PENN STATE ELECTRO-OPTICS CENTER

WORKFORCE SURVEY OF THE MEMBERS
OF THE ELECTRO-OPTICS ALLIANCE

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Introduction

The Penn State Electro-Optics Center (EOC) undertook a survey of companies, which are members of its Electro-Optics Alliance (EOA). The Electro-Optics Alliance (EOA) is a collaborative network of U.S.-based industrial, academic and government organizations that forms a critical link between research and development and commercialization, with the purpose of advancing DoD critical electro-optics Manufacturing Science and Technology, transitioning that technology to industry, and promoting U.S. preeminence in all areas of electro-optics. To meet that goal, the EOA is designed to facilitate the formation of dynamic, geographically distributed teams of best-qualified EOA members from government, industry and academia to address specific issues and opportunities.

The survey was designed to assess the industry’s workforce challenges, with the purpose of helping the EOC develop programming to assist firms in Electro-Optics with recruitment and training matters. 428 Electro-Optics Alliance members, approximately 350 of which are companies, received an emailed questionnaire with the online link to the survey and 26 returned a completed form, for a response rate of 7%. One half of the returns (13) came from Pennsylvania (7) and California (6).

A critical point must be emphasized regarding the survey, which is that it was not intended to produce statistically valid generalizations about the industry. The membership of the EOA is a sample of the overall industry whose characteristics are unknown. Furthermore, due to resources, only very limited efforts were made to maximize the survey’s response rates. The purpose of the survey is exploratory, i.e., it was created to provide insights allowing the EOC to develop pilot programming in the area of workforce. It is the market response to such pilot programming that will put to a practical test the findings reported in what follows.

Occupations In Which Recruitment Represents a Challenge

The first set of questions referred to those occupations in which companies have a challenge recruiting. Respondents could name three occupations in the category of technicians and skilled workers, and three more among engineers, scientists and managers. Potentially, therefore, the 26 firms that filled the survey could list 78 different occupations under each of these two general categories. In fact, respondents named 34 different occupations within the technicians category, and 36 within the engineers/scientists/managers category as ones in which they have difficulty recruiting. 18 out of 26 firms stated that recruiting technicians represents a challenge to them, while 19 out of 26 said the same about engineers and scientists.

The most salient finding has to do with the sheer number and variety of occupations mentioned – optical fabricators, grinders and polishers, electronic technicians, assemblers, fiber optic technicians and many others among
technicians and skilled workers; and electronics engineer, circuit designers, R & D scientists, optical design engineers, manufacturing engineers and project managers under the “engineers, scientists and managers” category.

An attempt at grouping the many titles listed yields the following:
- Technicians – 9 mentions (out of 34 occupations – 26.5%) for Assembly and Testing workers; 3 mentions (8.8%) for optical fabrication, including coating and optical coating; and 3 mentions (8.8%) for device and sub-system testing and integration.
- Engineers, Scientists and Managers – 7 mentions (out of 36 occupations -19.4%) for Optical Design Engineers, here including those involved with optical testing; and 5 mentions each (13.9%) for Electronics Engineers (including those engaged with electronics for electro-optics sub-systems and circuit design) and R & D Scientists (especially those dealing with product design and development).

**Technicians: Reasons For Their Scarcity; Education; Experience**

The reason most often mentioned for the difficulty in recruiting technicians was that the skills required do not exist within the general population (mentioned by 15 respondents, or 57.7%, in relation to 15 different occupations). 9 firms (34.6%) stated that schools and Career and Technology Centers are not preparing youth adequately, and 8 firms (30.8%) said that schools do not produce sufficient numbers of graduates.

Answers relating to the educational requirements for technicians were somewhat surprising, and deserve a closer look:

- 10 companies (38.5%) said they require a High School degree or GED (for 17 occupations);
- 11 companies (42.3%) said they require a Vocational Certification (for 20 occupations);
- 8 companies (30.8%) said they require an Associate Degree (for 14 occupations);
- 5 companies (19.2%) said they require a Bachelor’s degree (for 5 occupations); and
- 3 companies (11.5%) said they require a Graduate degree (for 5 occupations).

The suggestive finding has to do with the significant number of firms that appear to demand higher education (Bachelors or even a Graduate degree) for occupations defined as technical in nature. In part this highlights the scientific and technological complexity of the Electro-Optics industry, but more generally it indicates a blurring of the lines between science and engineering activities on the one hand, and skilled or technical work on the other. Current technology is reaching or has reached the point in which the latter kind of work calls for
individuals with levels of preparation similar or close to the levels usually associated with science and engineering activities.

Regarding the experience that is desirable for technicians and skilled workers, 15 firms (57.7%) look for people with prior experience in a similar kind of job (26 occupations mentioned), versus 8 firms (30.8%) that look for general work experience (10 occupations mentioned).

In summary, when searching for technicians and skilled workers the industry looks for individuals who are experienced in specific lines of work and who have more education than one would perhaps expect. Candidates must meet high standards, which helps explain why recruitment is seen as a challenge.

