Developing an Outcome-Based Industrial and Systems Engineering Program

Hesham K. Alfares [†]

Systems Engineering Department, King Fahd University of Petroleum and Minerals
PO Box 5067, Dhahran 31261 Saudi Arabia, E-mail: alfares@kfupm.edu.sa

Umar M. Al-Turki

Systems Engineering Department, King Fahd University of Petroleum and Minerals
PO Box 5067, Dhahran 31261 Saudi Arabia, E-mail: alturki@kfupm.edu.sa

Saleh O. Duffuaa

Systems Engineering Department, King Fahd University of Petroleum and Minerals
PO Box 5067, Dhahran 31261 Saudi Arabia, E-mail: salihod@kfupm.edu.sa

Abstract. In this paper, a systematic methodology is proposed for developing an outcome-based undergraduate Industrial and Systems Engineering Program at the Systems Engineering Department of King Fahd University of Petroleum & Minerals (KFUPM) in Saudi Arabia. This program is an upgrade of the Industrial Engineering and Operations Research (IE/OR) option, which has been in existence since 1984 and has been revised several times since then. The methodology and process used is motivated by the Accreditation Board for Engineering and Technology (ABET) 2000 criteria and has been employed to develop the program's objectives and outcomes. Subsequently, a curriculum is designed that is expected to deliver the objectives and outcomes. The paper presents the methodology, objectives, outcomes and the developed curriculum of the outcome-based program.

Keywords: Industrial and Systems Engineering, Engineering Education, Program Objectives, Program outcomes

1. INTRODUCTION

The undergraduate program in the Systems Engineering (SE) Department of King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia, has been in existence since 1984. This SE program has two options: Industrial Engineering and Operations Research (IE/OR), and Automation and Control (A/C). The program has been revised several times since then, based on recommendations from the Accreditation Board for Engineering and Technology (ABET). The last revision was also made in response to directions from KFUPM administration to reduce the number of credit hours from 141 to 132.

Since the last revision of the program, several developments have taken place in both the industry and the academia. Consequently, several special topic undergraduate SE courses have been proposed and many comments and suggestions have been received from industry and alumni. Several concerns were also voiced regarding the IE/OR option's unclear identity and excessive overlap with the A/C option. This has necessitated that the Systems Engineering IE/OR option be revised and also upgraded into a full-scale Industrial and Systems Engineering (I&SE) program.

Industrial and Systems Engineering (I&SE) is characterized by two unique features: (1) the particular attention to decision making components of the industrial environment, and (2) the wide-scope applicability of its system methodology in both manufacturing and other types of organizations. These two features explain the wide spectrum of the job market for industrial engineers. The graduates of the IE/OR option are securing jobs in various industries and the government at a rate of four jobs per graduate and almost 90% are employed within six months of their graduation.[1] In the Kingdom of Saudi Arabia, only three other universities offer IE programs with different focuses. The IE/OR program in KFUPM focuses on quantitative methods and personal skills.

The proposed I&SE program is developed to deliver certain program's objectives and outcomes. The objectives and the outcomes are formulated based on

---

† : Corresponding Author

input received from the following:

- The strategic plans of the SE department with its new vision of having two programs.
- ABET previous evaluation and current accreditation criteria.
- Literature review and benchmarking with top IE programs.
- Employers, alumni and graduating students through self assessment surveys.
- The SE Department Industrial Advisory Committee (IAD).
- Faculty members in the department and visiting scholars.

Due to the fact that ABET 2000 criteria emphasizes outcome assessment, new program objectives and outcomes are developed based on the current strength of the department and the input received from various entities. Next a new revised program I&SE program is developed and presented in this paper. The remainder of this paper is organized as follows. Section 2 provides a brief literature review of Industrial and Systems Engineering curriculum development and revision efforts. Section 3 contains the program objectives and the program revision methodology. Section 4 presents the program's main features and provides the list of required I&SE courses. Finally, Section 5 offers some concluding remarks.

2. LITERATURE REVIEW

In this literature review, recent publications relevant to I&SE undergraduate curriculum development are classified according to program title categories: (1) Industrial Engineering title and its variations, including Industrial and Systems Engineering, and (2) Systems Engineering title and its variations.

