

# Broad Partnership of an Engineering Program with Industry: A Success Story\*

KAHINA LASFER and ART PYSTER

School of Systems and Enterprises, Stevens Institute of Technology Castle Point on Hudson, Hoboken NJ 07030–5991 USA.

E-mail: kahina07@gmail.com, art.pyster@stevens.edu

TAL BEN-ZVI

Howe School of Technology Management, Stevens Institute of Technology Castle Point on Hudson, Hoboken NJ 07030–5991 USA.

E-mail: tal.benzvi@stevens.edu

As part of its overall strategy, the Systems Engineering (SE) graduate program at an Engineering School has adopted a broad partnership with industry, which consists of sponsorship of professional students to complete a Masters and/or PhD degree in SE. The main objective of the present study is to evaluate the impact of a Graduate Systems Engineering Program (GSEP) of this small university in the workplace through assessment of the program sponsors' satisfaction and the performance of the program's professional student graduates in their jobs. Qualitative and quantitative data were collected for the period 2004–2010 to assess and evaluate GSEP through survey questionnaires, interviews, and course evaluations.

The results of this study revealed that overall up to 95% of the program sponsors and its students are satisfied with the program. The main reasons for partnering with the present studied institution were stated by the program sponsors to be tailoring the program and its courses to their needs and offering the program at the sponsors' sites. Through its broad partnership with industry, GSEP corporate partners were able to successfully deploy SE concepts and understand the value that SE brings to their organizations.

**Keywords:** Systems Engineering; higher education; partnership

## 1. Introduction

With the rapid technological changes and globalization threats, it has been widely recognized that the successful 21st century engineer must acquire more than just technical skills. In addition to basic science and mathematics, there is a need to acquire vision, dedication, and commitment towards innovation and entrepreneurship as these skills became requirements for modern era engineers [1–4]. In response to the various concerns in industry about the quality of U.S. engineering graduates, in 2000 ABET developed new criteria for undergraduate engineering programs known as the ABET EC2000 criteria [5] that are designed to guide programs in conducting outcomes-based self-assessment as a requirement for securing ABET accreditation.

In 2004, the National Academy of Engineering [3] published a report summarizing visions of what the engineering profession might be like in the year 2020. They had deployed the so-called scenario-based strategic planning to develop their prediction of the future. A year later, they published a follow-up report on how to educate the engineer of 2020 [6]. In brief, they made clear that engineering education has to be adapted to the challenges of the future, the practice in industry, while facing increasing globalization threats.

Apelian [7] observed that the engineer of the

twenty-first century must constantly be able to gather information and decide on a course of action, including identifying what tools are needed for a given task. Technical skills, people skills, and innovation are required of the future engineer. In 2007, the National Academy of Sciences (NAS) [8] published a report titled: “Gathering Above The Rising Storm—Energizing and Employing America for a Brighter Economic Future”, as another wake-up call that raised concern in Washington and throughout the engineering education community on engineering education and its impact on American economic growth.

## 2. Challenges facing engineering education

Within the past decade or so, Engineering disciplines have experienced rapid growth in industry and government sectors. However, the demand for qualified engineers who can meet existing challenges in this highly multi-disciplinary field has increased much beyond the available supply, and forward-looking corporations and governmental agencies are increasingly focusing on this problem [9]. Consequently, it is critical for an academic institution to conduct effective planning that allows it to identify strategic goals and objectives that respond to the needs of its industry and government constituents, prioritize activities needed to achieve those objec-

tives and make careful decisions to allocate scarce resources [10, 11]. In addition to R&D development and research collaborations, government and industry need to actively participate in curriculum design to specify their needs and expectations for skills and knowledge that graduates should acquire [2]. Graduates' knowledge and skills become critical as they enter the workforce with specific skills needed to jump-start their careers [11]. A carefully defined strategy is also important in enabling a higher education institution to recognize and respond to changes that are constantly occurring.

Furthermore, engineering graduate students face big impediments combining work schedule and course availability, although finances are the biggest obstacle [10]. In a survey of current and potential graduate students [12] the following were identified by professional students as their major obstacles to enroll in graduate study:

- 65% of the respondents identified finances and busy work schedules.
- Approximately half of the respondents recognized program or course availability as the main obstacles.
- The enrollment process and motivation were least likely to be viewed as obstacles.

Recent studies and related reports [3] have identified industry needs that call for graduates to acquire the breadth of educational experience that extends

beyond just pure technical content and include skills such as communication, leadership, management, professional responsibility and public policy. However, "traditional" tenure-track faculty may not possess many such skills, and therefore may not be qualified to teach them. This raises the question whether such faculty members need to expand their education or do new industrial faculty members need to be hired? According to a recent study conducted by Waltman et al. [13], Non Tenure Track Faculty (NTTF) often cited teaching as a reason for choosing their job over tenure track positions. They have often expressed high satisfaction with their teaching job and how they enjoy working with students and expressed their desire to make a difference in students' lives [14].

As we enter the second decade of the 21st century, engineering education in the US is beginning to suffer from global competition [15–16] as shown in Fig. 1.

As the number of scientists and engineers working in foreign countries continues to increase, the number of foreign-born engineering graduates increases [16]. Thus the US comparative advantage in generating scientific and engineering knowledge especially in the high-tech sectors and products associated with that knowledge is declining at an alarming rate [15, 16].

