Industrial Engineering Defined
In general, industrial engineering is concerned with the design of production and service systems. The industrial engineer analyzes and specifies integrated components of people, machines, materials, and facilities to create efficient and effective systems that produce goods and services beneficial to mankind. Industrial engineers are the bridge between management goals and operational performance. They are expected to exert leadership in workplace education as well as analysis, design and implementation of systems and plans for operating those systems that bring value to the organization. Industrial engineers identify opportunities for improvement with equipment, materials, methods, layouts, and they develop plans. Below are examples of fields or careers in industrial engineering.

Manufacturing, Automation & Quality Control
A nation's standard of living depends on the level of manufactured goods and services available to people. Therefore, manufacturing plays a very important role in human life. The objective of manufacturing is to organize people and equipment so that production can be performed more economically and efficiently. Also, manufacturing continuously seeks ways to automate and/or computerize how products are manufactured or how various functions interact. Once a product is designed, its transformation from raw materials to finished product and all the related activities are the responsibility of manufacturing. This encompasses activities fundamental to Industrial Engineering like material selection, process planning, selection of machinery, design of fixtures and tooling, design of production lines and arrangement of machines, assembly, inspections and quality control, and automation. Modern manufacturing automates many of these functions, and parts can now be produced in totally computer integrated manufacturing systems.

Some example careers in this area include working as a manufacturing engineer, designing, planning, controlling, and justifying capital investments. You may also work in technical sales or supervising the manufacturing of goods. Manufacturing engineers are involved in careers that require designing the production processes for a product. Manufacturing engineers select the processes, design the tooling, and decide on the various parameters involved in making products. Other jobs include automation of existing equipment to automatically manufacture parts or programming machines for the automated operations. Some manufacturing engineers are responsible for cost estimation in manufacturing products. Quality engineering careers are primarily focused on making certain that products meet the functional specifications and devising appropriate techniques for inspection.

Since manufacturing is related to designing processes to produce products, it is closely related to all the other areas in industrial engineering. Students with interests in manufacturing need to be familiar with the design safety of products and processes, various production constraints and their optimization, economic justifications, and modeling and analysis of manufacturing systems.

Courses in the manufacturing area include the manufacturing engineering practicum (IE216), manufacturing processes (IE316), automation and control of manufacturing (IE416), computer integrated manufacturing (IE417), and quality design and control (IE443.)

The premier technical societies in this area include the Institute of Industrial Engineers (IIE) and the Society of Manufacturing Engineers (SME). IIE has several special interest groups related to manufacturing. IIE and SME host annual meetings and have student-oriented programs for both undergraduates and graduate students.

Work Design, Human Factors & Ergonomics
Industrial engineers design complex work systems by considering the capabilities and limitations of human operators. They seek to optimize work performance, safety and comfort by "fitting" the task, machine and environment to the human—often referred to as ergonomics. There are two general divisions of ergonomics: industrial (or occupational) ergonomics and cognitive ergonomics. The former area focuses on the dimensions and strength capabilities of the human body in relation to performance of manual work tasks, such as material handling. This subdivision also concentrates on potential affects of the work environment on the human, including thermal conditions, vibration, etc. Work in this area is aimed at reducing occupational injuries and promoting work environment safety. In the area of cognitive ergonomics, engineers attempt to quantify human behavior in interacting with complex systems as a basis for designing display interfaces and controls to support decision-making. Task analysis is a primary tool used to ensure systems are developed to support operator goals, limit workload and promote situation awareness.

Examples of some careers in this area include working as a plant engineer in implementing interventions such as standardized work practices, redesigning manual work (lifting and upper-extremity tasks) and

applying personal protective equipment (PPE). Other jobs include working as an ergonomics consultant to educate companies on workplace safety in order to ensure conformance of work systems designs with Federal regulations. Careers in cognitive ergonomics are primarily research- oriented and include working as a systems design engineer for aviation equipment manufacturers developing aircraft cockpit displays and controls, or working for the Federal Aviation Administration to design a new air traffic control workstation. Careers in human factors consulting are also available in cognitive ergonomics, including those that support the government in new military systems designs, etc.

The ergonomics area is closely related to the manufacturing area in terms of educating students about the need for workplace safety and how to design safe production systems.

Courses in the ergonomics area include work measurement (IE 352), ergonomics (IE 452), occupational safety (IE 541), human factors (IE 540) and several others.

The premiere technical society in the ergonomics area is the Human Factors & Ergonomics Society (HFES). It hosts annual meetings for engineers and psychologists, as well as professionals from other disciplines, and allows them to network and share information about recent research in human-machine system design.

Simulation Analysis & Optimization
Systems analysis and optimization involves the formulation, analysis, and optimization of mathematical models of complex organizations involving flows and interactions of financial and physical resources, information and people. The objective is to understand the operation of such an organization and ultimately to improve that operation with respect to its effectiveness, efficiency or profitability. This area is closely allied to the fields of operations research and the management sciences. The methodological tools of this area include: (i) mathematical programming, (ii) probabilistic modeling, (iii) simulation modeling, and (iv) decision analysis. Applications of mathematical programming involve linear, nonlinear, integer, and network-flow models of such diverse problems as airline crew scheduling; design and operation of large-scale logistics networks; and planning the overseas deployment of military units. Applications of probabilistic and simulation models typically involve modeling and analysis of complex queuing (traffic-flow) phenomena that arise in the design and staffing of call centers, manufacturing cells, hospitals, etc. Other applications of simulation and decision analysis include financial engineering (that is, the design and evaluation of financial instruments such as derivatives) and medical decision making (for example, improved protocols for organ transplantation or screening for certain types of cancer).

Students majoring in systems analysis and optimization find equally strong demand for their skills in the government, industrial, and the military sectors. As suggested by the application areas mentioned above, many students work as corporate-level consultants, or logistics or supply-chain engineers. Recently, increasing numbers of students have taken jobs in the fields of telecommunications, health systems engineering and financial risk analysis. Others work in areas related to national security, including cryptography.

The methods and problems of this area are closely related to those of the production area, and students with interests in systems analysis and optimization typically take much of their allied coursework in the production area.

Popular courses taught in the area of systems analysis and optimization include linear and dynamic programming (IE 361); stochastic models in industrial engineering (IE 401); production systems design (IE 453); and system simulation (IE 441).

The Institute for Operations Research and the Management Sciences (INFORMS) is the premier technical society in this area. INFORMS hosts meetings twice a year, with special student-oriented programs for undergraduates and graduate students who are seeking careers in the area. The Institute of Industrial Engineers (IIE) also offers a special interest group devoted to this area.