Design of a Professional Development and Support Program for Future Photonics Industry Team Leaders

Michelle Hall-Wallace[a], Nancy L. Regens[a], Stephen M. Pompea[b]

[a]CATTS Program, Department of Geosciences, University of Arizona, 1040 E 4th Street Tucson AZ 85721-0077 USA[1]
[b]Pompea & Associates, 1321 East Tenth Street, Tucson AZ 85719-5808 USA[2]

ABSTRACT

The University of Arizona's Collaboration to Advance Teaching Technology and Science (CATTS) program sponsored by the National Science Foundation has found a successful way to unite public and charter school students and teachers, university science outreach programs, graduate and undergraduate students, and university faculty for the betterment of science education. A key aspect of this success has been the ability of the project to assist stakeholders in understanding the different cultural perspectives of all of the participants.

The success of this program has led us to create a template for a professional development and support program emphasizing the degree of cross-cultural understanding appropriate for today s multinational photonics industry. This template is designed to give future photonics technical, managerial, and manufacturing leaders training in a variety of areas that can enhance their productivity and ability to lead teams. The design would be appropriate for photonics research and development teams, sales and marketing teams, teams with diverse members, new college hires, and newly emplaced managers. This education template would also be appropriate for students in photonics industry technician and graduate-level programs. This type of program is not a substitute for other forms of professional managerial training, but rather augments such programs with material that can aid in a more global perspective.

1. INTRODUCTION

Countries are no longer the business units of companies. Photonics companies are increasingly global in all key aspects. For example, a large telecommunications company may have six laboratories in six different countries, each focusing on one key area (e.g. laser diodes, or fibers). All of these facilities may be part of the research division and report to a research director at the company headquarters in still another country. Production facilities may be located in ten different

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[1] Dr. Michelle Hall-Wallace is a faculty member in the Department of Geosciences, College of Science at the University of Arizona. She is PI on the CATTS Project. She can be reached at hall@geo.arizona.edu. N. Regens is the Program Coordinator for the CATTS program and can be reached at nregens@geo.arizona.edu or http://www.geo.arizona.edu/catts/.

[2] Education Co-Chair, Arizona Optics Industry Association, Adjunct Faculty, University of Arizona, Telephone 520.792.2366 Email:spompea@pompea-associates.com

countries, with each manufacturing plant creating a major product that is distributed and sold worldwide. Other smaller key parts may be produced in several dozen additional countries as well. The testing and introduction of new products is likewise global and may be conducted in a dozen other countries before worldwide introduction. Teams in each area of the company and in each country are often highly diverse, with members and managers hailing from all parts of the globe.

Given the international nature of business in the optics and photonics areas, what models would be appropriate for creating a professional development and support program for future photonics industry team leaders? This paper argues that such future leaders will be primarily leading knowledge workers rather than factory production workers. Leading and supporting knowledge workers is critical for a company s success since the current extreme mobility of technical knowledge workers puts a premium on keeping them content, productive, and well-supported. Although pay incentives for knowledge workers are important, these workers have a different set of needs than factory manufacturing workers. At some level, these workers are pursuing values tied to the actualization of their personal and professional lives, using Maslow s well-known terminology. The long-term success of the corporation, and even the industry is tied to the ability of the corporation to support its knowledge workers in these pursuits.

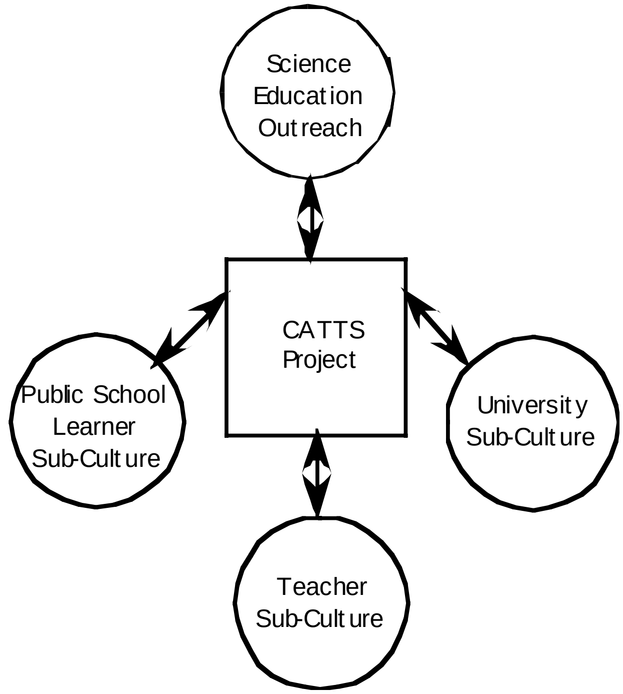
The Collaboration to Advance Teaching Technology and Science (CATTS) program at the University of Arizona emphasizes the development of leadership skills in undergraduate and graduate students. These skills are necessary for their work with a diverse set of schools and science education programs. Given their educational level, the selection process, and their creativity and initiative, these students are certainly knowledge workers. Since the CATTS Fellows (as the students are called) often work closely with classroom teachers and with students from Hispanic or Native American backgrounds, they need a general understanding of each group. This is provided in a professional development program presented as a university course and through close work with the program PI (Hall-Wallace) and the coordinator (Regens).