Given these challenges facing engineering education, many universities in the U.S. and globally took

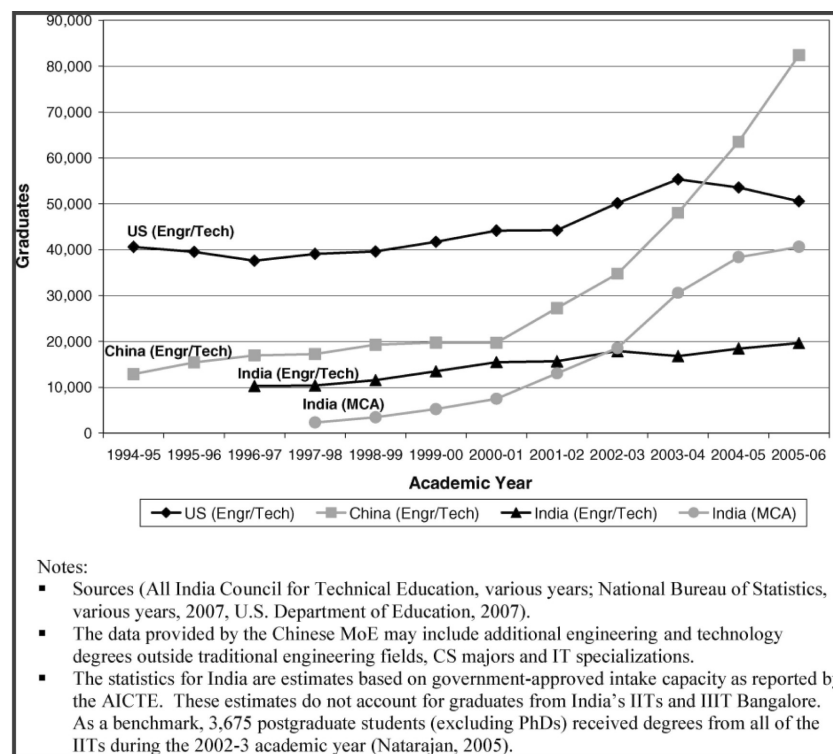


Fig. 1. Production of Engineering Master's Degrees in the United States, China, and India [16].

innovative approaches to produce high quality engineers who could compete in the global economy. Within these trends, GSEP was launched in 2000 in a US engineering school in the Northeast and successfully faced most of the challenges listed above. The program is based on a range of partnerships with industry and government to leverage GSEP's resources in building the program. One key objective of GSEP's strategy is to allow the program to grow and respond to the current and future demand and challenges by creating strategic alliances with industry and government agencies where the needs for SE education are in high demand. By tailoring course content and delivery mode to the sponsors' needs, GSEP was offered to a large number of professional students from government and industry who rapidly embraced the education received as it had direct application in their jobs. Courses were taught by GSEP faculty members with extensive industry experience. These faculty members adopted effective strategies that blend theory and practice, making the classes very interactive. New processes, tools, and techniques are being continuously developed in most industries creating the need to integrate these into curricula that provide students with required skills. GSEP is designed to tailor course content to address such evolving trends; e.g., through industry-based case studies, using organization-specific tools, and teaching industry/government specific processes, all the while maintaining the strong academic rigor required for graduate education. These non-traditional methods came after substantial study and learning about client needs and changing economies. Industrial partners routinely augment GSEP resources by providing case-study raw material and staff to help convert that raw material into classroom presentations. Such symbiotic arrangements greatly expand the effective resources of GSEP while giving the sponsor highly relevant classroom instruction.

The main objective of the present study is to evaluate the impact of GSEP on the performance of professional students in the workplace and their career advancement. Both quantitative and qualitative data were collected from different sources including GSEP administrators, faculty, course evaluations, alumni, and sponsors executives.

### 3. GSEP partnership description

GSEP adopted a novel model called the Open Academic Mode OAM [22, 23] to lead its strategies through five key principles: (1) *Broad partnerships* with industry and government, (2) *Blurred boundaries* between academia and industry by tailoring academia's needs in course contents, (3) *Community sharing* of information and educational resources,

(4) *Agile environment* by offering flexibility in course content and scheduling; and (5) hiring Non-Tenured Track Faculty (NTTF) defined as *Second-Career Faculty (SCF)* who have extensive industrial experience to teach and assume a managerial role in the program. Led by OAM, GSEP became one of the largest master's degree programs in the US [22]. GSEP recruited professional students sponsored by their industry employees and offered them a program titled the Systems Design and Operational Effectiveness (SDOE) program. The SDOE program consisted of a one-week, executive-style education program with a schedule that consisted of 40 contact hours, delivered in person by an instructor over one week at a sponsoring organization's location, followed by ten weeks of homework and project assignments during which the faculty member interacts with the students remotely via email telephone, Web postings, and other virtual collaboration tools. Such non-traditional course schedules were created after significant learning about client needs and changing global economies. In its early inception, the SDOE program held classes for a group of professional students in a cohort structure, in which the same group of students took classes together until they completed the program. This structure facilitates tailoring of the courses and program to the needs of the students and their sponsoring organization. For example, project assignments, including a capstone project, which is an important component of the program, are often selected by students based on their field and career interests. Such assignments often focus on solving current industry problems defined by students or their sponsors, bringing value to both the sponsors and GSEP as these projects can lead to defining research problems of current sponsor relevance. The SDOE format is by far the most popular mode of GSEP course delivery amongst sponsored programs at GSEP.

