SCOP

Southwest Center for Optics and Photonics

White Paper Table of Contents

Section 1 - SCOP Purpose

Southwestern Center for Optics and Photonics (SCOP) is a non-profit dedicated to advancing the regional optical community. SCOP will engage the community through the establishment of a technical consortium to develop technologies, foster collaboration across the community, and establish a community lab to enable small companies to work together to share equipment, expertise, and ideas to foster growth.

Many small companies in the area have roots in the Space and Defense Industries, such that there is a significant familiarity with the technology development ladder required to meet industry needs. Small companies, by themselves, do not always possess the infrastructure, equipment, and knowledge needed for all aspects of the optics industry. SCOP is dedicated to providing companies with opportunities to come together and leverage the abilities of any one company by providing access to equipment and services they would not otherwise have on their own.

Innovation also requires new ideas and methods. SCOP is developing the future workforce in optics through teacher education and optical technician curriculum development. In conjunction with Pima Community College, SCOP is developing a curriculum for technicians resulting in a “Level One” 4-class program which is currently being taught through Spring 2025, and a “Level Two” 9-class certificate program which will be taught in the 2025-2026 class years. This curriculum is planned to be certified into a full 2-year A.S. degree program which is anticipated to be accredited in the 2027 timeframe.

SCOP is breaking down the barriers to success for businesses as well as training the next generation to ensure that advances in optics and photonics are supported in Optics Valley.

Section 2 - Incorporation & By-Laws

SCOP was established with by-laws that have the flexibility to support both the current nascent state of the organization and planned growth into a larger entity over time. The business and affairs of SCOP are to be managed by a Board of Directors, with a mandatory minimum of three members and maximum of 13. Directors serve for three years and may be reelected for a maximum of two consecutive terms. The officer positions within SCOP are President, Vice President, Secretary, and Treasurer, and serve for three years. The Board of Directors may also hire an Executive Director. While not mandated by the by-laws, it is expected that the Board Member who serves as Vice President would move into the Presidency to support continuity in the leadership structure and long-term strategic goals.

SCOP was incorporated with three committees - Internal Affairs, External Affairs, and Governance - in addition to an Executive Committee which consists of the elected officers of the Board. The Board may also create or disband Advisory Boards as necessary for specific purposes. The *Internal Affairs Committee* is responsible for SCOP's budget, internal operations, and financial and internal business affairs. The *External Affairs Committee* is responsible for SCOP's fundraising strategies and activities, program development, events, and engagement with the regional optics and photonics community. The *Governance Committee* is responsible for SCOP's governance matters, including recruiting and evaluating candidates for the Board of Directors, overseeing the function and duties of the Board of Directors and its committees, proposing and drafting policies of the SCOP, and ensuring the overall compliance with applicable laws and regulations.

SCOP was incorporated with five Directors, with attention paid to diversity of careers, areas of expertise, past volunteer experience, gender, and age. Information regarding each of SCOP's current Board of Directors can be found below.

- President - Cat Merrill: Mrs. Merrill has over 20 years of experience in the optical field both in the private and public spheres. She has served as program director at the University of Arizona for astronomy missions and is currently the owner of Ruda Optical which specializes in custom optical engineering and assemblies. She has also served as the president of the JobPath board of directors seeking to improve educational and vocational achievement within Tucson.
- Vice President - Dr. Lukas Gruber: Dr. Gruber has more than 25 years of experience in the photonics industry and is currently responsible for business development in industrial, scientific and energy markets at Leonardo Electronics.
- Treasurer and Secretary - Dan McCormick: Mr. McCormick has over 15 years of experience in optical engineering, including the fields of diode lasers, space defense applications, and interferometry. He also serves as adjunct faculty at Pima Community College where he is developing and teaching optical courses for technicians.
- Board Member at Large - Scott Stewart: Mr. Stewart has over 35 years of experience in optical engineering, predominantly in the test arena. Additionally, he also served for 18 years on the Pima Community College Board championing workforce development programs.
- Board Member at Large - Dr. Elka Koehler: Dr. Koehler has over 25 years of optical experience, serving at NASA Langley, Raytheon, Teledyne, Worldview, and GEOST. She has also served as a AAAS Congressional Science and Technology Fellow where she advised the senate on policy issues. She is currently the head of optical engineering at NSF NOIRLab.

The incorporating Board has staggered term limits to support continuity in the leadership structure and long-term strategic goals.

Section 3 - Focus Areas

SCOP has two major areas of focus for long-term goals and planning: the creation of a community lab and workforce development.

