**IE59000 (Spring 2015) Structured Engineering Innovation**

Requirement: graduate standing of engineering and sciences background with experience of a research or design project, or consent of the instructor.

Course Description:

Innovation used in this course is broadly defined as: New ideas, methods, products, processes, services and systems that add value and lead to success for a set of defined objectives. Thus we are not only interested in the creation of new ideas but also the creation of new values leading to success.

Next waves of major economic opportunities will be most likely created by innovation. Innovations can change the game of competition. There are well developed courses on functional and system designs and optimization in most engineering disciplines and courses on management of technology in most business schools. Yet there is no course known to the instructor for teaching how the creation of functional and system designs and optimization can be enhanced by seeking innovations that can change the game of competition, be for a product, a process, a service or a technology.

The objective of this course is to address this central issue of wealth creation in civilization by teaching a structured approach for achieving successful engineering innovation. In this course, we will provide an opportunity for the student to acquire the knowledge and understanding for industrial innovation and a structured thinking process leading to successful innovation, thereby to enhance his/her own ability and impact in his/her career. We plan to introduce several innovation structuring and creation methods newly developed by the instructor, including the instructor’s own innovative experiences in industry and academia for competitive new product design and process R&D. We will also facilitate the students to study structured and case-enhanced approaches for product and manufacturing process innovation, including extending them to service area.

Our preliminary plan is to cover the following: (1) a review of the instructor’s own experiences in product and manufacturing innovations and lessons learned, (2) strategy and innovation creation, (3) manufacturing and innovation creation (4) materials and innovation creation, (5) product design and innovation creation, (6) drivers and causes leading to product, process, service and technology innovations, and (7) dynamics of industrial innovation. Practical examples may include innovations in jet engines, commercial aircrafts, industrial equipment, mobile phones, laundry products, bearings, cutting tools, machining processes, 3-D printing/additive manufacturing, nanomanufacturing and nanotechnology applications. Topics may include “product strategy: why Boeing developed 787 Dreamliners and yet Airbus Jumbo A-380X”, “ innovation driver: how jet engines have driven innovations in new materials”, “enhancing competitiveness: how Harley Davison was rebuilt through innovation”, “new product development: developing a competitive consumer product evolved to become industry standard”, “Innovative R&D: R&D leading to a revolutionary processes for making load- carrying components”, “industrial competition and innovation”, etc.

The major homework for the student is to develop a term paper/case study and present it in power point slides with voice explanations. Video recording may be required. There are also small exercises used for illustrating some methods for developing innovative ideas.

Term paper/case will study the relationships among the innovations and the causes leading to their creation. The study may include: innovation evolved for a specific or a class of products, manufacturing processes and technology; drivers of industrial innovation; methods of idea generation such as a review and applications of Triz method; dynamics of industrial innovation; innovation induced by competitive strategy, and any topic on innovation of interest to the student, a company, an industry or a society.

**References include the following:**

1. **The instructor’s own notes on competitive strategy, product and process innovations, structure of innovations, the relationship between the innovations and causes.**
2. **Numerous video media including innovative products, processes and systems, such as Boeing 787, How to build a jumbo jet, How to build a jet engine, etc.**
3. **Burgelman, Christensen and Wheelwright, Strategic Management of Technology and Innovation, 5th edition, McGraw-Hill Irwin.**

**3. Paul Trott, Innovation Management and New Product Development, 5th Edition, Prentice**

**Hall, 2012.**

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About the instructor: Professor Liu is recognized for a number of engineering innovations: (1) by SME/NAMRI Wu Research Award, for having created “single step finish/super-finish hard machining, leading to a new market and a science base for engineering a new generation of processes, machine tools, cutting tools and manufacturing systems”;

(2) by ASME Ennor Award “for his seminal research on surface integrity and fatigue performance of manufactured

surfaces”, (3) by IR100 Award for his research leading to significant accuracy enhancement of machine tools. Currently he is working on a new high rate scalable method of making nanomaterials and a new modeling approach for predicting fatigue initiation life including multi-scale mechanisms. He is a pioneer for creating the concept of the existing global supply-chain based manufacturing structure, widely used in industry. He developed an innovative process for making high quality bearings, which is been applied by several major US bearing suppliers and users. He also served as a research engineer in industry where he developed a dominant product, and as a VP of Industrial Technology Research Institute of Taiwan, where he led to strengthen several product/process based industries. He has published over 180 peer reviewed research papers. He has taught courses on Design, on Manufacturing and on Strategic Planning for Products and Processes.