New ABET requirements are considered a primary factor in IE curriculum development efforts. Shea and West (1996a, 1996b) use multi-objective programming to design the Industrial and Manufacturing Engineering curriculum at Oregon State University. The model aims to achieve multiple objectives reflecting different IE skills required by various employers, while satisfying university, college, ABET, and course sequence requirements. Elizandro and Matson (2001) discuss the effect of the ABET 2000 Criteria on the approach to IE program development and management. Essential requirements of ABET 2000 Criteria include setting goals and objectives, developing and implementing a plan to achieve them, and evaluating the effectiveness of the plan. Aiming to satisfy ABET requirements at Tennessee Technological University, Matson et al. (2005) describe a junior-year IE curriculum and a set of associated projects utilizing an Integrated Systems Laboratory.

Information technology (IT) concepts have been a key ingredient in revision efforts of IE curricula. Duran et al. (2000) describe a pilot implementation of a Web-enabled ERP (Enterprise Resource Planning) system to integrate the contents of eight industrial engineering courses. During the last three years of the IE program, students apply different ERP concepts (logistics, finance, etc., depending on the given course) on a product line of a fictitious manufacturing company. Stanfield and Davis (2002) present the ALIVE (Active Learning In the Virtual Enterprise) System at NC A&T State I&SE Department. ALIVE consists of 20 web-based learning modules that integrate the curriculum by applying supply chain and IT concepts. Jackman et al. (2004) present a set of modules based on realistic problems for the IE curriculum. These modules utilize IT to link different build courses and enhance engineering problem solving skills. Olafsson et al. (2004) present IE curriculum development through a Web-based learning environment that focuses on engineering problem solving, increased IT content, and higher order cognitive skills. Olafsson et al. (2005) describe the Web-based Engineering Learning Portal (ELP), designed to improve engineering problem solving by focusing on the cognitive activities of planning, monitoring, and evaluating.

Integration of courses is another important factor in IE curriculum development. Leonard et al. (2003) describe a new IE BS-degree model designed by the IE Department at Clemson University to shift from an IT course core to a fully integrated IE curriculum. Leonard et al. (2004) apply this model to refine an introductory IT course and report results from three national surveys of IE faculty who evaluated this model. Taylor and Mozrall (2004) describe a revised first year curriculum in industrial and systems engineering at Rochester Institute of Technology. The improved curriculum has greater course integration, practical content, active learning, and stronger IE identity. Aikens and Jackson (2005) de-scribe the undergraduate IE curriculum at the University of Tennessee, Knoxville. The program is based on a modular structure of integrated courses, focusing on pro-blem-based exercises, research, IT, and faculty teaming.

A variety of other objectives drive the revision of IE curricula, such as the changing IE role, growth of the service industry, and emphasis on design. Kuo and Deuermeyer (1998) present IE program development at Texas A&M University under concerns about poor IE student preparation, lack of technical rigor, low relevance to current industry, and overall decline of the IE discipline. Crumpton-Young et al. (2004) expect many future IE graduates to work in areas other than traditional manufacturing, such IT, Service Industries and Engineering Management. Therefore, they modify the IE curriculum, establish a minor in Engineering Management, explore Instructional Strategies, and integrate IT into the curriculum. Norman et al. (2004a, 2004b) reform the IE program at the University of Pittsburgh aiming to teach students to synthesize and integrate concepts across the curriculum, and develop problem solv-

---

1) Verbal communications with KFUPM Vice Dean of Students Affairs for Training and Employment.

ing skills. Colgate *et al.* (2004) describe Northwestern University's new design-intensive Bachelor's program in Manufacturing and Design Engineering.

System Engineering (SE) is a loosely defined term which is often synonymous with computer engineering. However, most variations of SE programs are interdisciplinary but closely related to IE. Brown and Scherer (2000) compare and classify undergraduate and graduate SE programs in the US, focusing on future SE education and job opportunities. They also examine the issues that influence SE curriculum development, such as the definition of SE, associated professional societies, and the role of IT in SE.

Several SE courses and curricula emphasize the use of applied projects and case studies. Thissen *et al.* (1995) discuss the use of projects to promote active learning in the interdisciplinary curriculum in Systems Engineering, Policy Analysis and Management (SEPA) at Delft University of Technology, The Netherlands. Thissen (2000) describes the SEPA program revision process, emphasizing the choices made on educational structure, disciplinary mix, and educational form. Walter and Stiebitz (2001) discuss the development of the System Engineering courses at Rutgers Institute of Technology. The course focuses on system thinking and problem solving utilizing case studies and a joint team project. Simpson *et al.* (2004) describe IME Inc., an undergraduate course in which multidisciplinary teams of students design and produce a saleable product to gain realistic manufacturing experiences.