Program sessions for the Fellows emphasize team building, cooperative learning, inquiry-oriented research, self-assessment, and data analysis. The genesis of the paper was the realization that the program used for the professional development of CATTS Fellows also has wide applicability to meeting the needs of the photonics industry. The CATTS program spans many sub-cultures and provides professional development activities for undergraduate and graduate science students. The template presented here from that program can be superimposed on a more traditional content-based training course and can also be used for new hires, interns, or even as a support system for underrepresented groups in the workplace. The partnering, teaming, and support logistics prevalent in the CATTS program has significant utility for all varieties of photonics teams.

2. CATTS PROGRAM

The CATTS program at the University of Arizona is described in detail elsewhere.[1] The diagram below shows how the key program components interact. Some of the most relevant aspects of the program for this discussion include the extensive support system, which includes individual meetings with science outreach project managers and students and a formal university class designed as a support and professional development opportunity. The mentoring/support system emphasizes the following areas:

- team building
- cooperative learning
- inquiry-oriented research
- self-assessment
- data analysis



The formal class, which all CATTS Fellows must take, addresses in depth a number of other issues that have relevance to the management of photonics teams. Some of the focal points include: working with creative teams, diverse composition teams, teams with fluid compositions, and teams where responsibilities are shared in complex ways. This latter category corresponds to a system of matrix management so prevalent in industrial and corporate settings.

The CATTS support system and professional development template can be applied to photonics industry team leaders seeking to augment their technical capabilities with more advanced management techniques as well as so-called soft skills. Soft skills include, for example, communication and group leadership skills. The potential audience for such a program includes future technical leaders, managerial leaders, manufacturing leaders, new college hires, newly emplaced managers, and students in technician and graduate level programs. Research and development teams, sales and marketing teams, and teams with diverse members could also benefit.

This paper provides a template of what this professional development training might look like. Goals for professional development are described in detail as follows:

3. OVERVIEW OF LABOR FORCE PROFESSIONAL DEVELOPMENT NEEDS: TRAINING THE MANAGER OF KNOWLEDGE WORKERS

The growth of the optics and photonics industry and future needs for trained professionals has been well documented[2]. There must be a significant increase in training and professional development to meet current and future demands. In this paper, the term professional development will be generally be used rather than the more limited term training . Training often implies a limited scope of activities designed to bring the employee into competence in a given area. In contrast, professional development implies an ongoing set of activities for the professional development of the employee. Professional development efforts are not limited in scope to the present position of the employee but usually are in accord with the development of the individual for a future position of greater responsibility.

Since production of skilled technical and managerial specialists in the photonics area is limited, it is likely that many if not most future participants in the photonics field will be from other, related industries. The photonics industry is one of the most global of all industries, and because of this has special industry training requirements. The general requirements are well summarized:

A world of work that has become more interdisciplinary, collaborative, and global requires that we produce young people who are adaptable and flexible, as well as technically proficient.
—National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine, 1995 report.

The management of knowledge workers is fundamentally different than the management of a factory or production facility. Management of production facilities requires the production of a product at a certain minimum quality level. Applying the principles of Total Quality Management (TQM) is an effort to reduce production that falls below that minimum standard of quality, in order to increase efficiency and reduce waste costs.

