

Female Pupils' Perception of Electrical Engineering

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INTRODUCTION

Recent studies have focused on gender issues and women's underrepresentation in fields such as computer science, software engineering (Camp, 1997, 2002), and information technology (Varma, 2003). This article broadens the discussion to include the field of electrical engineering (EE), in which the underrepresentation of women is even more salient than in the aforementioned fields. For example, the percentage of female undergraduate students in the Department of Electrical Engineering at Technion: Israel Institute of Technology (IIT), Israel's leading school of engineering, is less than 15%.

Although there are no easy solutions to the complex problem of attracting women to the field of EE, we argue that certain measures can nevertheless have an impact. Specifically, a partial solution might be to increase the awareness of female high-school pupils, first, to the very existence of the field of EE, and second, to its diverse nature. This article reports on an annual exposure day that aims to do just that. This event, entitled "Electricity in the Palms of Her Hands," specifically targets female high-school pupils who excel in mathematics. This exposure day, the title of which follows the words of a popular Hebrew song, gives the pupils a glimpse of the variety of subfields EE encompasses, and thus gives them a very different perspective on EE as well as a different image of the professionals working in the field.

Specifically, the article examines the perception of EE as expressed by high-school female pupils on two such exposure days. We focus on one main observation: the change the exposure day induces on the pupils' perception of the profession of EE. Our

study shows that, whereas in the morning of the exposure days, the pupils perceived EE to be a technical field and did not consider it as a major field of study, by the end of the days, the pupils were describing its multifaceted nature, and many of them perceived EE to be a profession that they might consider studying.

BACKGROUND

The Department of Electrical Engineering at Technion¹

The Department of Electrical Engineering at Technion is ranked among the top-10 electrical engineering and computer science departments in the world. It is the largest of Technion's departments, with 1,800 undergraduate students in four main study programs (electrical engineering, computer engineering, computer and software engineering, and electrical engineering and physics), and over 400 graduate students. The department is a center of excellence in both applied and theoretical research. Over 10,000 of the department's graduates hold leading positions in the Israeli hi-tech industries, and they comprise 70% of the chief executive officers and vice presidents of development and engineering in Israel.

Women in Technion's Department of Electrical Engineering

The percentage of women studying EE at Technion is relatively low. In 2002, only 12.3% of the

department's undergraduates were women, and that ratio increased only slightly in 2003 to 13% and in 2004 to 14%. The existence of associations in several of the leading universities that aim to provide community, mentoring, and enrichment for graduate women students in EE reveals that a similar phenomenon exists in other universities as well (see, for example, the Women in Electrical Engineering [WEE] organization at Stanford—<http://wee.stanford.edu/index.php>).

At the same time, achievements of the female EE students are, on average, high. According to Professor Baruch Fischer, former dean of the department (1999-2003), women are equally capable of succeeding in EE studies as are men. "The low representation of women in the department results from the low awareness of what the department offers and what its research areas are, as well as the unjustified 'masculine' image of the profession of EE," said Professor Fisher in the *Technion Magazine* of winter 2004.

In the past 4 years, an attempt is being made to increase the representation of women in the Department of EE's undergraduate programs. The department decided to expose female high-school pupils to the richness and variety of subjects currently studied at the department, to its distinguished research laboratories, to career opportunities in EE, and to pros and cons of being a female electrical engineer. This decision materialized in the form of an annual exposure day entitled "Electricity in the Palms of Her Hands." During the past 4 years, about 400 female high-school pupils, from an array of Israeli high schools, attended these exposure days. During these days, the pupils heard lectures, saw demonstrations, visited laboratories, and met with female graduate and undergraduate students of the department.

The Exposure-Day Format

Table 1 describes the exposure day's agenda. Dr. Ayellet Tal, the second author of this article, formally opens the event. Dr. Tal is a female faculty member of the Department of EE and head of the exposure day's organizing committee. After the dean's greetings, a female undergraduate student describes her experience as a student at the Department of EE. The pupils then listen to a plenary talk on the interrelations among science, technology,

Table 1. Exposure-day agenda

Hour	Topic
9:00-9:30	Opening: Dr. Ayellet Tal, an EE female faculty member, describes her research on computer graphics. Dean gives words of greeting. An undergraduate student describes her social and academic life in the department.
9:30-10:00	Plenary talk
10:00-12:00	Parallel activities: Demonstrations and visits to the department's laboratories
12:00-12:30	Lunch break
12:30-13:30	A tour of the Technion campus
13:30-14:15	Parallel activities: Meetings with female alumni of the department
14:15-14:30	Closing session

engineering, and society. This plenary session increases the pupils' awareness of the facts that (a) women can succeed in EE, and (b) women are still underrepresented in the field of EE.