The growth of IT and service sectors is impacting SE curriculum development. Tonkay *et al.* (2004) describe the Information and Systems Engineering Leadership Program (ISELP) at Lehigh University. ISELP is managed by both the Industrial and Systems Engineering Department and the Enterprise Systems Center, and it is linked to the Information and Systems Engineering degree program. Noting the shift of the U.S. economy to the service sector, Sorby *et al.* (2005) use the Delphi method to predict relevant topics for establishing a new degree program in service systems engineering. Sorby *et al.* (2005) consider engineering management and IE to be rooted in the manufacturing sector, and thus not well suited for the service sector.

3. PROGRAM DEVELOPMENT METHOD–OLOGY

The methodology followed in revising the IE/OR option and upgrading it to a full-fledged I&SE program is depicted in Figure 1. This methodology consists of the following steps:

1) Reviewing relevant literature.
2) Comparing with top IE programs in the United States.
3) Collecting input from:
   - ABET evaluation report.

- Employers, and the Department Industrial Advisory Committee (IAD).
- Alumni and graduating students.
4) Formulating program objectives and outcomes based on items 1-3 above.
5) Developing I&SE curriculum to support and deliver the program's objectives and outcomes formulated in step 4.
6) Reviewing the proposed program by independent reviewers from industry and academia.
7) Approving the program officially and implementing it.
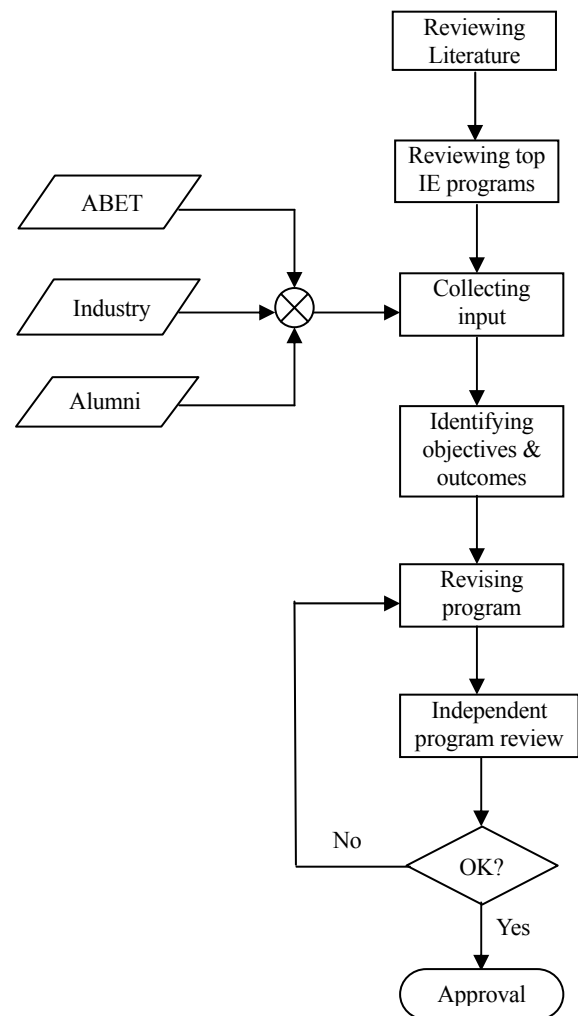
Figure 1. Flowchart of the program development/revision methodology.

The suitability of the above suggested methodology is supported by the literature review, and will be verified during implementation through the university self assessment system.

3.1 Reviewing Relevant Literature

The survey of recently published previous I&SE

curriculum development efforts is summarized in Section 2. The main factors considered in these previous efforts include the following:

- New ABET accreditation requirements
- Information technology (IT) concepts
- Engineering problem solving and systems thinking skills
- Integration of courses
- Growth of the service industry
- Use of active learning, applied projects, and case studies

3.2 Comparing with Top IE Programs

Many top IE programs in the US were reviewed, summarized, and compared to the existing curriculum of the IE/OR option. Table 1 shows the required IE courses in the top 10 undergraduate IE programs in the US. The results of comparisons with reputable international programs indicated that the proposed I&SE program adopts the current trends and approaches in terms of objectives, outcomes, core courses and electives. Actually some of the elements of the program were obtained based on benchmarking with top international programs. The review of top IE programs identified the following overall trends in IE undergraduate education:

- One modeling course.

