

## **AC 2007-1772: DESIGNING TRACKS FOR INDUSTRIAL AND SYSTEMS ENGINEERING MAJORS**

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# Designing Tracks for Industrial and Systems Engineering Majors

## Abstract

The breadth of potential employers for graduating industrial engineers is staggering these days. Traditional avenues of manufacturing, production, and consulting jobs are being supplemented by those in logistics, energy, health care, finance, information technology, and government sectors. According to employers, industrial engineers are sought for problem solving skills, quantitative abilities, and business skills, but it is clear that some exposure to work in that area before graduation – either in or out of the classroom – is appreciated. This has led our department to define tracks of courses tailored to possible careers, such as logistics and supply chain management or financial engineering, for students in their junior and senior years. This enables students to market themselves according to their career objectives, as they can identify a degree (Industrial Engineering (IE) or Information and Systems Engineering (ISE)) and an area of specialty, if they so choose. In addition to defining the different tracks and envisioned careers paths, we identify ways in which to facilitate this increase in course offerings through partnering with industries and other departments, often in other colleges.

## Introduction

Industrial engineering has evolved greatly as a profession over time, moving from strictly applying methods in manufacturing to working heavily in the service industry as evidenced by industrial engineers (IEs) now routinely being hired by logistics firms, health care agencies, and even Wall Street firms. In our meetings with potential recruiters, including major consulting firms, transportation companies, financial firms, health care providers, and manufacturers, it is clear that employers seek out IEs for their quantitative tools (probability, statistics, operations research tools), technology skills (databases, computing), general IE knowledge (process mapping, IE methods, human factors) and exposure to business skills (accounting, engineering economics). However, it has also been made clear that if students want to move into a particular application area, such as finance, then it is advantageous for them to acquire some aptitude in that area. For example, a recent recruiting team from Lehman Brothers told us that they are extremely interested in IEs that have taken courses in finance or at a minimum, are members of the student finance club. We have received similar input from health care providers.

Thus, as a department, we have taken a close look at our curriculum to ensure that it provides the solid foundation that every graduating IE requires to be successful but also provides enough breadth and flexibility such that a student can tailor a career path *if they so desire*. We have enabled this vision through two steps:

1. Increasing the number of electives. The main intent of this was to allow students to seek further education outside of our department, such as pursuing a minor in economics or international relations, for example.
2. Defining career tracks with suggested courses to be completed with in-department electives and/or technical out-of-department electives.

It should be noted here that a student is not required to define a track and complete courses in a given area. Rather, our curriculum only requires that a student take 4 elective courses at the 300

level in our department for the IE degree or 4 technical electives (advanced courses) from our department, computer science, math, or business for the ISE degree. In both degrees, the student has an additional 9 credits of free elective that can be applied to a track. If desired, the student can fulfill these requirements by exploring a breadth of areas. However, if the student would like to “sell themselves” as having expertise in supply chain management, then they may be more inclined to meet the requirements in a single track. The student may also tailor their resume accordingly.

It should be noted that defining tracks (or options or concentrations) in an industrial engineering curriculum is not new. However, it is clear that schools have taken a number of different approaches. Penn State<sup>1</sup> has defined tracks in three general areas: manufacturing, service, and information technology. Columbia<sup>2</sup> has defined a general track in operations research and further concentrations in engineering and management systems and financial engineering. Rutgers<sup>3</sup> has defined tracks that are more definitive of a career path, including financial systems, health care systems, quality engineering, manufacturing engineering, information technology, and supply chain. Georgia Tech<sup>4</sup> has a mix of general and career oriented paths with economic decision analysis, logistics, manufacturing, operations research and statistics, and quality, in addition to a “general” track.

In this paper, we define the tracks that are available to our students. As the number of courses required greatly increases with the number of tracks, we also identify partnering opportunities which allow the implementation to be successful without drastically increasing the load of the faculty.

### Defining and Implementing Tracks

As noted earlier, our department offers B.S. degrees in Industrial Engineering (IE) and Information and Systems Engineering (I&SE). The I&SE degree requires more operations research courses and emphasizes the use of information technology while the IE degree is more traditional, requiring more courses in manufacturing and production. However, both courses have similar cores defined by probability, statistics, operations research, databases, simulation, and engineering economics.