Depending on the sponsor's preferences, students are also allowed to enroll in SDOE courses for professional development only; i.e., no graduate credit is awarded. Such students fully participate in the modular lectures, but do not perform the 10 weeks of homework and project assignments. Mixing students who are seeking a graduate degree in the same class with those who are seeking only professional development has added to the quality and variety of classroom discussions. Specifically, students taking a course for professional development tend to have substantial industrial experience related to the course topics, which adds significantly to classroom discussions. Further adding value, some sponsors offer internal certificates of achievement for completing a specified group of courses.

## 4. Methods

To evaluate both sponsors and student satisfaction with GSEP quality, quantitative and qualitative data were collected based on Kirkpatrick's evaluation model [17]. Kirkpatrick [17–18] has developed a very popular evaluation model that has been used since the late 1950s by the training community. The main focus of the model involves measuring four kinds of outcomes that should result from a highly effective training program. Kirkpatrick's four-level evaluation model remains the most influential and prevalent evaluation approach among practitioners [17–19]. In this study, only Levels 1, 3, and 4 of the model are used to indicate the program's quality which are based on three criterion-measure categories of subjective learning (Level 1), subjective behavior (Level 3), and objective results (Level 4). Descriptions of the three criterion-measure categories are as follows:

1. Subjective learning includes measures that assess what principles, facts, attitudes, and skills were learned during or by the end of training as communicated in statements of opinion, belief, or judgment completed by the trainee or trainer.
2. Subjective behavior includes measures that evaluate changes in on-the-job behavior perceived by trainees, peers, or supervisors.
3. Objective results are measures that evaluate tangible results, such as reduced costs, improved quality or quantity, promotions, and reduced number of errors in making impact ratings.

Using carefully designed questionnaires, survey data were solicited from both GSEP sponsor executives and alumni, followed by telephone interviews using interview questionnaires that were designed to allow open questions to be added depending on the interviewee responses [20]. A structured questionnaire was prepared and shared with the interviewees in advance to give them time to think about the questions and be prepared for the interview session. Class evaluations reports were collected from the university's administrative offices.

### 4.1 Assessment of GSEP quality

Studies have shown that data related to quality are multi-dimensional [19–21] (Ballou et al., 1998; Huang et al., 1999; Redman, 1996; Wang et al., 1996). Quality assessment must deal with both subjective perceptions of the surveyed constituents as well as objective measurements based on the data collected [20]. Quality assessment based on subjective data reflects the needs and experiences of stakeholders: the collectors, custodians, and consumers of data products [19, 21]. The quality of

GSEP as defined above is measured by the value-added in improving SE program graduates' knowledge and capabilities in the workplace by collecting and assessing both subjective and objective data. Such value-added is assessed against the following output criteria. Criteria 1–3 represent the outputs which are assessed using Kirkpatrick's model, more specifically Levels 1, 3, and 4, namely: learning, behavior, and results which are defined as:

1. Level 1: Students' immediate reactions to the course material.
2. Level 3: Students' behavioral changes in the workplace.
3. Level 4: Impact of SE education on Sponsors' results improvement and Return on Investment.

The data needed to evaluate GSEP Quality/Impact include:

- Student feedback on the four core courses (course evaluations) for the period 2004–2010, including feedback on course content, teaching effectiveness, and delivery format (Kirkpatrick Level 1).
- Alumni and sponsors' feedback on the change in job behavior of employees upon their completion of GSEP (Kirkpatrick Level 3). A survey was built based on Kirkpatrick level 3 methodology and sent to all alumni who graduated between 2004 and 2010 and sponsored with partners who have been with GSEP at least for three years.
- Sponsors' feedback for the period 2004–2010 related to SE graduate education from the studied institution and its impact on the organization's productivity (Kirkpatrick Level 4). The survey was sent to all partners who have been with GSEP for at least three years, and sponsor at least 5% of total number of GSEP students.

### 4.2 GSEP quality performance measurement—Kirkpatrick Level 1

Student course evaluations are used as one of the main assessment tools for evaluating Quality/Impact of GSEP. Data related to student course evaluations have been collected for all four core courses in GSEP which are required for the Master's or PhD degree in Systems Engineering.

A sample of the student course survey is illustrated in Table 1. The questions used in the course survey are related to Kirkpatrick Levels 1 and 2 for the four main categories. The questionnaire used in the course survey is a standard one adopted by the university which includes:

- Instructor evaluation.
- Course evaluation.
- Student satisfaction.
- Suggested improvements to the course.