- One technical communications course.
- Management courses (especially accounting).
- Two computer science courses.
- Two operations research courses.
- More elective courses (higher flexibility).

3.3 Incorporating the Input of ABET

In their last evaluation visit to the SE Department in 1993, the ABET team observed that our students do not exhibit sufficient design component in their senior projects and co-op reports. They recommended providing students with adequate design experience. This observation made us focus on the program design component. For example, the proposed program has a new design course.

3.4 Incorporating the Input of Employers and IAD

The input of the employers of our graduates was obtained by formal structured surveys, conducted during the SE Department's self-assessment exercise. However, the input of the Industrial Advisory Committee (IAD), in which most major employers in the area are represented, was obtained during regular meetings of the IAD Committee. The input obtained from both the IAD and

Table 1. Summary of top 10 US undergraduate IE programs.

School	Required IE Courses
Georgia Tech	Probability, Statistics, Engineering Economy, Stochastic, Simulation, Optimization, Senior Design
Purdue	Probability and Statistics (2), Computing in IE, OR-Optimization, OR-Stochastic Models, Engineering Econ, Manufacturing Processes I, Production Systems I, Work Design I (2), IE Design, Industrial Controls Systems
Michigan	Operations Modeling (2), Probability & Statistics, Optimization, Ergonomics, Markov Processes, Linear Statistical Models, Data Processing, Simulation, Tech Communication, Senior Design
Berkeley	Eng Econ, simulation, 2 OR, LP, (Engineering Statistics, Quality Control & Forecasting), Tech communication, Senior Project
Texas A&M	Into. To Production Systems, Eng Econ, Linear Algebra, Statistics (2), Quality Control, ProductionSystem Planning, Production System Operations, OR, Facility Planning, Manufacturing Systems, Ethics
Stanford	Comp Science, Eng Econ, Optimization, Simulation, Information Science, Investment Science or Production Systems, Organizations Theory, Senior Project
Penn State	Engineering Economy, (Product Design, Specification and Measurement), Probabilistic Models in IE, Statistical Methods in IE, Introduction to Work Design, IT for IE, LP, Cognitive Work Design, Work Design - Productivity and Safety, Introduction to OR, Simulation Modeling for Decision Support, Manufacturing Systems, Design Project
Northwestern	Probability, Statistics, Deterministic OR, Stochastic OR, Simulation, (Field Project Methods, or Organizational Behavior), (Supply Chain, Production systems, or Operations Mgmt), Design Project, (IE Design, Systems Mgmt, Systems Mgmt Project).
Wisconsin-Madison	Accounting Principles, Engineering Economic Analysis, Production Planning and Control, Simulation and Probabilistic Modeling, OR-Deterministic Modeling, Human Factors, Introduction to Manufacturing Systems
Virginia Tech	Theoretical Statistics, Engineering Economy, Manufacturing Processes, Deterministic OR, Statistics for Engineers, Factory Planning and Material Handling, Work Measurement and Methods Engineering, Discrete-Event Computer Simulation, Probabilistic OR, Industrial Ergonomics, Intro to Human Factors Engineering, Data Mgmt for IEs, Project Mgmt and Sys Design (2), Production Planning & Inventory Control, Global Issues in Industrial Mgmt, Statistical Quality Control

employers is summarized as follows:

- The Systems Engineering name does not reflect the degrees (or options) the graduates have.
- The Systems Engineering graduates need more up-to-date skills and knowledge in the IT area.
- The teamwork and communication skills of the graduates need to be enhanced.

Output from the employers' survey and the IAD resulted in the following modifications incorporated in the revised program:

- The Systems Engineering options were upgraded to programs and each option was given a distinct name.
- A course in data base systems was introduced to enhance the program's IT component.
- A course in cost accounting was added to the program to alleviate the deficiency in the area of management and social sciences.
- Several courses were revised to enhance teamwork and communication skills.

