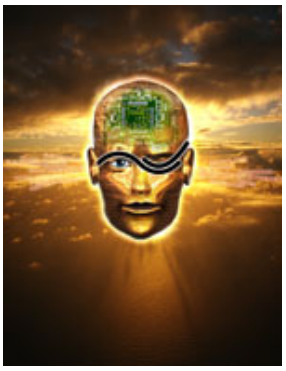


INVENTION & TECHNOLOGY DEVELOPMENT – ISE 555

Instructor: B. Khoshnevis

About the Course

Great engineering systems, processes and products are usually based largely on the exercise of inventive thinking and not on routine procedures for engineering analysis and optimization. Research could conservatively aim at making marginal improvements to the state-of-the-art in the chosen domain, or it may be based on original and novel ideas and potentially lead to breakthrough impacts and discovery of new frontiers. Creative engineers and researchers use inventive, non-routine approaches and in most instances their creations clearly stand out. Inventive thinking and problem solving enriches professional life and brings prosperity to organizations and society. Creativity in technology, i.e., the ability to invent, can be acquired and enhanced.

This course intends to prepare the students with a strong motivation and some knowledge to take the path of inventive thinking and to initiate and pursue novel ideas that lead to successful creation of new products, processes, and systems.

The course uses a pragmatic approach to familiarize the students with the process of engaging creative thought that when augmented by the tools and techniques introduced in the course can lead to meaningful inventions. Essentials of inventive thinking and technological creativity that could lead to breakthrough engineering designs and research endeavors will be presented and several realistic case studies in invention and technology development will be discussed. The course also covers the related activities required for bringing the invention to the production phase. A methodology that aids the invention process along with the related software tools will be taught. Student teams are then guided through the process of idea formation, patent search, design, prototyping, manufacturability considerations, product design and evaluation, and inception of the production and commercialization stage in the context of a practical term project.

The course offers:

- A systematic approach to establishing an attitude and a skill set conducive to creativity
- Use of tools such as software and prototyping hardware to aid in the invention and design processes
- Presentation of realistic case studies (see last page) in invention and product development based on the instructor's experience.

References

1. Various handouts written by the instructor.
2. Cracking Creativity, M. Michalco, 10 Speed Press, 2001.
3. *The Innovation Algorithm,* G. Altshuller, Technical Innovation Center, Inc., 2000.
4. *Product Design and Development*, K. Ulrich, S. Eppinger, McGraw-Hill, 2000.
5. Manuals on IronCAD, TechOptimizer, and IDEATION software systems.

About the Instructor

Berok Khoshnevis is a Professor of Industrial & Systems Engineering and is active in CAD/CAM, robotics, and mechatronics related research and development projects that include the development of two novel Solid Free Form (Rapid Prototyping) processes called *Contour Crafting* and *SIS*, a technology for automated construction of housing structures, development of mechatronics systems for biomedical applications (e.g., restorative dentistry, rehabilitation engineering, and tactile sensing devices), autonomous mobile and modular robots for assembly applications on earth and in space, and various other hi-tech projects. He has several major inventions which have been either commercialized or are in the commercialization process. He has also been closely involved in several product development processes. He routinely conducts lectures and seminars on the subject of invention.

Course Content

- The passion for invention - profile of great inventors in history, their creations and impacts
- The impacts of *attitude*, *affection for arts,* and *interest in nature* on creativity
  - The right value system (having true intention, commitment to the process, detachment from results, desire to becoming immortal through making lasting impacts, the virtues of 'being' rather than 'having')
  - Visual thinking – practices in drawing 2D shapes, 3D perspectives, human portrait and anatomy, and natural elements
  - Learning the truth from nature, seeing the unseen connections, value of science
- The impacts of *problem identification(i.e., asking the right questions), lateral thinking, tolerance for ambiguity* and *practice* on creativity and invention
- Technological creativity in idea generation
  - Creating ideas based on needs (Application Pull)
  - Creating ideas based on observation of phenomena (Technology Push)
  - Understanding the role and use of *Space*, *Time*, *Matter*, and *Energy* in invention
  - Recognition and effective use of *Resources* in invention
  - Using analogy and feature transfer for invention
  - Recognition of patterns of technological evolution and their use in invention

- Turning ideas into meaningful inventions
- Some relevant (but not necessary) tools
  - The TRIZ concept (Theory of Inventive Problem Solving – TIPS)
  - Use of TRIZ based software in the invention process
  - Computer Aided Design (lab sessions with Iron CAD)
  - Prototyping techniques and technologies

