

Engaging the optics community in the development of informative, accessible resources focusing on careers

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ABSTRACT

Young people often have biased and pre-conceived ideas about scientists and engineers that can dissuade them from considering a career in optics. This situation is compounded by the fact that existing resources on careers in optics are not suitable since they mostly focus on more general occupations such as a physicist and an electrical engineer. In addition, the linguistic register is not adapted for students, and many of these resources are only available to guidance counselors. To create appropriate resources that will inform high school students on different career opportunities in optics and photonics, we sought the collaboration of our local optics community. We selected seven specific occupations: entrepreneur in optics, university professor, teacher, technician, research and development engineer, sales representative and graduate student in optics. For each career, a list of daily tasks was created from the existing documentation by a guidance counselor and was validated by an expert working in the field of optics. Following a process of validation, we built surveys in which professionals were asked to select the tasks that best represented their occupation. The surveys were also used to gather other information such as level of education and advice for young people wishing to pursue careers in optics. Over 175 professionals answered the surveys. With these results, we created a leaflet and career cards that are available online and depict the activities of people working in optics and photonics. We hope that these resources will help counter the negative bias against scientific careers and inform teenagers and young adults on making career choices that are better suited to their preferences and aspirations.

Keywords: Outreach, careers in optics, education, counseling

1. CONTEXT AND ISSUES

The entertainment industry provides various scientist role models to young people. Allan Scott, the first Green Lantern, is a railroad engineer. Peter Parker (Spider-Man) was a high school science teacher before becoming a journalist. Bruce Banner (Hulk) is a physicist who created the gamma bomb that later caused him to turn into a super hero. Tony Stark (Iron Man) received Master's degrees in electrical engineering and physics from MIT [1]. And the list goes on... It is not surprising that teenagers have a distorted idea of what scientists are like and what their job consists of, not to mention that they are not aware of the wide variety of scientific fields and careers. A survey conducted in Canada in 2010 showed that only 7% of young people studying science in college consider optics and photonics as a potential career choice and have the capacity to pursue graduate studies in optics [2]. Our field is little known and young people are unaware of the different career opportunities related to the sciences of light.

In Canada, very few documents are available to teenagers about careers in optics [3-4]. In addition, these documents are often imprecise and incomplete and they are not specific to optics but focus on general professions like physicist or electrical engineer. They are sometimes only accessible to guidance counselors [5] and their language register is not appropriate for young people. To fill the gap, members of the Université Laval SPIE and OSA student chapters decided to create a leaflet and career cards intended for young students. Seven specific occupations were selected: entrepreneur in optics, university professor, teacher, technician, research and development engineer, sales representative and graduate student in optics. In order to develop interesting and pertinent documents, surveys about these occupations were designed by a team of graduate students in optics and a Master's student in counseling. More than 175 professionals answered the surveys.

This paper describes the methodology that was used to design the surveys, as well as the layout and content of the leaflet and career cards. This study is part of the FEMTO project [6] that is presented in the conclusion.

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2. METHODOLOGY

The study has been divided into three main steps: expert validation, brainstorming and construct validity study. The process is described below. The project was conducted in close collaboration with a Master's student in counseling working in the field of psychometrics, *i.e.* the study of theory and technique of psychological measurement and their validity.

2.1 Validation with an expert in the field

The main goal of this work was to come up with accurate lists of daily tasks for seven professions. To begin with, existing lists of daily tasks related to the chosen occupations were used [5]. The most complete information is only available to guidance counselors and contains very general information that is not specific to optics. The expert, a person working in the field of optics, looked at the validity of each task for every targeted career. Tasks were added, eliminated or modified to better represent the different professions according to the expert. The modified daily task lists were then validated by two other experts. These three experts did not participate in the construct validity study described in section 2.3.

2.2 Brainstorming and other information

Various brainstorming sessions were conducted at this stage. It was important to include all the questions that we would like to ask the survey participants such as: "When did the surveyed entrepreneurs start their first business?" or "What is the most important quality to pursue graduate studies in optics?" For each occupation, the experts and the Master's student in counseling identified several interesting topics. The experts also put together a list of optics-related words. The goal of this list was to identify appropriate words to place on the cover of the leaflet.