3.5 Incorporating the Input of Alumni and Graduating Students

The input of the employers of alumni and graduating students was obtained by formal structured surveys, conducted during the SE Department's self-assessment exercise. The alumni and graduating students input is summarized as follows:

- The students in the IE/OR option take too many courses in the Automation and Control (A/C) area.
- More elective courses in the major are needed and a balance between major (IE/OR) courses and A/C courses should be made.
- A balance between theory and applications is needed.
- Management and computer skills need improvement.

The input of the alumni and graduating students has been reflected in the following revisions incorporated in the proposed program:

- Reduction in the number of control courses to be taken by IE majors. The number of credit hours was reduced from 11 to 4.
- A course in cost accounting was added to the program.
- Two free electives were added to the program to satisfy students' special interests.
- Many courses were revised to balance theory with applications.

3.6 Formulating Program Objectives and Outcomes

Through the previous steps the following objectives have been formulated for the revised program:

1) Prepare graduates with the necessary skills and knowledge to understand and formulate real world problems in the domain of Industrial and Systems Engineering and who can apply problem-solving skills to obtain valid realistic solutions.
2) Prepare graduates who will be able to improve planning, productivity, processes and utilization of resources and assist organizations to make optimal decisions.
3) Prepare graduates who can plan, design, conduct experiments, collect data, and perform analysis and interpretation to draw valid conclusions.
4) Prepare graduates who are proficient in applying information technology.
5) Develop students' abilities in critical thinking, problem solving and teamwork.
6) Prepare graduates who can communicate effectively both orally and in writing.
7) Graduate students with the ability to engage in life-long learning and growth in the field of Industrial & Systems Engineering, who understand professional and ethical responsibility.

A set of program outcomes that support the above objectives have been drafted. The outcomes heavily overlapped with ABET a-k outcomes. Therefore it has been decided to adopt ABET outcomes. Table 2 shows the mapping between objectives and outcomes. Each triangle indicates that the outcome helps in realizing the corresponding objective.

Table 2. New (proposed) program objectives versus outcomes.

Outcomes	Objectives						
	1	2	3	4	5	6	7
a	▲	▲	▲		▲		
b	▲		▲				
c	▲	▲		▲	▲		
d	▲				▲	▲	
e	▲	▲					
f							▲
g	▲	▲				▲	
h	▲						▲
i							▲
j	▲	▲		▲			
k	▲	▲	▲	▲			▲

The program outcomes are:

a) apply knowledge of mathematics, science, and engineering;
b) design and conduct experiments, as well as analyze and interpret data;
c) design and improve integrated systems of people, materials, information, facilities, and technology;
d) function as a member of a multi-disciplinary team;
e) identify, formulate, and solve industrial and systems engineering problems;
f) understand and respect professional and ethical responsibility;

g) communicate effectively both orally and in writing;
h) understand the impact of engineering solutions in a global and societal context;
i) recognize the need for, and have an ability to engage in life-long learning;
j) have a knowledge of contemporary issues;
k) use updated techniques, skills and tools of industrial and system engineering throughout their professional careers.

3.7 Developing the Curriculum for the Proposed Program

Based on all the inputs and objectives, a draft proposed I&SE program was developed and then successively refined. This process involved several regular meetings in which all IE/OR faculty members of the SE Department participated. In order to meet the program objectives, a revised I&SE curriculum with 133 credit hours has been proposed. Three new courses were introduced in Cost Accounting, Information Systems, and Modeling and Design. Moreover, an additional I&SE elective course has been introduced, increasing the number of elective courses from three to four. The contents and descriptions of several other courses have been modified. Table 3 shows the required I&SE courses in the new curriculum, and their contribution to the stated program outcome.

The total number of credit hours required for the B.S. degree in Industrial and Systems Engineering has been increased by only one credit, from 132 to 133. In order to limit this increase, four outdated or less relevant courses have been removed, and one credit hour each has been reduced from two other courses. Moreover, the contents and descriptions of several other courses have been modified. The additional ISE elective course increases the number of ISE electives from three to four. To provide wider flexibility in the I&SE program, the four I&SE electives may be chosen from the following areas of concentration.
● Operations Research and Statistics
● Production and Quality Control
● Reliability and Maintenance
● Productivity and Process Improvement
● Automation and Control

Two choices are offered to I&SE students to gain practical experience: (1) summer training, and (2) co-operative work. Summer training lasts eight weeks, and is worth zero credit hours. Summer training students are also required to register for the senior project course (ISE 490). Co-op lasts 28 weeks, and is worth 9 credit hours. Three courses with a total of 9 credit hours (including the Senior Project) are dropped from the requirements of co-op students.