Knowledge-worker quality has a different characteristic. As Drucker (1999)[3] points out, quality is not a minimum or restraint, but rather the essence of the output of the knowledge worker. For the manual worker, the question is how best to do the task? For the knowledge worker, the relevant question is often what is the task? If the company does not have skilled knowledge workers properly defining the direction of the effort, the company will be in dire straits. For example, the training of a surgeon involves both production and knowledge worker management principles. Surgical technical proficiency can probably be taught to a wide variety of individuals with the requisite motor skills. This would correspond to factory production work. Knowing under what circumstances to operate and how to proceed when the operation takes an unexpected turn involves a set of complex skills achievable only with significant past and ongoing professional development. The achievement of these skills may take place in only a limited number of professionals and with very specialized and well-supervised professional development. Similarly, the productivity of a photonics company is highly dependent on the performance of the key knowledge workers, and these workers should be given the maximum level of support and professional development. Goals for this high level of professional development are given in the next section.

4. PROFESSIONAL DEVELOPMENT GOALS

Goal 1: Development Of Photonic Technical Skills

The educational programs for developing photonic technical skills will not be discussed in detail as excellent summaries are given, by for example, Mohran and Soileau (1995)[4], Hull (1995)[5], Litynski et al. (1995)[6], and Gaskill et al. (1995)[7]. A high level of technical proficiency is essential.

Goal 2: Development Of Better Skills Related To Technical Commerce

To develop more effective managers, technically trained people must have a broader exposure to areas essential to conducting business in a technical commerce environment. Graduate students with technical degrees often lack a fundamental knowledge of business law, management principles, and organizational management. A variety of programs have been established to give technically trained students more competence in commerce areas.

Under the sponsorship of the Sloan Foundation, a professional masters program has been created at 24 universities, including the University of Arizona. Unlike a traditional masters program which is usually a step towards a doctorate, a professional masters program is designed to give the student special educational opportunities that better prepare them for a career in industry. The professional masters program does not have a thesis as a requirement, but does have a strong emphasis on working in teams. It also emphasizes projects. The program combines a core scientific or engineering curriculum with business courses that cover areas such as marketing, intellectual property, research management, and technology transfer.

The objectives of the University of Arizona programs are to create a new generation of students who can work in interdisciplinary teams working to solve complex problems. These students must be highly competent in computational techniques, be effective communicators, and be proficient in business and legal issues connected with their scientific projects (Levine, 2001[8]). Such a program is an effective way to develop managers with a stronger set of business skills and capabilities.

Goal 3: Developing Engineering Project Management Skills

The development of further project management skills is critical. A photonics training program must cover in some detail the normal training associated with project management process and project constraints. Some topics inherent in engineering project management professional development courses are material and case studies associated with:

- Project Plan Life Cycle
- Project Management Issues
- Project Management Tools, including sequence planning methods
- Root Cause Analysis Techniques, including fault tree analysis

Goal 4: Development of Non-Technical And Soft Skills

In the past, companies have emphasized development of the technical skills of their employees. These skills can be quantified using years of experience, level and type of university degree, and specific courses and courses of study completed. Companies are increasingly recognizing the importance of non-technical or soft skills in doing business. In particular, companies that do business internationally must pay particular attention to these soft skills as they move into countries where beliefs and culture are very different from the parent company s country. There are a large number of soft skills such as initiative, cooperation, and teamwork.

Heath (2000)[9], in a study of skills valued and needed by the oil industry, arrived at the list of the most valued soft skills, given below. The most valued skills appear in the upper portion of the table. Although there is a widespread perception that many of these skills are innate, there is substantial evidence that many of these skills can be both taught and modeled. For example, problem, solving, ethics, and teamwork skills can benefit from training and professional development courses.

Soft Skills Most Needed by Companies

Initiative	Ethics/Integrity	Willingness to Learn
Adaptability/Flexibility	Commitment	Summarization/Abstraction
Desire to Achieve	Cooperation	Analytical Skills
Coping with Stress	Drive/Enthusiasm	Dependability/Reliability
Self-Management	Teamwork	Listening
Taking Responsibility	Problem Solving ability	Time Management

5. UNDERSTANDING OF CROSS-CULTURAL ISSUES: DIMENSION OF CULTURE

Companies that work globally are in particular need of team leaders who are skilled in cross-cultural areas. The last element of our template responds to the question What skills are needed to work effectively with people from other cultures as superiors, peers, or subordinates? One of the most important skills is the ability to understand cultural differences. For example, the time orientation among countries and culture can vary greatly. For example, China has a very long-term time orientation and this characteristic can be effectively measured and described. Other forms of cultural variability are equally important in the workplace. An excellent introduction to cultural issues is given in Trompenaars and Hapden-Turner (1998).[10]

Hofstede (1980)[11] described four dimensions of cultural variability, commonly referred to as "Hofstede's Dimensions." These dimensions include: Uncertainty Avoidance, Power Distance, Masculinity-Femininity, and Individualism-Collectivism, and will be explained in detail. These dimensions came from a large study (sample size = 116,000) of survey data from a multinational corporation. A score for each of these dimensions for 40 different countries was generated from this research.