The exposure day then proceeds with two sessions of parallel activities conducted in small groups. During the first session, groups of about 20 pupils each visit several of the department's laboratories, hear talks, and see experiments. Each pupil is directed to activities and laboratories related to topics that are close to her own fields of interest.

After a lunch break, each small group of female high-school pupils meets a female alumna of the EE department. These women alumni represent a wide range of areas in which an electrical engineer can develop a career following graduation. The objective of the meetings is to increase the pupils' familiarity with the actual work of electrical engineers in general, and to expose them to the personal stories of female electrical engineers in particular.

The main ideas emphasized throughout the exposure day are the following:

- **The Interdisciplinary, Multifaceted Nature of the Profession of EE and the Variety of Topics that it Encompasses:** In order to change the vague public image of EE, the exposure day deals with a variety of topics (microelectronics, artificial intelligence, image processing, connections to biology, computer graphics, etc.).
- **The Close Relationship Between EE and Society and Real-Life Applications:** Research reveals that "women, to a somewhat

greater extent than men, are apt to choose fields of study they believe will contribute to the social good, and engineering and related sciences are not widely perceived as professions making such contributions" (Muller, 2003, p. 121). Accordingly, women might not choose an EE career if their perception of the field does not include social aspects. For this reason, the exposure day emphasizes applications and products developed by electrical engineers that directly affect everyday life, culture, and art, such as state-of-the-art technologies for picture and music processing.

- **Women's Representation:** The percentage of women who play an active role in the conference is much higher than their overall representation in the department. In addition, these women are from different backgrounds and hold various degrees and positions: faculty members, graduate students, undergraduate students, and alumni. The assumption is that this close interaction with female electrical engineers from different backgrounds has the potential to influence the pupils' perception of the professional lives of electrical engineers.
- **Students' Cultural and Social Lives:** Although learning and professional development are the main goals of students who choose to study at the Department of EE, the cultural, social, and communal aspects of student life cannot be ignored since they may influence the pupils' future choice whether or not to study in a specific department. To illustrate some of the social aspects of life in the Department of EE, the exposure day is held on a day of the week on which the students' arts and crafts fair takes place. As can be seen in Table 1, the conference schedule includes a tour of Technion, which allows for free time to visit the fair, listen to the music, taste the Technion atmosphere, and talk with current students.

MAIN THRUST OF THE ARTICLE

The study described in this article was guided by two main objectives. First, we wished to reveal the pupils' perception of EE. Second, we wished to evaluate how the exposure days can impact this perception. In

order to accomplish these goals, we used open questionnaires and ethnographic observations. The questionnaires are presented in Hazzan, Levy, and Tal (in press).

From a comparison of the pupils' written responses given at the end of the day with those given in the morning, it is clear that a change took place during the day and that the pupils reconstructed their perception of EE. As is illustrated in what follows, while in the morning the pupils' preconception of the profession of EE indicated ignorance and a lack of awareness to what EE is, the end-of-the-day perception was focused and addressed the multifaceted nature of the field.

Tables 2 and 3 illustrate the change of perception seen in the questionnaires at the 2003 conference. As Table 2 indicates, only one third of the pupils expressed any meaningful perception of EE in the morning, whereas the other two thirds had either no meaningful answer to give or gave answers that reflected ignorance and lack of awareness. In contrast, when asked again at the end of the day, most of the pupils' answers indicate that during the day they had constructed an academic, engineering, scientific, and human-related image of the profession. Furthermore, at the end of the day, terms that indicate a multifaceted perception of EE were used to describe the profession of EE (e.g., *variety, combination, broad, no limits*).