2.3 Construct validity study

In this case, we hypothesized that the lists of required qualities or daily tasks for a specific career were adequate since they had been validated by experts in the field. These qualities and tasks are the constructs that will be validated by a large number of people working in the field. For each career, a survey was created using the online platform SurveyMonkey [7]. The surveys were sent out to the optics community and people were asked to answer the one that corresponded to their current occupation. The following general questions were found in all the surveys:

1. *In the following list of words, check the three that best represent optics and photonics according to you.*
2. *What aspect of your occupation do you enjoy the most? (open answer)*
3. *In the following daily tasks list, check the three that best represent your everyday work.*
4. *What advice would you give to a young person who wants to pursue your profession? (open answer)*

Question 2 was designed to discriminate between answers to question 3. Since question 2 was asked before the people had seen the daily tasks list, the answers helped to determine if some important items had been forgotten in the list. Question 4 was included to obtain advice that will add personality to the documents. Each survey needed to be answered by at least 10 professionals to be considered valid. We received between 12 and 43 completed surveys, depending on the career.

3. LEAFLET AND CAREER CARDS

The results from the different surveys were used to create two types of documents. The first document is a leaflet that summarizes the most important information about careers in optics. The second set of documents is a collection of career cards that give more complete information about each profession. All the documentation is prepared in letter format so it can be easily printed at home or at school.

3.1 Leaflet

The leaflet gives a short list of daily tasks that was established for each profession. In the graduate student section, the most important qualities to pursue graduate studies in optics are also presented. Inside the leaflet, there is an inspiring quote about the challenges of tomorrow. All these items come from the surveys that were performed within the optics

community. In addition, the words innovation, technology and multidisciplinary were added on the cover because these words were voted as the most representative in the field of optics, in the different surveys. Information about the level of education and median wage from SPIE 2013 Global Salary Report [8] was added to complete the document.

Graduate Student

- Invent new technological solutions to solve existing problems
- Work in a team
- Design products and measurement procedures from experiments performed in a laboratory

Education

Engineer
Professor
Teacher
Technician
Representative
Entrepreneur (variable)

Median Wage

Engineer
Professor
Teacher
Technician
Representative
Entrepreneur (variable)

Curiosity
Resourcefulness
Precision/Minuteness
Organizational skills
Perseverance
Versatility
Autonomy
Passion
Imagination
Adaptability

ICIP CIPI
COPL
Centre d'optique, photonique et laser
REPOL

To learn more, visit www.FEMTO.ca

Sources
Independent survey of 178 professionals in optics and photonics in Quebec
SPIE Wage Report: "2013 Global Salary Report"

OPTICS & PHOTONICS
MY CAREER CHOICE

Explore careers in optics and photonics

Entrepreneur

- Lead, control and organise the entirety of your employees' tasks
- Invent new technological solutions to solve existing problems

University professor/researcher

- Direct and supervise people or a group of people
- Exchange ideas and collaborate with other researchers
- Teach at the university level

Technician

- Conceive and realise, in part or in full, electronic, optical and mechanical assemblies
- Assist engineers, researchers and/or students in their research work

Specialised sales representative

- Evaluate clients' needs and recommend appropriate products
- Travel to meet potential clients
- Persuade clients to buy new products
- Inform and advise clients on the newest in scientific equipment

R&D support engineer

- Invent new technological solutions to solve existing problems
- Work in a team
- Conceive products and measuring procedures based on laboratory experiments

Teacher

- Teach one or many university or college level subjects
- Conceive, supervise and correct exams, homework and practical laboratory work
- Plan the content of courses and teaching materials

The future belongs to those that wake up early, love scientific challenges and are committed to the training of specialists for tomorrow's society.
Christine Tremblay
École de technologie supérieure

Fig. 1 Career leaflet contains information about seven occupations

3.2 Career cards

Since all the information that was gathered during the survey could not appear in the leaflet, career cards were created as a complement. The career cards contain all the daily tasks that were chosen by at least 50% of the professionals who were interviewed for a specific occupation. It also presents suggested educational paths as well as an inspiring quote from one of the respondents to give personality to the card. The entrepreneur card also highlights the most important personality traits to succeed in this field according to the entrepreneurs who answered the survey. Fig. 2 shows the entrepreneur career card and identifies the different sections.