Community Lab

Much like the wider optics and photonics (O&P) industry, many companies in the Southwest region are small to medium sized entities. Product, process, and technology development within the O&P industry often requires highly specialized and expensive equipment. The concept of a shared lab space within the community has long been discussed and desired to support regional company needs. A community lab space could also serve as a location for continuing education and employee training, wider community outreach and education, and professional networking events.

Workforce Development

The O&P industry is perpetually understaffed across all education levels and roles due to a variety of factors including low industry awareness and few dedicated education programs compared to other engineering initiatives. A workforce shortage is especially acute at the technician level. There are a wide variety of ways to attack this problem and SCOP is working at multiple levels to increase the technical workforce. SCOP is working with established non-profits to support student mentoring, projects and competitions in STEM fields. Additionally, SCOP is working to train middle and high school teachers to bring optics and photonics curricula into the classroom. Finally, SCOP is working to develop technical training programs for post-high school students to support the growing needs of the industry. Pima Community College (PCC) in Tucson, AZ has a new Advanced Manufacturing Building that opened in 2023 as part of their Center of Excellence in Applied Technology. This facility has dedicated optical lab space and is committed to the development of a certified optics technician training program.

Details of the development process for each of these areas can be found in subsequent sections of this document.

SCOP itself will work first towards awareness and recognition of our brand by communicating our mission and goals, establishing relationships with regional O&P entities, and gathering feedback from O&P community members. In parallel, a focus on

an initial seed funding campaign will begin in earnest, followed later by a focus on larger grant proposals and annual contributions to propel our community lab and workforce development plans forward and ensure SCOP's longevity. An approximate vision of the first 10 years is as follows:

Year 1: Formation, development planning, seed funding, awareness campaign
Year 2: Funding focus, regional development and awareness, strategy refinement
Years 3-5: Continuity planning (funding, leadership), board growth and diversity
Years 5-10: Self-sustaining funding, growth of education programs beyond PCC, lab capital expansions

Long term, we envision that the Southwest Center for Optics and Photonics will exist as a centralized physical community lab space, with partner virtual and physical lab spaces throughout the Southwest Region. This network of labs will enable regional O&P businesses to collaborate and innovate, driving the local O&P ecosystem forward. A thriving series of programs at all educational levels that increase access and awareness of career opportunities in optics and photonics, culminating in an Optics Technician Training program through PCC, will raise awareness of the field and fill the long-term regional needs of the high-tech workforce.

Section 4 - Community Lab

One of the key products of SCOP is a Community Lab. The idea for the lab's formation began when members of AZ Optics Valley found that their home institutions had unused, intermittently available, or scrap optical test equipment. Much of this equipment is expensive and long-lead to procure such that many small companies would not have access to it. In the case of space and defense related development, barriers to test equipment – specifically environmental chambers – can limit the ability of a company to mature a product to a high enough Technology Readiness Level (TRL) that the technology would be a candidate for use in space or defense products. Typically, a design or technology needs to be at least TRL 5 to be considered for use in a development program (and a TRL of 6 is required prior to flight testing). This lack of infrastructure is a key barrier to small companies creating products in these fields. AZ Optics Valley members saw the unused equipment as an opportunity to provide a service to the whole of optics valley.

Additionally, many companies have equipment which is not often utilized or may have been purchased for a previous use, and this valuable equipment sits unused. Other companies may have need of the equipment - as well as the expertise in using it - and could make use of it rather than procuring the equipment for themselves. This sharing of equipment has the potential to benefit both companies financially as well as fostering communication, trust, and collaboration. By strengthening both lender and lendee the entire optics ecosystem is enhanced and more projects, jobs, and regional success will be achieved.

The community lab has now been in development for over 2 years, predating SCOP's incorporation. A steering committee, meeting bi-weekly over that timeframe, has developed a three phased approach for the lab maturation. In part, the three-phase program is due to limited funding available for the work, but it also enables the steering committee to assess the highest priority needs of Optics Valley members to develop services based on needs. By taking over this committee effort and formalizing the funding, organization, and goals, SCOP is speeding the lab's creation and capabilities. The three-phase approach is as follows:

Phase One - "Cup of Sugar"

In the first phase of the program, the community lab will focus on collaboration and allowing participating companies to trade or contract services within the capabilities of other companies. As an example case, Company A has a highly accurate test set-up that is not used very often. Company B needs an independent check of the performance of a system in development. Company B can search the community lab website to see who is offering that capability. Company B uses the website to find organizations capable of fulfilling that need and is matched with them. The community lab enables the two companies to connect and create a small contract or trade to provide a service. Company B gets the answers they need. Company A has an open dialog with Company B on their skills and capabilities that could help foster collaboration as well as serve as a matchmaker for partnerships in the future. Exactly as good neighbors will share a bit of their skills and possessions, we are fostering sharing and collaboration between local companies.