More specifically, as Table 2 shows, the pupils' perception of EE underwent transformation over the course of the day with respect to three categories. First, the multifaceted nature of the field, barely mentioned in the morning, was mentioned frequently in the pupils' answers at the end of the day. Second, the technical (instrumental) aspect, which was so prominent in the morning, all but disappeared throughout the day. Third, the social aspect, which was not mentioned at all in the morning, emerged at the end of the day. The emergence of the last category is important since, as mentioned earlier, women tend to choose human-related professions.²

Table 3, which addresses typical activities associated by the pupils to electrical engineers, adds another dimension to this process of perception changing. More specifically, while in the morning pupils' descriptions tended to be vague and general, much more specific and concrete descriptions were

Table 2. Perception of EE before and after the 2003 exposure day

	Before the exposure day	After the exposure day
Question	No. 5: What do you think EE graduates do when they graduate from Technion?	No. 2: What would you say if you were asked to explain what EE is in two sentences?
Total number of answers	120	45
Number of meaningful answers (%)	44 (36%)	40 (89%)
Elaboration on the meaningful answers	Only two answers addressed the multifaceted nature of EE, e.g., "A combination of several branches that are involved in the invention of instruments in different domains (such as medicine)."	21 answers (50%) described EE as a multifaceted field, e.g., "A huge variety of similar, as well as different, domains that are connected to the society, economy, industry, and to our life in general."
	7 pupils mentioned computers.	18 pupils mentioned computers.
	18 pupils presented the profession of EE as a technical profession, addressing tools and instruments.	3 pupils indicated tools and instruments.
	4 of the above 18 pupils indicated the electricity company, e.g., "They go to work in companies like the electricity company," and "Maybe they go and work as technicians in areas that are related to electricity, etc."	4 pupils specifically indicated that EE is not the electricity company, e.g., "Now I know that it does not mean only working in the electricity company."
	None of the pupils indicated any connection to society or to any other social issues.	5 pupils indicated social issues, e.g., "A kind of engineering that is manifested in electrical products and contributes to the quality of life."
Number of non meaningful answers (%)	76 (64%)	5 (11%)
Examples of meaningless answers	"Engineering electricity," and "Look for a job in companies in which electrical engineering can work."	"I can't explain it in two sentences." *

*Note: *This answer might also be interpreted as a reflection of the idea that EE is too rich to be described in two sentences.*

Table 3. Activities performed by electrical engineers: Pupils' perception before and after the exposure day

	Before the exposure day	After the exposure day
Question	No. 5: What do you think EE graduates do when they graduate from Technion?	No. 3: List at least three things that people who work in EE do when they graduate from Technion.*
Number of answers	120	39
Areas in which electrical engineers work	10 general areas were mentioned, such as research and development (19 pupils), and hi-tech (18 students, e.g., "Work in hi-tech companies").	20 areas were mentioned; 11 of them were specific areas presented during the exposure day (e.g., robotics, image processing, artificial intelligence).
Indication of specific topics	Only 4 pupils indicated a specific topic such as robotics.	37 out of a total of 84 items mentioned were specific domains to which the pupils were exposed during the day.
Teaching	2 pupils mentioned teaching (e.g., "Work as teachers or in companies for engineering of electricity").	9 pupils indicated "academic teaching."
Technical image	18 pupils mentioned instruments and/or the electricity company (e.g., "Build electrical circuits for instruments," and "Engineering machines, prepare the electrical systems in buildings, etc.>").	No technical or tool-oriented answers were given. Only 1 pupil mentioned the electricity company.

*Note: *It may be the case that had the pupils been asked also in the morning to mention three items, their morning answers would be more focused. Still, these answers would probably be general in nature.*

Table 4. Possible future studies at Technion's Department of EE

Would you consider studying at Technion's EE Department?	2003		2004	
	Morning (N=124)	End of the day (N=44)	Morning (N=86)	End of the day (N=56)
Yes	19 (15%)	29 (66%)	22 (26%)	46 (82%)
No	50 (40%)	11 (25%)	28 (33%)	7 (13%)
Maybe	52 (42%)	4 (9%)	33 (38%)	3 (5%)
N/A	3 (2%)		3 (3%)	

exhibited at the end of the day. Furthermore, Table 3 reveals that on the afternoon questionnaire, a greater proportion of pupils mentioned a wider variety of specific areas in which electrical engineers work compared with the morning questionnaire, and that the predominantly technical image of EE was transformed over the course of the exposure day. Moreover, from among the 20 domains mentioned by pupils in their afternoon answers, 13 were mentioned by more than one pupil. The most frequently mentioned domains were software and hi-tech (appeared in 23 answers, 16 of which mentioned the names of well-known companies, such as Intel and IBM); research (10 answers); and academic teaching, robotics, and electronics (9 answers each).³ Similar observations were found in the 2004 conference (Hazzan, Tal, & Keidar, n.d.).