A. Uncertainty Avoidance

The uncertainty avoidance dimension describes how comfortable people feel towards ambiguity or ambiguous situations and represents a level of tolerance towards uncertainty. A culture ranked low compared to other cultures would feel more comfortable with the unknown or in uncertain or ambiguous circumstances. These cultures would have a more relaxed atmosphere and have a higher tolerance for deviance. Hong Kong and Sweden are among the areas ranked lowest on this measure, and therefore have a greater tolerance of uncertainty.

In contrast, high uncertainty avoidance cultures are more comfortable with formal rules, may maintain rigid codes of belief and behavior, and have less tolerance for deviation. These cultures perceive uncertainty with higher anxiety than low uncertainty avoidance cultures. Greece, Guatemala, and Uruguay ranked highest on this measure.

B. Power Distance

Hofstede & Bond (1984)[12] define power distance "as the extent to which the less powerful members of institutions and organizations accept that power is distributed unequally".

In countries with low power distance, an individual may value equality and may question orders from superiors. Israel is ranked as country with a very low measure on the power distance scale. Other countries with low power distance measures are Ireland and Sweden.

Members of high power distance cultures are much more comfortable with a larger difference in status and power than low power distance cultures. They recognize the role of power and authority as part of life and place a higher value on obeying orders from superiors. Malaysia, Guatemala, and the Philippines rank among the countries with the highest power distance values.

C. Masculinity-Femininity

This dimension refers to the social roles played by the sexes and is a description of the expected gender roles in a culture. According to this measure, the more "feminine" cultures have a greater ambiguity in their expectation of what is expected of each gender. They also possess more gender role flexibility. Women can have more assertive roles while men take on more caring roles, for example. Examples of countries in this more feminine category are Sweden, Costa Rica, and Yugoslavia.

High masculinity scores describe a culture that has very distinct and different expectations of male and female roles in society. In this case, men would have outgoing and assertive roles while women would be expected to have caring/nurturing roles. Countries with high scores on this measure are Venezuela, Mexico, and Ireland.

D. Individualism versus Collectivism

Individualistic cultures place a high emphasis on the achievements and goals of individuals. Collectivist cultures emphasize the subordination of individual desires to that of the group and emphasize group membership and group goals. Examples of countries with the most individualistic cultures are the United States, Sweden, and Ireland. The most collectivist countries, according to the research by Hostede are Panama, Columbia, Pakistan, and Indonesia.

Individualist	**Collectivist**
Individuals will speak up in large groups	Individuals speak only in small groups
Individuals speak up in class when the instructor asks for a general response	Individuals speak only when personally called upon by the teacher
Positive association with what is new	Positive association with tradition and what is rooted in tradition
Emphasis on learning what is new	Emphasis on learning what is traditional
Little emphasis on saving face	Neither teacher or students will be allowed to lose face
Confrontation and conflict can be brought into the open, may be useful to the process of education	Formal harmony should be maintained

The implications of Hostede s cultural dimensions on the design of an educational or professional development program at any level are enormous, even if only one of the four dimensions is examined. For example, using the individualism versus collectivism dimension, there is a significant contrast in how teacher-student relationships are conducted. For example, the values regarding teacher-student interaction in a highly individualistic country like the United States may be contrasted with that of a more collectivist perspective in the following table, adapted from the work of Hostede (1986)[13]

6. CONCLUSION

The design of a professional development program for the photonics industry is a challenge. Such a template must combine technical, business, managerial, and cultural education. Particular attention must be paid to cross-cultural issues if effective teams are to be formed. The success of the formal and informal professional development and support program defined in the Collaboration to Advance Teaching Technology and Science (CATTS) program at the University of Arizona can aid in the creation of a robust model for professional development for the worldwide photonics industry. We plan to work with optics association such as the Arizona Optics Industry Association, and optics and photonics professional societies, to implement this template.

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