**Table 1.** Sample Course survey questionnaire based on Likert scale 1 to 5

Instructor Evaluation	Course Evaluation
<ul style="list-style-type: none"> <li>Clearly explains the objectives of the course.</li> <li>Is prepared for class.</li> <li>Presents material in an organized manner.</li> <li>Has command of the subject.</li> <li>Successfully communicate the subject.</li> <li>Is fair and consistent.</li> <li>The guest lecturers were effective during the week.</li> <li>Overall—the instructor was an effective teacher.</li> </ul>	<ul style="list-style-type: none"> <li>The course is well structured.</li> <li>The course material (notes and text books) is well organized.</li> <li>The material was adequately covered in the allotted time.</li> <li>The course was structured to facilitate discussion and participant contributions.</li> <li>The subject matter has significant usefulness to my organization.</li> <li>I can apply what I have learned in this course on projects. (underway or future) in my organization.</li> <li>The course will enable me to enhance my career objectives.</li> <li>Overall, this was an excellent course.</li> </ul>

Student comments related to the strengths and weaknesses of the courses were also documented. The most common comments were then compiled and analyzed as discussed below.

#### 4.3 Students behavior in the workplace— Kirkpatrick Level 3

To explore the research questions, survey data related to program quality was obtained from sponsor executives and alumni. A set of complementary quantitative and qualitative data collection techniques and tools were identified in advance. The Delphi method (Gordon and Helmer, 1962; Parker, 1975) combined with appropriate interview questionnaires and surveys was used. In addition, data from relevant documents, databases, websites, and archives was used as appropriate to answer the defined research questions with a higher level of confidence.

To acquire more feedback beyond surveys, a series of face-to-face and telephone interviews were conducted with administrators, sponsors, alumni, registrar, and faculty members. The interview questionnaires were designed to allow open questions to be added depending on the interviewee responses (Kumar, 2008). A structured questionnaire was prepared and shared with the interviewees in advance to give them time to think about the questions and be prepared for the interview session. A pilot survey was used to determine whether the planned timeline is feasible and whether or not the interview and survey questions are appropriate and effective. Based on the results of the pilot, adjustments were made.

#### 4.4 Return on investment ROI—Kirkpatrick Level 4

The objective of Kirkpatrick Level 4 is to determine what final results, congruent with organizational goals, occurred as a result of the participation in the program. Measures would typically be business or organizational key performance indicators such as: volumes, values, percentages, timescales, return on investment, and other quantifiable aspects of organizational performance related to for example: number of complaints, staff turnover, attrition,

failures, wastage, non-compliance, Quality, achievement of standards and accreditations, growth, retention [18]. The ROI has been included as part of the questionnaire.

#### 4.5 Participants

A total of 200 course evaluations were completed on average by twenty students for the four core courses. This selection was random and based on its availability. They were collected from GSEP registrar and represent four different sponsors for all four GSEP core courses for the period 2004 to 2010. Fig. 2 illustrates the number of evaluations received for each course, for each year.

To evaluate the performance of GSEP based on Kirkpatrick Levels 3 and 4, relevant assessment data was collected from two key constituents of the program namely program sponsors and alumni. Five GSEP sponsor executives completed a survey which represents 12% of the total sample size. These five sponsors altogether sponsor approximately 20% of the total number of GSEP courses. This selection of sponsors was diversified as they represent five different industries from different locations in the US. Each of these sponsors partnered with the studied institution at different times between 2004 and 2010. Each of the sponsor executives was contacted individually and there was no communication between the selected sponsor executives. Interview sessions were scheduled with each sponsor executive to elaborate on the responses received. A summary report of the interviews was sent back to the interviewees to check its accuracy.

For the sponsored student survey, 14% of the total students who graduated from GSEP responded to the survey. This sample of students that responded to the survey was random. The student alumni belong to five different industries and graduated with a SE masters degree at different times between 2004 to 2010.

#### 4.6 Accuracy of the data collected

For a specified total population, the minimum statistically valid sample size was determined using the model presented by Andeson, et al. (2010).

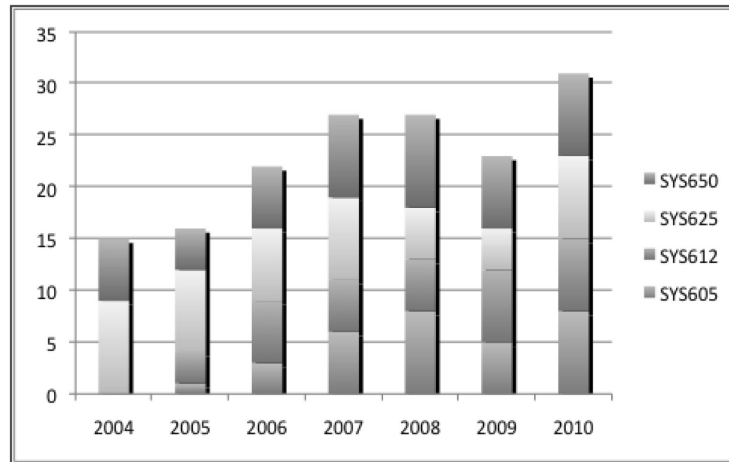


Fig. 2. Data Collection Sample Size.

In the present study, an expected confidence level of 95% was selected for the validation of sample sizes used. The accuracy was calculated according to each population size as follows:

- The number of sponsors surveyed ( $n = 5$ ) is based on the total population size of  $N = 40$  sponsors, and an accuracy of 35% resulted.
- The number of alumni surveyed ( $n = 40$ ) is based on the total population size of  $N = 670$  GSEP masters degree graduates between 2004 and 2010, and an accuracy of 12% was obtained.