This image change may explain the reduction in pupils' resistance toward the idea of studying EE as a major field of study, as presented in Table 4. In both the 2003 and the 2004 conferences, a considerable increase in students' interest in the department was observed. Specifically, this interest increased during the 2003 conference from 15% in the morning to 66% by the end of the day; during the 2004 conference, interest increased from 26% to 82% (Table 4).

FUTURE TRENDS

In order to study the long-term influence of such exposure days, we plan to examine the way in which the female high-school pupils who attended the exposure days will perceive EE at several future points in time. Such an exploration will help refine observations and recommendations about the preferred way in which the profession of EE should be

presented to a female audience that is not familiar with the nature of the profession.

CONCLUSION

The aim of the study described in this article was to examine the perception of EE by female high-school pupils at the beginning and at the end of an exposure day organized by Technion's Department of EE. The rationale for the day stemmed from the very salient underrepresentation of women among the undergraduate students and graduate students in the department.

We derive two major conclusions from this study with respect to the way in which the profession of EE may be presented when the objective is to attract more women to the field.

First, as in the case of computer science, the profession of EE seems to suffer from a misconceived image among the public. In the case of computer science, many people think that to be a computer scientist means sitting in front of a computer screen all day long, without communicating or socializing with other people (Margolis & Fisher, 2002). In the case of EE, from the pupils' responses at the beginning of the day, we learn that their image of EE was very technical and that they were unaware of the social, scientific, and multifaceted nature of the field. The exposure day described in this article shows that this image can be changed in a relatively short period of time, provided such a day is well organized so as to include the relevant ingredients that inspire a more realistic image of the profession. Specifically, we argue that emphasis should be placed on the multidisciplinary nature of the field in general, and on the direct influence of this trait on society in particular.

Second, we suggest exposing the pupils attending such a day to female role models. Such exposure enriches the image of the profession by adding the individual perspective of the profession to the more global perspective that was explained in the previous paragraph.

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KEY TERMS

Artificial Intelligence: The field concerned with making computers behave like humans. The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology.

Computer Engineering: The application of engineering principles and methods to the design and development of hardware systems. (<http://www.hpcc.gov/pubs/blue94/section.6.html>)

Electrical Engineering: Electrical engineering is one of the broadest of the engineering disciplines. It deals with electronics, computers, and communication. The professional activities of electrical engineers directly affect the everyday lives of most of the world's population.

Image Processing: The field concerned with analyzing and manipulating images with a computer.

Multimedia: The use of computers to present text, graphics, video, animation, and sound in an integrated way.

Robotics: The field concerned with creating robots: devices that can move and react to sensory input. Robotics is one branch of artificial intelligence.

Shrinking Pipeline: The pipeline represents the ratio of women involved in computer science from high school to graduate school. The pipeline shrinkage problem focuses on several exit junctions: from high school to undergraduate school, at the bachelor's level, and at the seniority levels both in academia and the industry.

Software Engineering: The application of engineering principles to software. It applies principles of computer science and mathematics for the development, operation, and maintenance of software. Software engineering addresses not only the technical aspects of building software systems, but also social, management, and cognitive topics.

ENDNOTES

- ¹ For additional details, visit the department's Web site at <http://www.ee.technion.ac.il/>.
- ² The drop in the number of responses between the survey at the beginning of the exposure day and the responses after the exposure day is due to the fact that the transportation organized by several schools had left before the day ended.

- ³ In addition, lasers was mentioned six times; image processing, computerized graphics, or animations was mentioned five times; and information processing, film dubbing, and machines were each mentioned three times. The following domains were mentioned only once: multimedia, biomedicine, artificial intelligence, the electricity company, cellular-phones companies, and job seeking.