Table 3. Required I&SE courses versus program outcomes a to k.

Courses	a	b	c	d	e	f	g	h	i	j	k
ISE201 Introduction to Systems Engineering						2				2	
ISE 205 Engineering Probability & Statistics	3			1	2						1
ISE 302 Linear Control Systems											
ISE 303 Operations Research 1	3				2						
ISE 304 Principles of Industrial Costing	1				2					1	
ISE 307 Engineering Economic Analysis	1	2			1			1			1
ISE 320 Quality Control		2	1		3		1				1
ISE 323 Methods Engineering		2		2	2		2				
ISE 325 Engineering Statistics	3	3			3						1
ISE 351 Co-op	3	3	3	1	3	2	3	2	2	1	2
ISE 361 Fundamental of database systems			1	2	2						2
ISE 390 Seminar						1		2	1	2	
ISE 391 Industrial Engineering Design		2	3	2	3	1	2		2		1
ISE 399 Summer Training					2		2				
ISE 402 Production Sys. & Inventory Control	1		2		3			1	1	1	1
ISE 405 Stochastic Systems Simulation	1	2	1		1			1			3
ISE 421 Operations Research II	3				2						1
ISE 422 Facility Layout and Location	3		1	1	3	1	2	2	1	1	1
ISE 490 Senior Project	3	3	3	1	3	2	3	2	2	1	2

Note) 1: Low contribution.
2: Medium contribution.
3: High contribution.

3.8 Getting an Independent Program Review

The proposed I&SE program has been reviewed both internally (inside KFUPM) and externally (outside KFUPM). All the comments received from the reviewers have been addressed and incorporated in the final program proposal. Internal review and evaluation has been done by:

- Other relevant departments within KFUPM.
- The College Council (dean and chairmen of college departments).
- The Deanship of Academic Development.
- The Academic Committee.

The revised program was sent to the external reviewers and their opinions have been taken into consideration regarding the objectives of the program and the likelihood of the proposed courses achieving those objectives. External review of the program has been performed by the following:

- A number of international experts.
- Local industry and employers of the SE Department graduates.
- Alumni in the Kingdom of Saudi Arabia.

4. FEATRUES AND ADVANTAGES OF THE PROPOSED I&SE PROGRAM

The proposed I&SE program in KFUPM adopts the systems approach for solving, analyzing and optimizing engineering systems using various Industrial Engineering models and tools. It focuses on the following:

1) Quantitative methods: the program has several core courses in operations research and statistics, namely ISE 205, ISE 303, ISE 325, ISE 405, and ISE 421, in addition to several elective courses.
2) Modeling and design: at least one core course in modeling and design, namely SE 391, in addition to course projects.
3) Enhancing the Information Technology component in the program, by introducing a required database course (ISE 361) in addition to a computer science programming course and an elective course in industrial information systems (ISE 464).
4) Developing management and costing skills by introducing a required course in managerial and cost accounting (ISE 304).
5) Providing a wide variety of electives in different areas of concentration.
6) Emphasizing personal skills such as communication, teamwork, and leadership through course projects and assignments.

In order to show the relative advantage of the proposed program, it was compared to the previous program in terms of their objectives and how they cover the ABET outcomes. While the proposed program has seven objectives, the previous program has only five objectives that focus on knowledge rather than skills, and are formalized as follows:

1) Prepare graduates who can understand, and formulate problems in the domain of Systems Engineering with emphasis on Industrial Engineering and Operations Research (IE/OR) and who can apply tools to obtain realistic solutions.
2) Prepare graduates who can improve planning and utilization of resources and help organizations to make optimal decisions.
3) Prepare graduates who can collect data, perform analysis and draw valid conclusions.
4) Prepare graduates who can identify, examine, stabilize and control processes.
5) Prepare graduates who can communicate effectively (orally, and in writing) in organizations.

Table 4 shows the relationship between the previous program objectives and the outcomes stated in Section 3.6.

Table 4. Previous program objectives versus outcomes.