This capability has already been launched as part of OCLTucson.org. Companies can register to list a capability or service to anyone. Companies can therefore showcase their trademark skills and abilities, as well as underused capabilities. Companies can search for skills or capabilities locally such that face-to-face meetings and collaboration is possible. Access to local capabilities also enables quick turn-around for testing of hardware. In phase 1, companies and local subject matter experts can list their skills and set their rates. It is up to each institution offering the service to define the rate, including allowing in-kind credits or performing the work for no cost as part of business development.

Phase Two – "Lending Library"

In the second phase of the program, a physical library of items is created with expensive tools or capital equipment so that companies can borrow hardware from SCOP. SCOP currently works with Pima Community College to house all donated hardware. SCOP is responsible to ensure the hardware at time of lending is in good working condition, that there is necessary user training available for the hardware, and the hardware is calibrated if required. SCOP is working through AZ Optics Valley to solicit donations of hardware and move hardware for storage and lending.

To date, SCOP has developed terms and conditions for lending and borrowing hardware; best practices are also listed as part of the website. SCOP is currently working to collect, organize, and maintain hardware. The board is responsible to develop and track metrics to identify key equipment that is needed based on feedback from Optics Valley. As funding increases, a full-time “librarian” will be employed to test equipment and train users.

Equipment in the library must be evaluated to be “good”. To do this, SCOP will establish baseline test cases, including targets and/or standards, for each piece of test equipment. Each item will be visually inspected and a function test performed on the hardware. For optical equipment, accuracy and repeatability are always a concern. As with any quality organization, SCOP will keep a running record of the performance or “health” of the hardware based on baseline tests. Borrowers of the equipment will observe the baseline test before “checking out” the equipment. The borrowers are strongly encouraged to repeat the baseline testing at their facility. This enables the borrowing company to know that they can operate the hardware correctly and that the hardware was not changed as a result of the transportation. The baseline testing can be performed throughout the time the company has it checked out, and it is tracked and trended in the SCOP database to understand the performance of the hardware and to identify if there are changes that SCOP needs to investigate or fix. On return of the hardware, baseline tests are performed again to ensure the hardware is returned in good working order.

This phase of the program is currently limited by several factors: Space for storage, Ability to create a tracking system for all hardware, Ability to maintain calibrations and tests for baselines, and Availability of subject matter experts to test and train others on the hardware.

Ultimately, SCOP seeks to have a library that contains donated hardware and hardware procured by SCOP via library equipment funding, maintain and train local companies on the use of the hardware, and maintain historical references for companies to enable companies to have confidence in the findings with the equipment. This requires funding and personnel for space to manage and maintain the website, hardware, calibrations, and other maintenance functions.

Phase Three – "Turn Key Community Lab"

Phase Three represents the initial goal that inspired the birth of SCOP. In this phase, there are one or more laboratory spaces that have capabilities that are staffed and maintained by SCOP. Driven by an early survey of companies and their needs, specific labs may include: Environmental test facilities, Thermal and dynamic test facilities, General metrology, Spectral / radiometric testing, Geometric testing, and Testing that can be transferred to international standards.

This vision requires significant infrastructure including floating optical tables, electrical systems with surge protection for different equipment, cryogenic backbones, cleanroom areas, ovens for cleaning/baking, and classified processing - to name just a potential few.

Classified processing and testing specifically is a limiting factor for many small companies. Several of SCOP's founding members come from the defense and space industries and have identified the inability to participate in technical development due to limited ability to house and process classified material. SCOP has already started developing how to segregate areas and equipment to allow for classified data collection, and data processing. Companies can request time within a closed area with a defined computer system.

In all, Phase 3 is a significant step in both required funding, personnel, and complexity, and is a major long-term aspiration of the SCOP organization. Building networks and awareness within the business community will be key in order to reach this phase.

Section 5 - Workforce Development

One of SCOP's main efforts will be in the development of educational programs to support the optics and photonic industry. This includes support of programs to develop K-12 educational content and a specific focus to develop curriculum for optical technicians.