## 5. Results

### 5.1 Instructor evaluation

#### A. Overall instructor evaluation

The data from student course evaluations is represented in Fig. 3 where it is shown that:

- For the period 2004–2010, more than 80% of the students have responded consistently that they either agreed or strongly agreed that the instructor was an effective teacher.
- On a one-to-five scale, the average rating of the

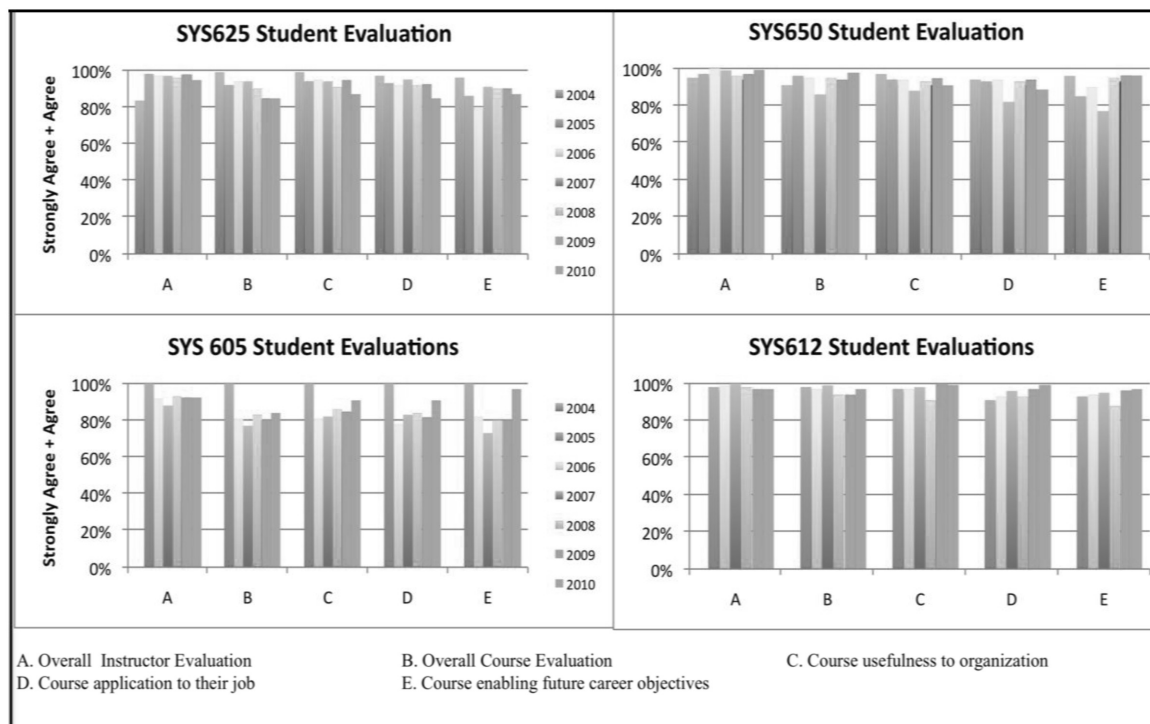


Fig. 3. Student Course Evaluation Data Analysis.

instructors for all four core courses varied between 4.7 and 5.0 throughout the period 2004–2010.

The following comments related to the instructor were made by more than 95% of the students who took the survey:

- Industry experienced instructor.
- Real-life examples were used by the instructor.
- Instructor is experienced and has practical insight.
- The instructor has the ability to relate course subject to real business examples.

## 5.2 Course evaluation

### B. Overall course evaluation

From the course evaluation data it was found that for the period 2004–2010, more than 80% of the students have responded consistently that they either agreed or strongly agreed that the course was excellent.

The following comments related to the quality of each core course were made by more than 90% of the students who took the survey:

- Relevant to the organization.
- Real-life examples were used.
- Hands-on approach and visual tools were used.

### C. Course usefulness to the organization

- For the period 2004–2010, more than 80% of the students responded consistently that they either agreed or strongly agreed that the course material was useful to their organization.
- On a one-to-five scale, the average rating of course usefulness varied between 4.0 and 4.6 throughout the period 2004–2010.

Some of the most common comments that students made about the course usefulness include:

- Relevant to the organization.
- Real life examples were used.
- Knowledge of industry was intertwined into the course.

### D. Course application to their job

- For the period 2004–2010, more than 80% of the students responded consistently that they either agreed or strongly agreed that the course was applicable to their job.
- On a one-to-five scale, the average rating of all four core courses varied between 4.5 and 4.8 throughout the period 2004–2010.

Some of the most common comments that students made about the course applicability to their job include:

- Case studies applicable to the job.
- Very relevant to the job and to their professional experiences.
- Practicality for on the job application.

### E. Course enabling future career objectives

- For the period 2004–2010, an average of 70% of the students responded consistently that they either agreed or strongly agreed that the course enabled them to enhance their career objectives.
- On a 1–5 scale, the average rating of all four core courses varied between 3.8 and 4.3 throughout the period 2004–2010.