Given the two degrees, we have defined six career tracks, as defined in Table 1. Two of the tracks are aligned with IE and two with I&SE with the two remaining tracks available to each. Given the courses for each track, the student could pursue a track with 3-4 courses from their free and technical electives. Again, a non-specified track would allow a student to select from a variety of tracks.

### Implementing Tracks

It should be clear that the development of new courses, tracks, and curriculums cannot occur without the consideration of resources. The roots of our department lie in industrial engineering with applications in manufacturing/production, operations management, and logistics. To meet the obligations of the remaining (nontraditional) tracks, we have developed new courses in financial engineering and health care, like many other schools.

Table 1. Tracks for each major along with course offerings and home department.

| IE Tracks                         | Common Tracks                     | I&SE Tracks                   |
|-----------------------------------|-----------------------------------|-------------------------------|
| <i>Production and Mfg Systems</i> | <i>Supply Chain Logistics</i>     | <i>Information Technology</i> |
| Facilities Planning (IE)          | Facilities Planning (IE)          | Data Communications (IE)      |
| Robotics (IE)                     | Supply Chain Logistics (IE)       | Mfg Info Systems (IE)         |
| Product Quality (IE)              | Enterprise Systems (ME)           | Data Mining (CS)              |
| Production Engineering (IE)       | Transportation Econ (Econ)        | Algorithms (CS)               |
| Metal Machining (IE)              | Electronic Commerce (Bus)         | Pattern Recognition (CS)      |
| Eng Reliability (ME)              | Transportation Eng (Civil)        | Managing IS Systems (Bus)     |
|                                   |                                   |                               |
| <i>Operations Management</i>      | <i>Health Care/Bioinformatics</i> | <i>Financial Engineering</i>  |
| Facilities Planning (IE)          | Elements of BioEng (BioE)         | Macroeconomics (Econ)         |
| Product Quality (IE)              | Biostatistics (Bio)               | Investments (Fin)             |
| Organizational Behavior (IE)      | Intro to Biomed Eng (BioE)        | Advanced Investments (Fin)    |
| Leadership (IE)                   | Bioinformatics (CS)               | Derivatives (Fin)             |
| Game Theory (IE, Econ)            | Health Economics (Econ)           | Intro to Financial Eng (IE)   |
| Industrial Psychology (Psych)     | Health Systems Eng (IE)           | Real Options (Econ)           |

We have also partnered with other engineering departments (Mechanical, Civil, Bioengineering, Electrical and Computer Science) as well as those in Business (Business Information Systems, Supply Chain Management, Economics and Finance) in order to develop a sufficiently diverse (and timely) offering of courses without the burden of offering them solely in our department. Again, this is not unique to other schools.

However, we have sought alternative forms of course delivery. For a new health care systems project course, we have partnered with the “management engineering” department of a large, local health care system. The department will sponsor unpaid internships and guide students through a semester long project. While this still requires faculty oversight, the workload for the faculty member is clearly not the same as a typical lecture course or in-house project course. Furthermore, this valuable experience will clearly provide an edge to a student interested in working in the health care field.

## Conclusions

The field of industrial engineering caters to many occupational sectors, including manufacturing, logistics, health care, and finance. While the basic tools for solving problems in these realms are the same, learning about specific applications in each area may be beneficial to students aspiring to careers in a given area. This has led to our department, along with others, to define tracks or concentrations, which allow students to take courses in a defined application area.

The difficulty with offering tracks is that it requires the maintenance of additional courses, which may stretch the limits of faculty. We have defined tracks that utilize courses from other departments and in some cases, industrial partners, in order to provide the necessary depth in each area. We believe this model may be useful for other programs looking for ways to diversify their curriculum for the needs of their students.

Our aim, in accordance with ABET recommendations, is to “track” our tracks over times, just as we do our curriculum. Specifically, we will continue to seek input from recruiters, students, and alumni to determine whether the tracks we offer are appropriate and sufficient and whether the

courses included in each track provide the necessary content. With this continual review, we believe the tracks can be adjusted accordingly over time.

## References

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