K-12 Education Initiatives

Arizona, as compared to other states, has a history of low academic performance. This means local school children are frequently under-prepared for or lack exposure to technical careers. SCOP seeks to be an industry partner to local nonprofits to support quality K-12 initiatives that raise the awareness of the optics and photonic industry for students and engage students to raise their technical abilities in STEM fields. In its inaugural event, SCOP hosted AmeriCOM's Teacher Training Program for optics. In this event, 23 teachers from across the state came to Tucson for 2 days of instruction and introduction to the optics industry. The teachers left with a curriculum that can be used in middle and high schools to explain the fundamentals of the study of light. SCOP aims to work with AmeriCOM and similar organizations that have developed and proven educational materials. SCOP hopes to facilitate teacher training programs and be a link for teachers to industry and therefore enable teachers to make technical career fields real to their students.

Additionally, SCOP works with nonprofits to directly engage students through academic competitions and events. SCOP will sponsor events and participate in programs with established non-profits such as SARSEF, MESA, etc. to meet and engage students. SCOP intends to sponsor awards in design competitions, act as mentors, serve as judges, and propose projects as appropriate across all age groups. In this way, SCOP will make the industry accessible and relevant to the students

Technician Training Program

Specific effort to build an optical technician curriculum is part of the core work of SCOP. This will be a "ground up" effort, requiring curriculum development, equipment purchasing and maintenance, the commitment of new teaching staff, and coordination with existing educational institutions. Currently, a program is being developed in coordination with Pima Community College (PCC) at their downtown campus under the Advanced Manufacturing Center.

The goal of this effort is to produce a continuous pipeline of trained optical technicians

which will be able to secure high paying technical jobs for themselves as well as making available a larger and more knowledgeable workforce for local optics companies. Currently, hiring optical technicians is a regular challenge for Tucson optics businesses, as there is no local formal education program. Most existing optics technicians have come from related fields such as electronics, machining, and manufacturing, and have had to undergo years of on-the-job training before they were truly versed in optical methods and understanding - SCOP seeks to close this gap.

Working Group

For approximately the last year, a working committee has come together to discuss and plan. This group is made up of industry members from local businesses (Ruda Optical, Edmund Optics, Raytheon, GEOST, Leonardo, 4D Technology) as well as personnel from AZ Optics Valley and interested business development volunteers. Additionally, the Dean of the PCC Advanced Manufacturing Center is a regular attendee and provides input for requirements and specifics needed by the college.

Organization & Planning

In the last year, the committee has met repeatedly to discuss and create an understanding of the key skills and knowledge which would be useful and applicable for optical technicians and increase their hireability. Given the diversity of the members of the committee, we are confident that a useful and accurate accounting of skills has been created. From this initial work a list of 9 classes was developed in order to address all the fundamental topics. While all companies have their specialities - and future specialized training is almost certainly required - these classes will give a solid foundation to any optical technician regardless of what specialty or company they choose.

Currently, 4 of these classes are planned to be offered in a grouping as a Level 1 Certificate program. The Level 1 Certificate constitutes a basic introduction to optics and optical science, and will provide the base level of skills needed for an entry level technician. The subsequent 5 classes will constitute the next Level 2 Certificate and comprise the knowledge required for a skilled technician.

