectives. Through KSC's Integrative Studies Program, students develop critical thinking skills, multidisciplinary teamwork experience, and oral and written communication skills. All students, regardless of their choice of major, secure this foundation, which results in diverse skill sets and a solid knowledge base. Our variety of educational pathways can help students greatly increase their earning potential and ability to advance within their careers. Along with four-year pathways, KSC recognizes the importance of providing educational pathways with shorter timelines to completion. These include accelerated degree-in-three plans and also more bite-sized options, such as microcredentials. The range of program opportunities at KSC can also serve to support other career areas of regional optics and precision manufacturing, such as business management, marketing and communications, computer science/information technology, and human resources.

Many student support services exist at Keene State to help prepare students for their entry into the workforce. Students have opportunities for career preparation development at workshops, job fairs, and guest seminar series. Opportunities both in and out of the classroom are increasingly available for students to develop their professional skills and practice these as part of internships and undergraduate research.



Figure 1: Professor Jim Wing instructs students in the Ultra-Precision Machining course at Keene State College

1.2 Educational Pathways in Progress

Keene State College is focused on creating student-centered partnerships between higher education and the regional optics and precision manufacturing industry. After collaborative identification of workforce needs, KSC created a series of courses focused on hands-on, technical, and conceptual optics education. These included Introduction to Optics, Thin Films for Optics, Laser Optics, and Ultra-Precision Manufacturing. The Introduction to Optics and Laser Optics courses place practical and conceptual understanding in the foreground so that mathematical representations are integrated with student understanding¹. The Ultra-Precision Manufacturing and Thin Films courses focus on hands-on education using diamond turning ultra-precision machining and thin film deposition techniques respectively to provide students the necessary technical skills. All courses are designed to be accessible individually or are stackable as multicourse microcredentials.

Microcredentials are groups of courses, typically 6 to 19 credits (or 2 to 4 courses), which are accessible to traditional undergraduate students as well as professional learners seeking to enhance their skills and increase their marketability. Microcredentials are designed to deliver a specific set of learning outcomes and/or skills that are of high value to students and employers. Microcredentials also provide a vehicle to deliver immediately useful professional skills and are built to meet the unique needs of our state’s commerce. Microcredential offerings include optics, precision manufacturing, digital marketing communications, and marketing analytics, among others.

Microcredential in **Optics** (8 credits)

INOPTC 101
Intro to Optics (4 cr.)

Understand the role optics plays in our lives. Learn how cameras, light and different wavelengths are used in industry to solve everyday problems.

INOPTC 110
Laser Optics (2 cr.)

Develop the skills needed to solve problems in, handle, and safely work with laser optical systems.

INOPTC 120
Thin Films in Optics (2 cr.)

Gain knowledge of how thin films are manufactured and used as optical interference filters.

Microcredential in **Optics & Precision Manufacturing** (12 credits)

The above courses plus:

SPDI 183
Ultra-Precision Manufacturing (4 cr.)

Acquire an understanding of and hands-on experience with high-precision manufacturing, including modern diamond-turning lathes used to produce optical components.

Figure 2: Microcredentials Offer Stackable Pathways for Education in Optics and Precision Manufacturing

Other pathways and opportunities for students include internships with regional employers, apprenticeships, undergraduate research, and project-based experiences. A central office and online database assist students in identifying regular annual internship opportunities with regional businesses and faculty and administrators regularly solicit network contacts regarding current needs for student interns and quickly work to fill those spots whenever possible. These relationships, some long-standing and bolstered by passionate alumni engagement, help connect both students and businesses to KSC programs as we work to grow and raise collective awareness of educational and career opportunities in the region.

Enrollment trends in the introductory courses have shown a steady increase since their inception and now regularly enroll to capacity within the first or second week of registration periods. Where our prior focus was engaging students to enroll in these exciting new courses, our attention now shifts toward strategies to add additional sections, find more teaching and laboratory space, and involve more modern equipment for student learning. Current sections for ultra-precision optics are typically in the range of 16 students, and the introduction to optics course enrolls up to 24 students. These class sizes are aligned with pedagogy of instruction for close interaction with students and engagement with tools and measurements.

The INSPDI 183 course focused on the ultra-precision diamond turning lathe is marketed to deliver job-ready skills desired by many businesses in southern New Hampshire and features a Nanoform-X donated from AMETEK-Precitech in Keene, NH. The course is part of the Sustainable Product Design and Innovation (SPDI) Department at Keene State, and also meets a core requirement for students in their overall graduation requirement. This course designation helps students find additional value in the course and allows students to consider it as an elective if their goals are outside of programs in SPDI.



Figure 3: Students get hands-on experience on the Nanoform X Precitech lathe as part of the INSPDI 183 course

Instructors are currently focused to rearrange the learning space for a better student experience and increase use of metrology equipment for characterization. The teaching space currently includes a large digital screen for viewing of the machining process by students in the space and will be adapted to include computer workstations and additional measurement tools such as advanced interferometry. This course in particular has featured a mixed demographic of both current KSC students and current employees of regional businesses looking for specific skill development in diamond turning machining.