## 5.3 Student satisfaction

Over 90% of the students' comments agreed on the following:

- Practical industrial experience of the instructor.
- Course included relevant real-life examples.
- Case studies relevant to the organizations' focus.
- Relevant and effective stories, videos, group work were used to reinforce lessons.
- Interactive class.
- Hands-on and practical class projects.

## 5.4 Suggested improvements to the course

The most common students' suggestions for improving the course were:

- Add more interactive exercises.
- Schedule the course for a longer period.
- Develop a strategy with the organization that would allow the student-employee to apply relevant course material in their job right away.
- Recommend reading course lectures before class.
- Reduce some of the general contents to allow time for more specific content relevant to the organization.

## 5.5 GSEP quality performance measurement—Kirkpatrick Levels 3 and 4

### Results of GSEP sponsor executives survey and interviews—Kirkpatrick Level 3

All GSEP partners surveyed sponsor their employees to enroll in the graduate master's degree program in systems engineering. Among them, three sponsor their employees to complete a graduate certificate in SE and two sponsor research projects. In addition, among GSEP sponsors, two sponsor their employees to pursue a PhD degree in SE, and two sponsor them to take SE courses not for graduate credit but as part of their professional continuing education training.

All five of the sponsor executives either strongly agree or agree that GSEP met their employees' educational needs, four of them agree that the

program had a positive impact on their employees' job performance, while three of them either strongly agree or agree that GSEP helped their employees retain their jobs. Two of the respondents either strongly agree or agree that GSEP education helped their participating employees in getting promoted though they all cited additional factors that are considered for such promotions (Fig. 4). All of the respondents agree or strongly agree that their reasons for partnering with the studied institution are tailoring the course contents to the needs of their industry and offering the courses on site. Among them, 80% agree that course relevance was important to the quality of GSEP. A predominant consensus among the sponsors (80%) is that the flexibility of including particular business needs into the course content was instrumental in enhancing program graduates' performance in the workplace.

#### 5.6 Results of GSEP alumni survey—Kirkpatrick Level 3

Forty six responses to the survey were received from GSEP alumni who are employed by the five sponsors. Among them, 76% of the respondents hold technical engineering positions and 23% hold managerial positions. Also, 65% of the respondents obtained a master's degree in systems engineering, 25% obtained a graduate certificate, 6% received a PhD degree, and 4% took GSEP courses for non-credit. All of the respondents graduated between 2006 and 2010. Among the respondents, 90% strongly agree or agree that their performance on the job improved after taking GSEP courses. Also, 85% strongly agree or agree that they use the knowledge acquired from GSEP on the job. Moreover, 45% of the respondents strongly agree or agree that

GSEP contributed to retain their job and 35% strongly agree or agree that GSEP contributed to their promotions (Fig. 5).

#### 5.7 Sponsors return of investment from GSEP—measuring Kirkpatrick Level 4

Finally, none of the sponsors interviewed has developed a specific process to measure the return on investment from partnering with the university to offer SE education to their employees. However, most agreed that qualitative observations show that this SE education improved the performance of their employees in the workplace.

## 6. Analysis and discussions

To evaluate the statistical validity of the sample sizes selected along with the accuracy of the data collected in the present study, the following statistical analysis is performed. With regards to the correlation between the results of both sponsors and alumni data, Table 2 shows a p-value > 0.1, which indicates no statistical difference and the correlation value of 0.95 that is sufficiently close to one, representing a very good correlation. Therefore both results from sponsors and alumni are well correlated.

As part of the questionnaire, the sponsors were asked to choose three main reasons for partnering with GSEP. All five sponsors indicated that the main reasons for partnering are: (1) tailoring the program and its courses to the needs of their company, and (2) on-site delivery of the courses. A predominant consensus among the five sponsors is that the flexibility of including particular business needs into the course content is instrumental in enhancing program graduates' performance in the

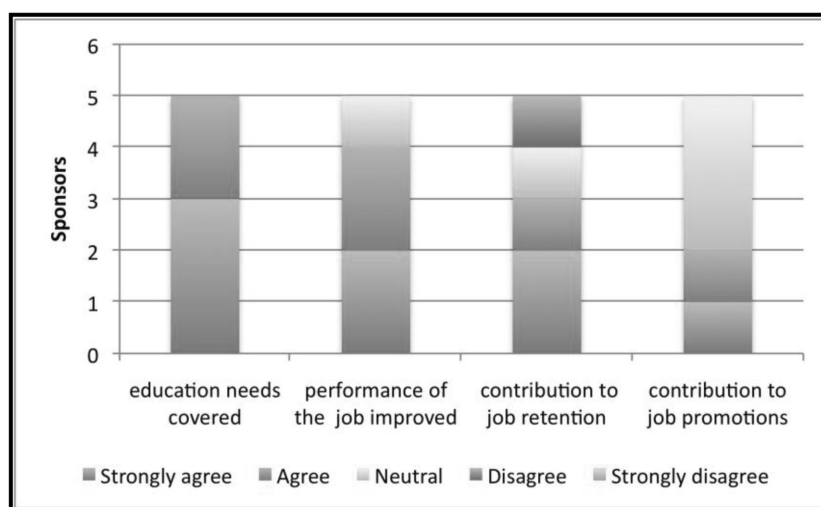


Fig. 4. Impact of GSEP Education—Sponsors' Survey Results.