**Engineers, Scientists, Managers: Reasons For Their Scarcity; Education; Experience**

The reason most often mentioned for the difficulty in recruiting engineers, scientists and managers was the inability to find qualified professionals within the industry (mentioned by 12 respondents, or 46.2%, in relation to 18 different occupations). 11 firms (42.3%) stated that they cannot find employees in the general population (17 occupations named), and 9 firms (34.6%) said that the required skills do not exist within the general population (19 occupations listed).

Regarding education, 15 firms (57.7%) require graduate degrees for 25 different occupations, while 12 (46.2%) call for a Bachelor’s degree for 19 occupations. One company each said that it looks for a High School degree (for one occupation), a Vocational certificate (also for one occupation) and an Associate degree (for 2 occupations).

The same phenomenon noted for technicians seems to be operating here, i.e., an upwards shifting of the desired educational credentials. If many technical jobs demand Bachelor’s degrees, a majority of companies (15 out of 26) look for graduate level education for their engineers, scientists and managers. There is not only a blurring of lines between technical and engineering/scientific work, but also a general lifting of the minimum education required at both the bottom and the top of the scale.

The same tightening of hiring requirements is visible in regards to experience: overwhelmingly, companies want their scientists, engineers and managers to have prior experience in similar jobs (20 firms, or 76.9%; 36 occupations mentioned).

**Time to Hire**

On an average, it took 17.4 weeks to hire a technician or a skilled worker, versus 23.3 weeks for an engineer, scientist or manager.
Respondents could name three occupations in the category of technicians and skilled workers where a need for training exists, and three more among engineers, scientists and managers. Potentially, therefore, the 26 firms that filled the survey could list 78 different occupations under each of these two general categories. In fact, respondents named 37 different occupations within the technicians category, and 29 within the engineers/scientists/managers category as ones in which training needs are found. 17 out of 26 firms saw training needs among technicians, while 14 out of 26 saw such needs among engineers and scientists.

Once again, the variety of occupations listed was the most apparent feature of the replies. Despite this, some clustering of responses did take place. Among technicians:

- One cluster had to do with assembly. It included occupational titles such as Optical Assemblers, Optical/Electro-Optical Assembly Technicians, Assembly Alignment Technicians, Sub-Systems Assembly Technicians and Photonics Components Assembly Technician. 7 out of 26 firms (26.9%) expressed training needs in this area.
- A second cluster, closely related to the first, involved testing and integration of sub-systems and devices. Occupations listed included Device and Sub-System Testing Technician, Technicians Integrating Optics with Carbon Nano-Tube Technologies, Electronics and Optical Device Testing Technicians and Test Technicians. 4 out of 26 firms (15.4%) showed these types of need.
- The third cluster involved coatings and film deposition. Occupations named included Thin Film Coatings Technicians, Vacuum Operations and Anti-Reflective Coatings Technicians, Optical Coating Technicians and Thin Film Deposition Technicians. 4 out of 26 companies (15.4%) listed these kinds of training needs.
- There were no clusters among the remainder of the occupations mentioned, which included titles such as Precision Surface Grinder, Semi-Conductor Processing Technician, Optical Fabrication Technician, Fiber-Optics Technician, Wire EDM Operator and Laser Design and Service Technician, among others.

Among engineers, scientists and managers the following groups should be noted:

- **Photonics Engineers**, which included titles such as Photonic Device Processing Engineers, Photonics Systems Engineers, Photonics Engineers and Photonics Systems Manufacturing Engineers. Three companies (11.5%) mentioned training needs in this area.
• **Optics and Electro-Optics Engineers**, which encompassed occupations such as Electro-Optics Engineers and Designers, Optics Engineers, Opto-Mechanical Engineers and Designers and Optical Test Engineers. Four firms (15.4%) expressed training needs relating to these occupations.

• Many other titles were listed as needing training – Electrical Engineers, Mechanical Engineers, Process Engineers, System Engineers, Thermal/Dynamic Engineers and Scientists, R & D Optical Scientists, Optical Material Scientists, and Scientists in Nanotechnology for Optical Devices, among others.

In summary, the picture that emerges is – as noted before – that of a complex industry located at the intersection of many disciplines and technologies (electrical, electronic, mechanical and optical engineering, physics and materials science, to name a few). The clusters and occupations reflect such complexity. Technicians are engaged in the assembly and testing of devices involving mechanical, electronic and optical components and exotic materials, while engineers must worry about designing, implementing and controlling intricate systems and processes. One is left with the impression that, beyond specific skills, training for the Electro-Optics industry must be aimed at producing individuals with multi-disciplinary capabilities and a facility for understanding systems and their integration into a whole.

**In What Skills and Competencies is Training Needed? Technicians**

The survey provided clear indications of the types of skills and competencies in which technicians need training:

• Hands-on Knowledge – this was by far the option companies picked most often; 13 of 26 firms (50%) chose this as the type of training their technicians require. 26 different occupations were mentioned.