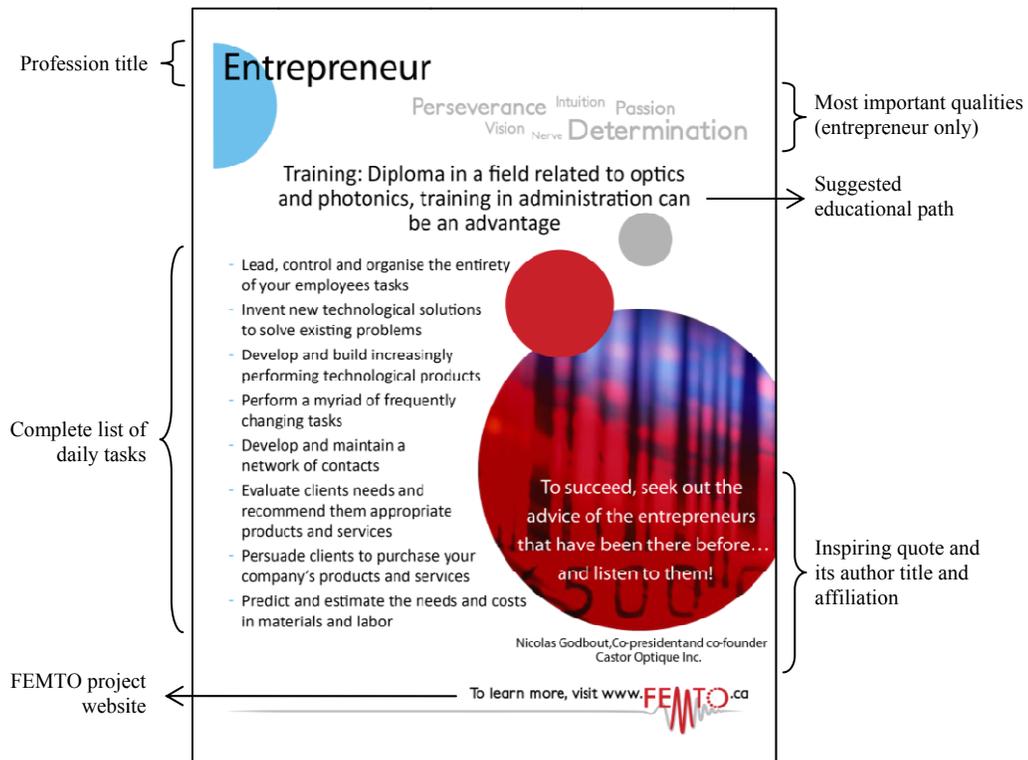


Fig. 2 Entrepreneur in optics career card

4. THE FEMTO PROJECT

FEMTO (Framework of Educative Material for Teaching Optics) is a Canada-wide bilingual student project financed by CIPI (Canadian Institute for Photonic Innovations). Its goal is to promote optics and photonics to young people. This project is application and career driven because we saw that there was a need and an interest from teenagers for these topics. The students from Université Laval SPIE and OSA student chapters who launched this project had previous hands-on outreach experience with over 200 high school students each year. Throughout these interactions, they realized that teenagers always had a lot of questions about the average workday of a scientist or an engineer and about how science manifests itself in objects they used in everyday life. We saw an opportunity to fill the gap with new material to answer their questions, and the FEMTO project was born.

There is another mission within this project: to showcase the expertise of undergraduate and graduate students all around Canada. A part of the funding of this project was dedicated to hiring students to work on different tasks. More than 22 optics students have worked on the project to this day to build or improve experiments, buy equipment and write protocols and didactic material. Some of them performed tasks that harnessed various other skills like graphic work, video editing, photography, French grammar review, and management of financial and human resources. In addition, three non-optics students were hired for website creation, translation and English grammar review.

The FEMTO project is divided into four parts that each answers a different need. Placed together, these parts create a complete resource about optics and photonics. All of the information related to each component is available at www.femto.ca/en, and the four sections are described below.

4.1 Examine applications: the demonstration laboratory

The demonstration laboratory is a dedicated outreach facility located at Université Laval [9]. This laboratory contains five demonstrations: (1) holography, (2) optical fibers, (3) oximeter, (4) imaging and optical aberrations and (5) high power lasers. The protocols are available online, including a list of material and the detailed steps to build each demonstration. The goal of this facility is to show the research environment with clear and uncluttered experimental set-

ups. Since its opening in October 2010, this versatile facility has welcomed more than 1750 visitors, from summer camp kids to college students, and guidance counselors to dignitaries.