1.3 Partnering for the Future

Our mission is to provide high-quality undergraduate and graduate credit courses and degree programs, as well as non-credit educational opportunities and microcredentials, that respond to the needs of local and regional businesses, industry, and community. The creation of educational pathways relies on the convergence, collaboration, and engagement from education, industry, and community partners. Keene State wants to build a brighter future through partnerships and innovation, positioning businesses to meet the unique demands of their respective industries and providing an array of pathways and services, including tailored apprenticeship offerings and intensive bootcamp workshops, to support students of all types. We aim to leverage existing strengths of academic programs at KSC and the region by fostering new connections between students, faculty, staff, businesses, and community members, including the Community College System of New Hampshire and high school career and technical education (CTE) centers.

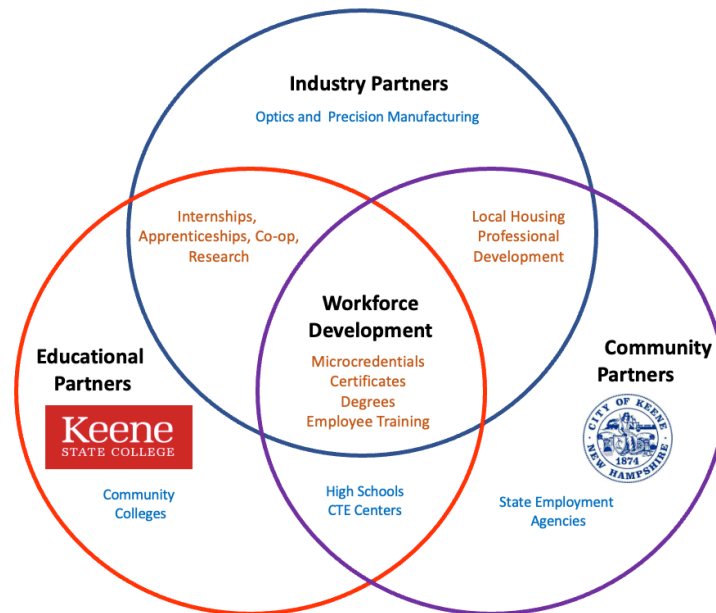


Figure 4: Workforce Development will benefit from the convergence of education, industry, and the community

KSC has had a strong focus in recent years to engage with regional CTE centers and establish articulated credit transfer agreements, to allow students an advantage for their completion of courses with skills in advanced manufacturing. These efforts not only provide students with a high value return for their educational commitment to precision optics and expedite their timeline to enter the workforce, but also raise awareness about additional educational opportunities at the college. Unlike larger institutions, Keene State’s students find a unique experience that prepares them not solely to be a technician, but instead provides critical thinking with a broader foundation and multiple perspectives across the liberal arts.

We hope our efforts will support and strengthen the local and state economy by expanding business opportunities for regional companies and connecting with statewide initiatives. The educational opportunities offered may help attract or retain capable young talent in the state by providing them with highly sought skills and knowledge, along with opportunities to build relationships with employers, that lead to meaningful careers in our region or state. Dr. Melinda Treadwell, President and alumnus of KSC stated, “We are making a purposeful effort to connect the students into the business community so that they know that their talents are essential to the future of New Hampshire.” We also hope that our collective community partnership will strengthen scholarship opportunities to support individuals from marginalized and under-served populations in the community. The microcredentials in optics and precision manufacturing have also been advertised through the New Hampshire State Employment Security Services division, which can provide tuition assistance and support for individuals seeking to obtain credentials related to key industry staffing gaps.

Exciting recent developments include the engagement with the American Center for Optics Manufacturing (AmeriCOM) and exploring opportunities to partner with their national initiatives in educational workforce development². AmeriCOM

staff visited the KSC campus in July 2022 for an assessment and discussion regarding our current efforts, challenges, and visions ahead. One identified action was to seek a formation of a regional precision optics network for NH, similar to those created in NJ and NY.

2. CONCLUSION AND FUTURE VISION

KSC is excited to be engaged with industry and national partners to grow what is currently in place, identify and meet gaps, and navigate challenges. We see equipment as the key catalyst to growth and student engagement. Students can learn through hands-on experiences with the same modern instruments in place on production and development floors, which is influential for their career choices and pathways from degree or credential. We are actively exploring thin-film deposition systems that would be appropriate for an education setting, to complement the thin-films course and allow skill development in that key area for optics. With the steady interest in the diamond turning course, we are exploring avenues to add capacity for more instrumentation as well as more concentrated trainings and offerings catered to industry. Adapting to increase capacity for larger enrollment will require addition staffing resources and classroom space, both of which could involve creative solutions through partnerships with the industry network. There is exciting potential to collaborate to offer short courses and industrial workshops to meet specific and common needs across the regional network, especially with diamond turning focused areas.

Additional marketing strategies are also needed to raise awareness about in-state careers in precision optics for students, and what educational pathways can get them there. Partnering with industry at regional educational meetings and conferences is one approach in action to raise this awareness. We also are inviting high school students, teachers, and administrators to campus for visit days to experience mini-courses and tour learning spaces. A fall 2022 STEM Visit Day will welcome junior and senior students from regional high schools interested in careers in STEM based program areas.

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