• Applied Knowledge – picked by 8 out of 26 firms (30.8%), it was the second most common choice. It reinforces the hands-on finding, as it is another way of stating the need for such an approach. 12 occupations were listed.

• A need for training relating to work habits is the only other choice made by a relatively large number of firms. 8 (30.8%) stated that their technicians can use this kind of training, and 12 specific occupations were mentioned.

It is interesting to note that companies in the survey do not feel that basic academic skills in math and science are a problem for technicians: only 4 (15.4%) highlighted this as an issue. It is unclear if this means that employers believe that technicians possess the knowledge although they must learn to apply it, or if they mean that absent theoretical knowledge is best imparted via an applied approach. In either case, the relative lack of importance attributed to basic academic skills strongly suggests a preference for, and a belief in applied training on the part of respondents.
16 companies (61.5%) see a need to have their technicians trained in emerging technologies (31 occupations listed).

In What Skills and Competencies is Training Needed? Engineers, Scientists, Managers

The patterns are not very different for engineers, scientists and managers:

- The need for hands-on training is once again the top choice of respondents – 11 firms (42.3%). 19 different occupational titles were mentioned.
- The second most common choice is the same as it was for technicians, i.e., a need for training via applied knowledge (8 companies, 30.8%; 15 occupations listed).
- Some difference occurs (as compared with the patterns for technicians) in that employers see other things besides better work habits as important for engineers, scientists and managers. Training involving work habits was considered necessary by 5 companies (19.8%), involving 8 occupations; 5 companies (19.8%) also pointed out a need for training in business fundamentals (10 occupations listed) and in basic academic skills (10 occupations listed).

The most important factor differentiating the perception employers have of engineers, scientists and managers – as contrasted with their views on technicians – is perhaps a greater emphasis on academic skills. There are too few cases to ascertain which specific skills are desired, but mention is made of math, science and programming.

11 companies (42.3%) see a need to have their engineers, scientists and managers trained in emerging technologies (18 occupations listed).

Training: Topics of Interest

The survey asked respondents to rank several potential training topics according to their knowledge of the topic and the latter’s applicability to their company; the topic’s relevance to their company; and their interest in the topic (i.e., interest in further training and education). A five-point scale was used, with 1 standing for the low end (no knowledge, no relevance, no interest) and 5 for the high end.

The chart below summarizes the responses:
The chart highlights a few major themes, which are of interest to firms as well as considered relevant and applicable to them:

- Project Management receives the top ranking in all three dimensions: interest in further training/education (3.35), relevance (3.67) and knowledge/applicability to the company (4);
- Quality Deployment is first in interest (tied with Project Management at 3.35), second in knowledge/applicability (3.91) and fifth in relevance (3.5);
- Industry Trends receives a 3.09 in interest (4th place), a 3.54 in relevance (third place) and a 3.75 in knowledge/applicability (5th place).
Besides these topics, which place in the top five in all three dimensions, three others deserve mention:

- Advanced Engineering Technologies is 3rd in interest (3.22) and third in knowledge/applicability (3.88), but is not in the top five in relevance (it is sixth with a 3.46 rating);
- Design of Experiments ranks 5th in interest (3.04) and 4th in knowledge/applicability (3.87), but is only 8th in relevance (3.33); and
- Strategic Market Assessment and Planning is 2nd in relevance (3.63) and 5th in knowledge/applicability (3.75), but only 8th in interest (2.87).

**Summation**

The purpose of this survey has been to generate insights to inform the development of workforce pilot programming by the EOC. 26 companies replied to an online questionnaire and provided valuable information on their recruitment and training needs. Key findings include:

- Firms face challenges in the recruitment of both technicians and skilled workers on one hand, and engineers, scientists and managers on the other hand. Among the former, difficulties center mostly around the recruitment of employees for Assembly and Testing, while among the latter Optical Design Engineers are especially hard to find.
- The educational requirements for technicians and skilled workers are rising – a number of respondents state that they want employees in these occupational categories to hold a Bachelors and even a Graduate degree.
- Prior experience is desirable for individuals looking for positions as technicians and skilled workers as well as for those seeking engineering, science and management jobs.
- Within the technical and skilled work field, employers consider training as a prime necessity in assembly occupations, in those involving the testing and integration of sub-systems and devices, and in those dealing with coatings and film deposition.
- Within the science, engineering and management field, training is seen as required for Photonics Engineers and for Optics and Electro-Optics Engineers.
- One of the most important insights derived from the survey relates to the type of training companies consider essential – it is applied, hands-on training, both for technicians and skilled workers and for engineers, scientists and managers. By contrast, remediation of deficits in basic academic skills is seen as less important or necessary.
- The top three training topics considered by companies as relevant and applicable to them, and in which they have an interest to pursue further training and education, are Project Management, Quality Deployment and Industry Trends.