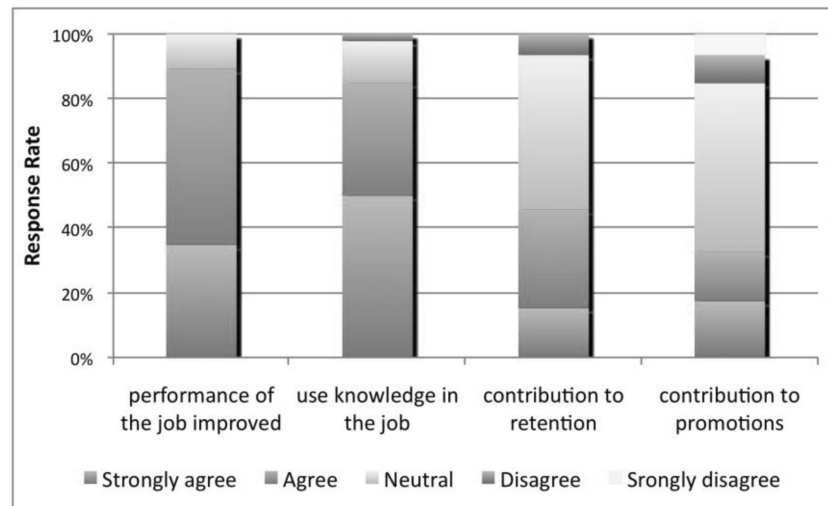


Fig. 5. Impact of GSEP education—Alumni survey results.

Table 2. Statistical Analysis

Variables	Sponsors Mean	Alumni Mean
Performance of the job improved.	4.2	4.2
Education needs covered.	4.6	4.3
Contribution to job retention.	3.8	3.5
Contribution to job promotions.	3.6	3.4

p-value = 0.28, Correlation = 0.95.

Table 3. Reasons for partnering

Reasons for partnering with GSEP	Sponsors Response Rate
Tailoring sponsors needs into the course contents.	100%
On site course delivery.	100%
Course relevant to the business.	80%
Research relevant to the industry focus.	40%
Faculty industrial experience.	40%
GSEP reputation.	40%
Teaching SE complexity skills.	20%
Students Positive feedback.	20%
GSEP Administrative high quality service.	20%

workplace. Other main reasons for partnering with GSEP include (Table 3).

Building partnerships with industry and government is a key strategy that led to increased student enrollements and sustained graduate program growth. As more partners become involved, student enrollements increase which subsequently increases the school budget while enhancing its reputation. Partnership is heavily dependent on the network that GSEP faculty and GSEP leaders connect with. To tailor the program to industry needs, faculty members with significant industrial experience are recruited. However, based on the required teaching load along with related course development and traveling time, these faculty have less interest and

time to perform fundamental research which may lead to fewer students interested in pursuing the PhD program.

GSEP has been growing since its inception and having an important impact on deploying SE education in the workplace. As shown in Fig. 6, the total number of sponsors has been continuously growing from 2001 to 2010 with a Compound Annual Growth Rate CAGR of 35%. The total number of course offerings has been growing at a CAGR of 20%. The total number of graduate students enrollment has been growing at a constant rate with a CAGR of 47% and the number of masters graduates has been growing at a CAGR of 39%.

According to the data collected, the average growth rate in number of sponsored courses from 2001 to 2010 differs from one industry to another as follows:

- A majority of courses offered (43%) were sponsored by government agencies with a CAGR of 22%.
- Defense industry represents a total of 28% of courses sponsored and their CAGR is 22%.
- Space industry represents a total of 21% of courses sponsored and their CAGR amounts to 21%.
- IT industry represents a total of 6% of courses sponsored and their CAGR is -6%.
- Universities represent a total of 2% of courses sponsored.
- A predominant number of sponsors are from government, space, and defense industries that altogether represent 92% of the total number of sponsors.

In summary, the number of sponsors and the number of courses sponsored from each industry

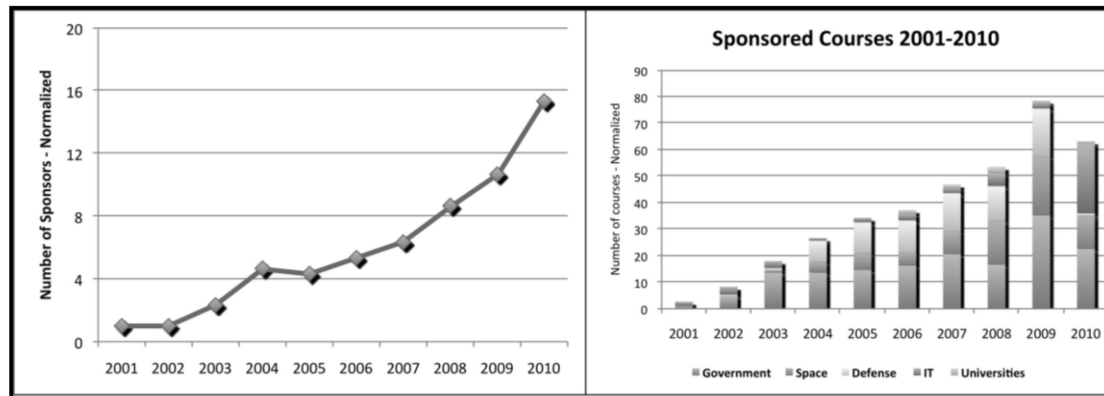


Fig. 6. Growth of sponsors and courses sponsored.

have been growing at similar rates. Also, the number of sponsored courses offered between 2004 and 2010 accounts for more than 65% of the total number of courses offered due to the increase in the number of sponsors, and a more established program reputation. The possible impact of the strategies adopted for building strong alliances with different sponsors to grow the program (“Broad Partnerships”) on the results discussed above.

