Course background and motivation: In all engineering functions in industry, new ideas/projects are created in all disciplines of all aspects (e.g., functional, geometric, material, system, etc.) of design, development and research. However, among the numerous new ideas, only a small fraction is likely to add value for a specific system. Among these new ideas adding value, even a smaller fraction will enable success for the objectives set for the system. Therefore, there is a strong need in adding a new approach for teaching engineering innovation to ensure that the engineers/managers can develop/identify ideas/projects that will add value and lead to success.

The objective of this course is to satisfy this need by teaching a new methodology developed by the instructor. This methodology systematically teaches the characteristics that a project/design must have in order to add value and lead to success. These characteristics are applied as guidance in new project design process, shown in dotted arrows in the figure below.

These characteristics include the following requirements: strategic, functional, geometric, material, processing, production and quality. When these profiles are systematically applied, the approach becomes a structured, systematic and effective method of seeking engineering innovations that can add value, lead to success for a given objective and even change the game of competition, for a product, a process, a service, a system or a technology. This course was offered first time in Spring 2015, enrolled with 46 professional students from industry as a distance course and 15 students on campus. The enrollments in subsequent years are also significant. The learning from the class was considered effective and time-efficient, which was reflected in many favorable class feedbacks (see a sample below).

Course Description: Innovation is broadly defined in this course as: new ideas, designs, methods, products, processes, services and systems that add value and lead to success for a set of defined goals/objectives. Thus we are not only interested in enhancing the creation of new designs but also to ensure that new designs will add values and lead to success for the predefined goals/objectives.

Next waves of major economic opportunities for an enterprise and/or an individual will most likely come from innovation. Innovation can change the game of competition, and is created usually by the activity of design. The objective of this course is to address this central issue of wealth creation and business survival by teaching a structured approach for achieving successful engineering innovation/design. In this course, we will provide an opportunity for the student to acquire the understanding of industrial innovation and a structured process leading to successful innovative design, thereby to enhance his/her own career and wealth.

Learning design and approaches:
We plan to introduce several innovation structuring and creation methods newly developed by the instructor, based on the instructor’s own experiences in industry and academia, for competitive new product, process and research
designs. We will also facilitate the students to study structured and case-enhanced approaches for product and manufacturing innovation.

**Grading** is mainly based on a term paper/case study and present it in power point slides with voice explanations. Video recording may be required.

**Topics may be covered:** Our preliminary plan is to cover the following, but these may be revised when needed: (1) a review of the instructor’s own experiences in product and manufacturing innovations and lessons learned about structured innovation, (2) strategy based innovative designs, (3) geometry/manufacturing based innovative designs (4) materials based innovative designs, (5) function based innovative designs, and (6) dynamics of industrial innovation.

**Campus Emergency:** In the event of a major campus emergency, Purdue’s home page (www.purdue.edu) is the official source of emergency information. In case of fire, quickly get out of the building. Course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Here are ways to get information about changes in this course: Instructor’s email (liuch@purdue.edu).

**About the instructor:** Professor Liu is recognized by several important awards for a number of research 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 with software for 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, now a key competitive factor for 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. He has published over 170 peer reviewed research papers, and taught courses on Design, on Manufacturing and on Competitive Strategies for Products and Processes.

**A sample of course feedback by a student from industry:**
“I have a lot of great takeaways from this course that I can and will apply shortly in my professional career. I will shortly be reviewing and constructing our divisional product strategy using the templates that I learned in class from the three strategists, Porter, Ohmae and Sun Tzu. Although Ohmae and Sun Tzu techniques are new to me, I feel that this course has given me the foundation necessary to conduct this exercise and more importantly to accurately convey the method and have a frank discussion with my coworkers and management.

I found the relationship matrix between innovations and methods creating them to be very helpful as a tool for formatting my term paper but also as a template for assessing future innovations. In my professional role, I am an R&D manager and I can use this to evaluate or identify new opportunities and also to accurately convey my thoughts and research to others in a structured manner. Developing my term paper is directly applicable to my job as an automotive engineer because I chose the topic of increasing fuel economy as my topic. I have already been able to discuss, in great detail, the legislation as a main driver of this innovation event with my colleagues. The hierarchical structure of a product and process design is also most helpful. I have worked within this structure for over 25 years and I have never seen it fully segmented in this way. Again, it is easy to convey my thoughts to others by making sense of the processes involved with this graphic.

Finally, I enjoyed the review of identifying customer needs. It is always true as engineers that we begin to identify ways to solve problems immediately without first revealing all of the spoken and unspoken needs of the customer or end user. As I write this final paper, I am invited to a meeting to review VOC for a product redesign here at work. Now I will be reminded to ask probing questions about what the customer is really asking for based on a primary function or request. I was excited to see this course offered and I altered my approved Purdue Plan of Study to take it. I feel that it has been well worthwhile and I would recommend it to others.”