Outcomes	Objectives				
	1	2	3	4	5
a	▲	▲	▲	▲	
b	▲	▲	▲		
c					
d					▲
e	▲	▲		▲	
f					
g	▲				▲
h	▲				
i					
j	▲				
k	▲	▲	▲	▲	

Table 4 shows that three ABET outcomes (namely c, f and i) are not reflected directly in the previous program objectives; however, these outcomes are covered in the program curriculum. Outcome c that deals with the design component is covered in the senior design course or the co-op training program. Outcome f that deals with professional and ethical responsibility is covered in the Islamic Studies courses. Outcome i that addresses the need and ability to engage in life-long learning is covered in several projects within regular courses as well as in the senior design course or the co-op training program.

The previous and the new programs can be compared in terms of the number of triangles in tables 2 and 4. The total number of triangles is 30 in Table 2, but only 19 in Table 4. This indicates that the objectives for the revised program provide a much more comprehensive coverage of the outcomes. It is interesting to note

that old program's objectives provide an equal coverage of only one outcome (namely a) and slightly more coverage of only two outcomes (b and e) than the revised program. However, the revised program's objectives much more adequately cover all other eight outcomes, especially outcomes c, d and j.

5. CONCLUSIONS

A systematic methodology for revising or developing an undergraduate curriculum in Industrial and Systems Engineering has been presented. This methodology includes reviewing literature and top IE programs, collecting input from ABET, employers, and alumni, identifying objectives and outcomes, and independently reviewing the proposed program. This methodology aims to keep up with global trends in the IE profession and IE academic programs, while satisfying moderns industry needs. Both the methodology and the proposed program can serve as benchmarks in similar program development or revision endeavors.

The proposed I&SE program adopts ABET outcomes as the standard and develops several objectives that cover all the outcomes including knowledge, skill, and behavior outcomes. The revised program has a wide variety of electives in different areas of concentration, more elective courses, and greater emphasis on modeling and design. The program introduces new courses in cost accounting, database systems, and engineering design. The main focus of the proposed I&SE program is quantitative methods, which is considered the main strength of the current program and faculty members. The program also emphasizes the basic computer and management skills, which are highly demanded in the market from our graduates. The program has been implemented since Sept. 2009. Since then, the suitability of the revised program and the methodology adopted is being reviewed and assessed through the university's existing self assessment system. The results of the assessment will provide feedback for further improvement. This process institutes a mechanism for continuous improvement.

ACKNOWLEDGEMENTS

REFERENCES

Accreditation Board for Engineering and Technology (ABET), http://www.abet.org/forms.shtml.

Aikens, C. H., Jackson, D. F. (2005), Ignite: A new paradigm for curriculum design and deployment in undergraduate industrial engineering education, *ASEE Annual Conference Proceedings*, Portland, OR, USA, 7467-7479.

Brown, D. E., Scherer, W. T. (2000), A comparison of systems engineering programs in the United States, *IEEE Transactions on Systems, Man and Cybernetics, Part C*, **30**(2), 204-212.

Colgate, J. E., McKenna, A., and Ankenman, B. (2004), IDEA: implementing design throughout the curriculum at Northwestern, *International Journal of Engineering Education*, **20**(3), 405-411.

Crumpton-Young, L. L., Hampton, E., Rabelo L., Williams, K., and Meza, K. (2004), ReEngineering the undergraduate industrial engineering program, *IIE Annual Conference and Exhibition*, Houston, TX, USA, 245.

Duran, A., Castro, M., Rivera, F. A., Martin-Romo, C., Ponce, E., de Mora, C., and Peire, J. (2000), ERP-based, Web-enabled integrated industrial engineering curriculum pilot, *Proceedings of the 30th Annual Frontiers in Education Conference*, Kansas City, MO, USA, **1**, T3D-17.

Elizandro, D. W. and Matson J. O. (2001), Industrial engineering program management in the ABET 2000 environment, *Proceedings of the 2001 ASEE/SEFI/ TUB International Colloquium*, Berlin, Germany.

Jackman, J. K., Olafsson, S., Peters, F. E., Ryan, S. M., and Saunders, K. (2004), Integrated curriculum to improve engineering problem solving, *IIE Annual Conference and Exhibition*, Houston, TX, USA, 249-254.

Kuo, W. and Deuermeyer, B. (1998), IE curriculum revisited: Developing a new undergraduate program at Texas A&M University, *IIE Solutions*, **30**(6), 16-22.