- Turning inventions into functional designs
- Building working prototypes
- Patent issues
  - Patent search
  - Patent types and application process
  - Basics of patent law

- Turning prototypes into commercial products
  - Design for manufacturability, serviceability, disposal
  - Incorporating the human element
  - Incorporating environmental issues

- Case studies in product conceptualization and development
  - Toys (a CNC for kids, a robot pet)
  - Biomedical products (a leg bag opener, a computerized system for dental restorations, a haptics device for breast cancer examination training)
  - Fabricators and machine tools (Contour Crafting, SIS)
  - Entertainment (A digital binocular system, a coin-op portrait etcher / engraver, a candle maker)

Grading

Rigorous homework and projects are assigned. The overall performance will be rated as Credit / No Credit based on:

1. Performance in homework projects and class presentations -- 35%
    a. Correctness in methodology (as taught in the course)
    b. Quality of solutions based on specific criteria for each project (cost, functionality, size, environmental impact, etc.)
    c. Quality of written and oral presentation

2. Performance in term project (as measured by the extent of creativity, rigor and quality) – 35%
    a. Extent of departure from convention
    b. Extent of rigor as represented by the amount of effort in following and implementing the related methodologies, and by the complexity of the project
    c. Quality of solution based on the applicable criteria

3. Extent of teamwork as evaluated by team members and reflected in students extent of participation – 30%
    a. Evaluation will be based on questionnaire forms filled by team members, and
    b. instructor's observation of student's performance in collaborative activities.

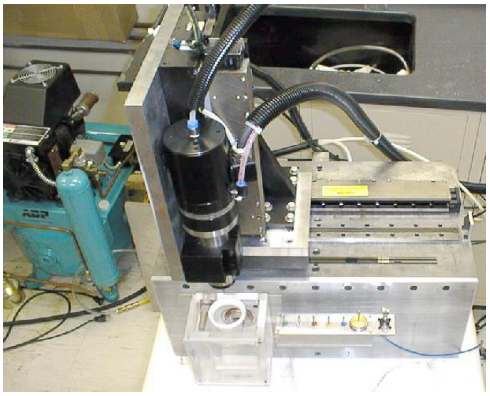
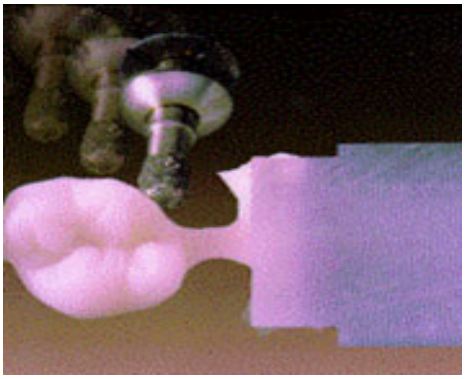
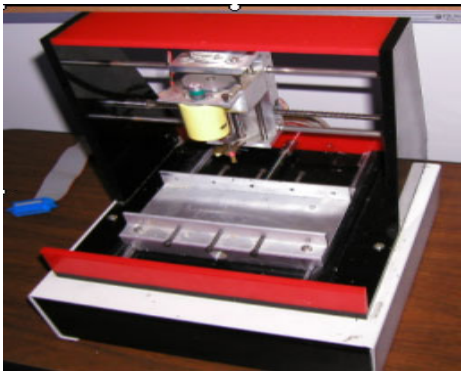
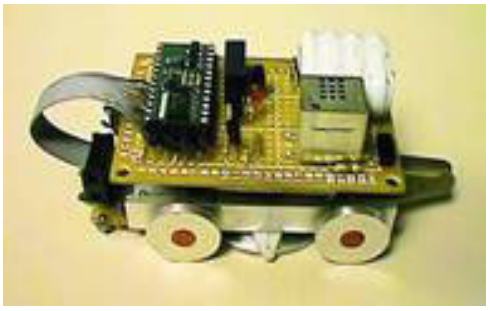
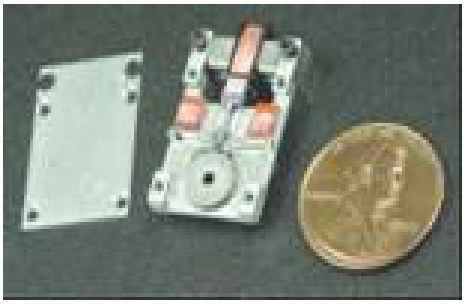
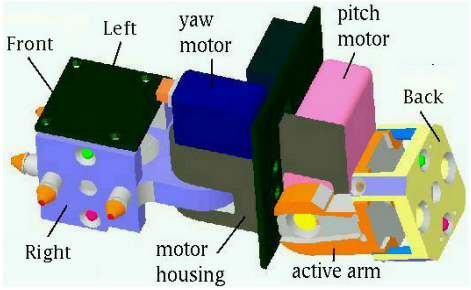
The overall percentage of effort will be the basis for the CR / No CR decision. According to the Graduate School the minimum grade for a graduate course to count toward degree is C (or 2 points out of a maximum of 4 points). This corresponds to at least 50% effort. Accordingly, all students whose aggregate percentage effort in the above categories exceeds 50% will receive a CR for the course.