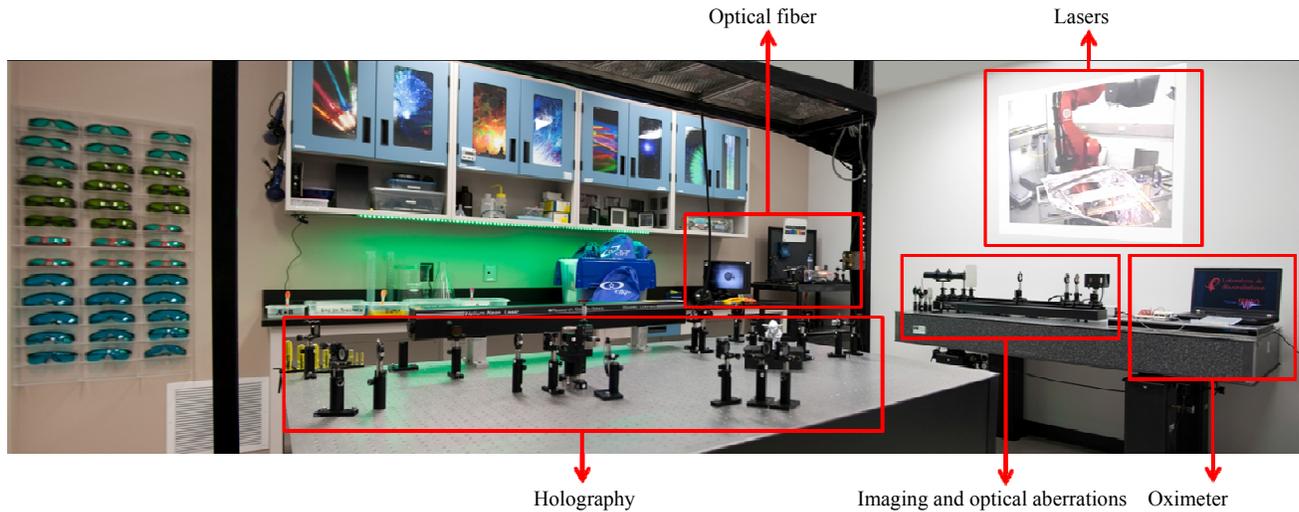


Fig. 3 Panoramic view of the demonstration laboratory at Université Laval

4.2 Discover photonics: the Canadian Photonic Kit

The Canadian Photonic Kit contains 8 hands-on experiments that can be carried out in a classroom. In teams of four, the students will perform an experiment and then explain it to the rest of the class. The subjects are various: light polarization, infrared radiation, optical communication, etc. The kit can also be used during an exhibition since the experiments can be presented as short demonstrations. More than 50 kits are available across Canada from museums, colleges, universities and non-profit organizations. The list of kit keepers can be found online to identify the one that is the nearest to you.

4.3 Explore careers: make an enlightened choice

The main goal of the FEMTO project is to provide Canadian students information about studies and careers in optics and photonics. In the previous sections, we discussed in detail how we proceeded to create documentation about career in optics that can be downloaded from the FEMTO website. All the information from the surveys has not been used yet, we are still thinking about ways to use some of it.

4.4 Develop your knowledge: other resources

There are a lot of interesting resources online, like videos about how to make a hologram or optical fiber. The website of the FEMTO project contains a list of them. We are also working on the creation of a series of four posters available in French and in English containing pictures and information about specific topics: polarization, fiber optics, fluorescence and colors of light. Another goal of the FEMTO project is to increase the awareness about laser safety and more specifically about the hazards related to the use of laser pointers. These pointers can now be easily purchased and used by the general public and serious concerns about the hazards of laser pointers have surfaced. We are working on a study of laser pointers bought in different stores and manufacturers on the Internet and we will present our results on the FEMTO website.

4.5 Website

To make sure that all the resources are available to as many people as possible, information about the contents of the CIPI Canadian Photonic Kit, the list of kit keepers, printable material such as posters and documents for guidance counselors are placed online on the project's website.

To open the doors of the demonstration laboratory to all Canadians, we will add a virtual tour with "hot spots" and short videos online, trying to make it as realistic as possible. To encourage other universities to build their own outreach facility, the protocols detailing the materials needed for each of the five experiments and the steps for setting them up are available online. We also included tips from our own experience in the creation of those experiments.

5. CONCLUSION

In the hopes of increasing young Canadian students' awareness of the field of optics and photonics and improving their perception of professionals in this field, we created a set of informative documents that can be used by guidance counselors, teachers, parents, and teenagers directly. To ensure that the information conveyed in these documents is pertinent and accurate, we followed a process of validation and sought out the input from a large number of professionals. The final documents are presented in a layout that is dynamic and attractive; with a style that we hope will stay fashionable for many years to come. Finally, we made these documents available to the general public as an essential part of a website that promotes optics and photonics demonstrations and that is aimed at anyone who is interested in either sharing the excitement of photonics or discovering it.

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