Leonard, M. S., Gramopadhye, A. K., Kimbler, D. L., Kurz, M. E., Jacob, R. J., McLendon, C. E., and Regunath, S. (2003), Department-level reform of undergraduate industrial engineering education: A new paradigm for engineering curriculum renewal, *ASEE Annual Conference Proceedings*, Nashville, TN, USA, 1833-1840.

Leonard, M. S., Gramopadhye, A. K., Kimbler, D. L., Kurz, M. E., Jacob, R. J., Mullenix, J. B., Regunath, S., and Tangudu, S. K. (2004), Validating an industrial engineering curriculum renewal process, *IIE Annual Conference and Exhibition*, Houston, TX, USA, 239-244.

Matson, J. O., Hunter, Sr. K. W., and Elizandro, D. W. (2005), An integrated systems lab and curriculum to address IE program criteria, *ASEE Annual Conference Proceedings*, Portland, OR, USA, 8267-8273.

Norman, B. A., Besterfield-Sacre, M., Bidanda, B., Needy, K. L., and Rajgopal, J. (2004a), Integration

and synthesis of the industrial engineering curriculum, *IIE Annual Conference and Exhibition*, Houston, TX, USA, 247.

Norman, B. A., Besterfield-Sacre, M., Bidanda, B., Needy, K. L., and Rajgopal, J. (2004b), A conceptual model for integrating and synthesizing the industrial engineering curriculum, *ASEE Annual Conference Proceedings*, Salt Lake City, UT, USA, 2261-2272.

Olafsson, S., Saunders, K., Jackman, J., Peters, F., Ryan, S., Dark, V., and Huba, M. (2004), Implementation and assessment of industrial engineering curriculum reform, *ASEE Annual Conference Proceedings*, Salt Lake City, UT, USA, 6791-6805.

Olafsson, S., Dark, V., Jackman, J., Peters, F., and Ryan, S. (2005), Engineering problem solving in industrial engineering curriculum reform, *ASEE Annual Conference Proceedings*, Portland, OR, USA, 5503-5515.

Shea, J. E. and West T. M. (1996a), A methodology for curriculum development using multi-objective programming, *Computers and Industrial Engineering*, **31**(1-2), 25-28.

Shea, J. E. and West, T. M. (1996b), An integration approach to industrial engineering curriculum design, *ASEE Annual Conference Proceedings*, Washington, DC, USA, 531-538.

Simpson, T. W., Medeiros, D. J., Joshi, S., Lehtihet, A., Wysk, R. A., Pierce, G. R., and Litzinger, T. A. (2004), IME Inc. A new course for integrating design, manufacturing and production into the engineering curriculum, *International Journal of Engineering Education*, **20**(5), 764-776.

Sorby, S. A., Bohmann, L. J., Drummer, T. D., Frendewey, J. O., Mattila, K. G., and Sutherland, J. W. (2005), Development of a curriculum for service systems engineering using a Delphi technique, *ASEE Annual Conference Proceedings*, Portland, OR, USA, 15085-15093.

Stanfield, P. and Davis, J. (2002), Systems engineering and information technology education through the ALIVE System, *ASEE Annual Conference Proceedings*, Montreal, Canada, 11435-11445.

Taylor, J. B. and Mozrall, J. R. (2004), An integrated first year curriculum in industrial and systems engineering, *ASEE Annual Conference Proceedings*, Salt Lake City, UT, USA, 7561-7567.

Thissen, W. A. H. (2000), Systems engineering education for public policy, *International Journal of Technology Management*, **19**(3-5), 408-419.

Thissen, W. A., Meinsma, R. R., and Twaalfhoven, P. G. J. (1995), Project learning in the TU Delft curriculum in systems engineering, policy analysis, and management, *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics*, Vancouver, BC, Canada, **5**, 4350-4355.

Tonkay, G. L., Zimmers, E. W., and Williams, A. N. (2004), Information and Systems Engineering Leadership Program (ISELP): A new honors program concept at Lehigh University, *ASEE Annual Conference Proceedings*, Salt Lake City, UT, USA, 7273-7279.

Walter, W. W. and Stiebitz, P. H. (2001), On developing integrated systems architecture and systems engineering courses at RIT, *ASEE Annual Conference Proceedings*, Albuquerque, NM, USA, 7551-7560.