Extensive interviews were conducted with the Dean, faculty members and administrators of GSEP related to effect of broad partnership on program impact. Broad partnerships enhanced: GSEP reputation; rapid growth in number and diversity of sponsors; rapid growth in geographical dispersion of sponsors; rapid growth in the number of enrollment and graduates; the ability to rapidly tailor course material to sponsors; the ability to make research more relevant to sponsors, the ability to recruit faculty from sponsors; and research funding from diverse set of sponsors.

GSEP had a direct impact on both sponsors and students as it offered current and relevant SE education that reflects diverse sponsors, and yet is tailored to each sponsor for enhanced relevancy and application in the workplace. Sponsors were able to obtain cutting edge research through collaboration with SE Program faculty and the research was conducted by employees of GSEP sponsors which was immediately relevant to their business. GSEP offered flexible course delivery that minimized overhead for students to attend classes.

## 7. Conclusions

GSEP started in 2000 as a new program in the Northeast of the US. To address the challenges that engineering programs face related to offering the education and training that are needed in the workplace, offering courses tailored to accommo-

date work schedules of graduate professionals, and engaging faculty members who have both academic and industrial experience. GSEP was successful in adopting the following strategies (1) having a diverse set of sponsors not limited by the proximity to the campus; (2) a willingness to tailor course content and recruit faculty for the needs of specific sponsors; and (3) a willingness to offer courses in a wide range of formats to accommodate each sponsor’s unique needs. Kirkpatrick Level 3 measurement shows that 80% of sponsors and 90% of alumni agree that the program had a positive impact on their employees’ job performance, while 60% of them either strongly agree or agree that GSEP helped their employees retain their jobs. Over 90% of students agree that: (1) The instructor was an effective teacher, (2) course content was excellent, and (3) the course material was useful to their organization and applicable to their job. There was no standard process used by sponsors to measure ROI, however qualitative observations show that SE education improved the performance of their employees in the workplace.

The success story of GSEP in deploying broad partnership with industry and government brought many advantage to both the university and practitioners as mentioned above. This model could be applicable in other disciplines and universities especially in small schools where policies tend to be more flexible. However, the leader of such a new program needs the right networking skills to build a strong partnership with industry and government agencies. The quality of a program is based also on its contents and the faculty hired to teach within the program. Adjustments in policies and practices may be required to hire qualified professionals from industry and government to teach professional students. The most substantial barriers against hiring NTTF are reduced contract length and a lack of available budget for hiring. Nevertheless, university policies would need to be also be in

adopting new policies regarding flexibility in course scheduling; and tailoring program curriculum and courses to customer needs. The program would need to be ready to revise its curriculum and change the content of its courses to accommodate a diverse set of business needs and related applications.

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**Kahina Lasfer**, Stevens Institute of Technology: Kahina Lasfer is a researcher at the Systems Engineering Research Center (SERC) sponsored by the Department of Defense. Her research area is in systems engineering education and organizational models. She earned her PhD in systems engineering from Stevens. She participated in many projects at the school of systems and enterprises including a project to create a model curriculum in graduate software engineering. She has a master's degree in computer engineering. She worked with Lucent Technologies as a Software Developer and Software Designer/Architect in embedded systems. She held other positions related to project management.

**Arthur Pyster**, Stevens Institute of Technology: Art Pyster is a distinguished Research Professor at Stevens Institute of Technology and the Chief Operating Officer of the Systems Engineering Research Center (SERC) sponsored by the Department of Defense. During Pyster's 35-year career, he held several senior positions, including being the Senior Vice President and Director of Systems Engineering and Integration for SAIC and the Deputy Chief Information Officer for the U.S. Federal Aviation Administration. He is an INCOSE Fellow and a member of their Board of Directors. He currently runs BKCASE, a project that is establishing the body of knowledge for systems engineering together with curriculum guidelines for graduate programs in systems engineering.

**Tal Ben-Zvi**, Stevens Institute of Technology: Tal Ben-Zvi is an Associate Professor and a Program Director with Stevens Institute of Technology, Hoboken, NJ. He has been conducting interdisciplinary research in the fields of Information Systems and Operations Research. His main research interests are decision analysis, decision support systems, simulations, and operations management models. His work was cited in a report submitted to the President of the United States with copies sent to the President Pro Tempore of the United States Senate and to the Speaker of the House of Representatives. Dr. Ben-Zvi was the recipient of the 2010 Bright Idea Award in the Decision Sciences for his book titled "Data Analysis: A Roadmap to Better Decision-Making". He was also the recipient of the 2008 Technology Instruction Development and Business Case Award.