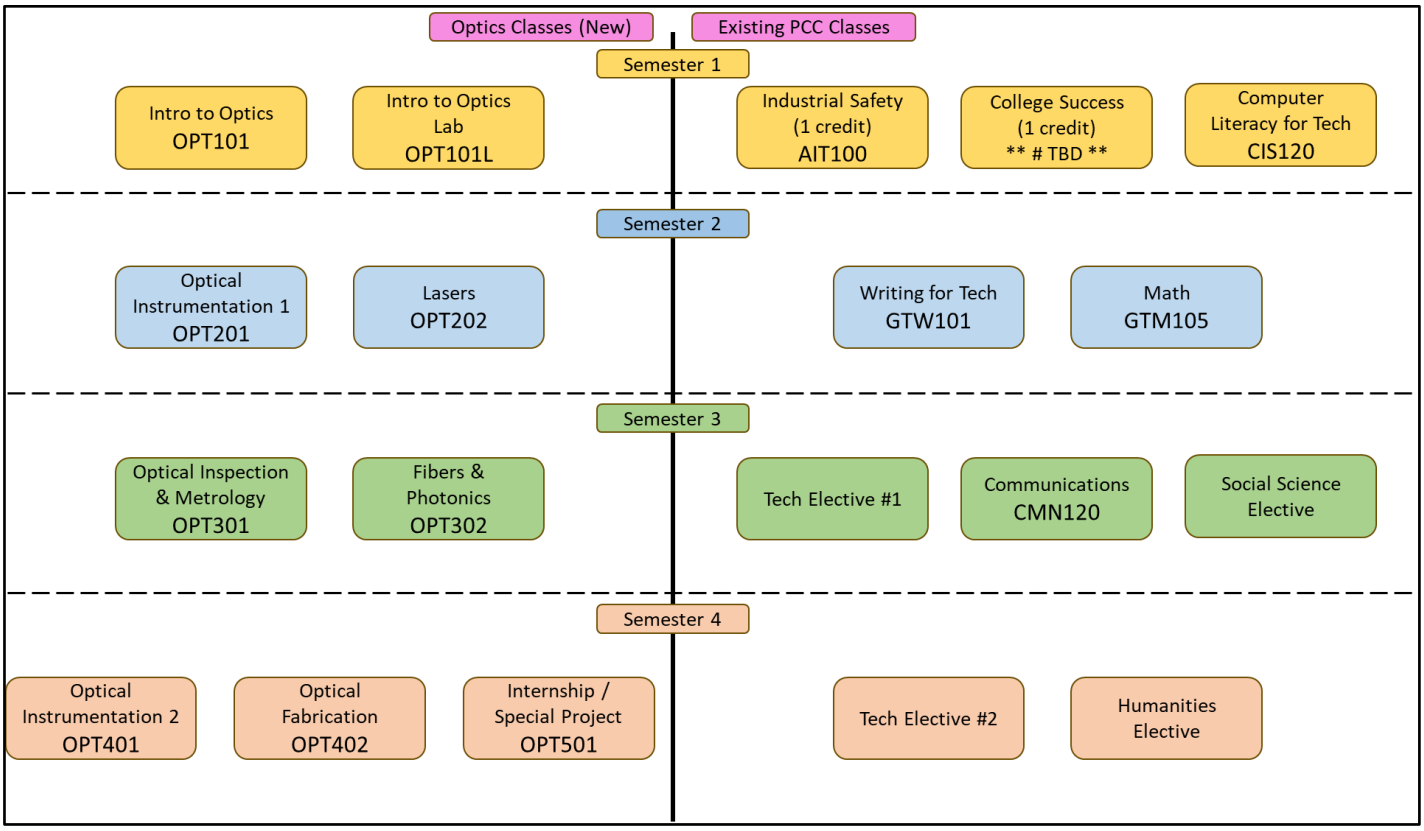
All classes are currently being offered through PCC as non-credit classes. Eventually a full 2 year Associate's degree (A.S.). PCC is experienced with the accreditation process,

and believes accreditation is possible within 3-4 years. Before accreditation, a steady pipeline of students and stability of the program must be demonstrated. Once accredited, previous students will be eligible for college credits for their existing work. The full A.S. degree will also include existing PCC classes for technical writing, workplace safety, technical electives, internship programs, and the like.

Given the expected timeline for accreditation, the program has already begun initial classes as well as continuing to develop classes and topics for future semesters. The first full cohort of students (~14) is expected in the 2024 Fall Semester with 2 classes. These students will continue with the next 2 classes in the 2025 Spring Semester, and a new cohort will begin the cycle again in the 2025 Fall Semester (see graphic below for planned semester layout).

Coursework Map

The anticipated listing and timing of all classes is shown in the diagram below. Note that all optics classes on the left side of the diagram are new and in development, whereas all classes on the right side of the diagram are already in existence as for-credit classes at PCC. The Level 1 Certificate will be comprised of the four optics classes listed in the first two semesters (as well as including Industrial Safety). The Level 2 Certificate will include the next five classes listed under semesters 3 and 4. The full A.S. degree will follow the entirety of the schedule and include all classes for a total of ~64 credit hours.


Optics Classes (New)
Existing PCC Classes
Semester 1
Intro to Optics
OPT101
Intro to Optics Lab
OPT101L
Industrial Safety
(1 credit)
AIT100
College Success
(1 credit)
** # TBD **
Computer Literacy for Tech
CIS120
Semester 2
Optical Instrumentation 1
OPT201
Lasers
OPT202
Writing for Tech
GTW101
Math
GTM105
Semester 3
Optical Inspection & Metrology
OPT301
Fibers & Photonics
OPT302
Tech Elective #1
Communications
CMN120
Social Science Elective
Semester 4
Optical Instrumentation 2
OPT401
Optical Fabrication
OPT402
Internship / Special Project
OPT501
Tech Elective #2
Humanities Elective