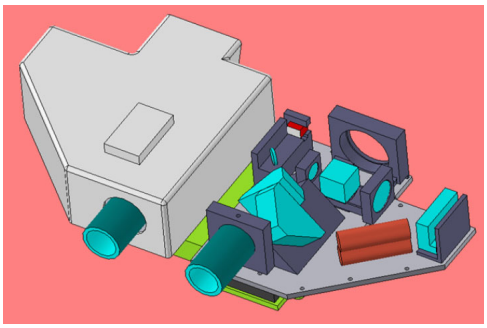
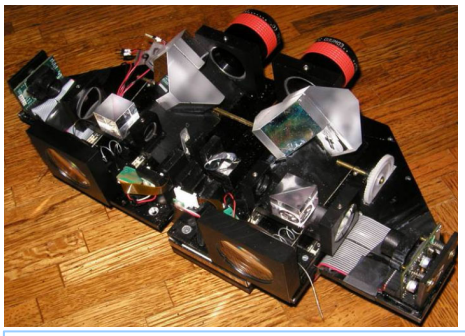
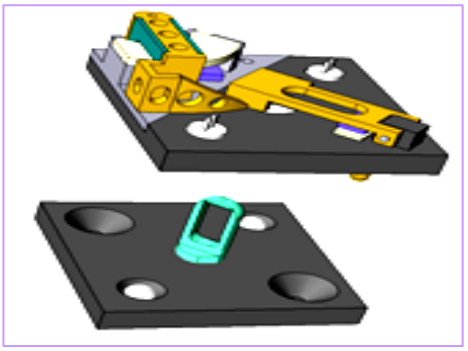
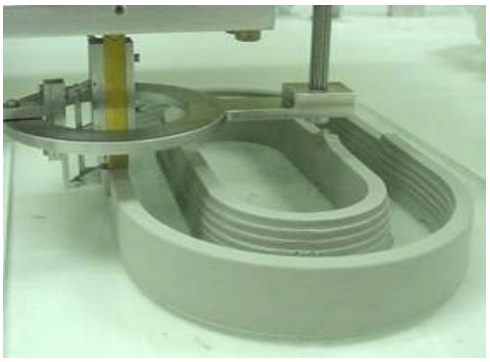
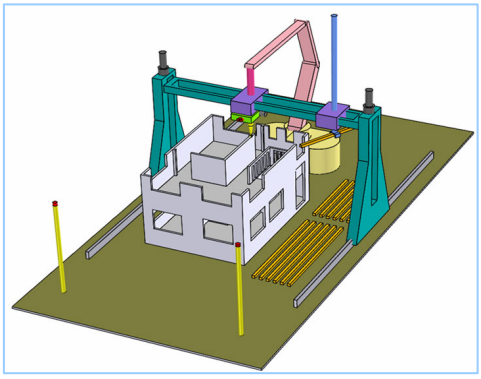
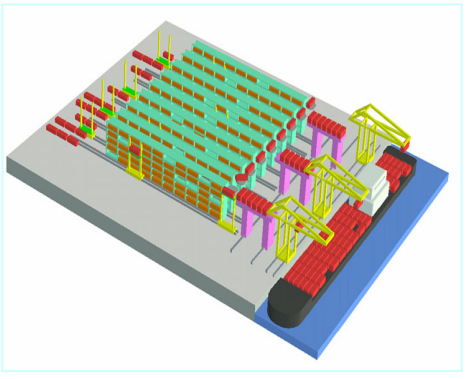
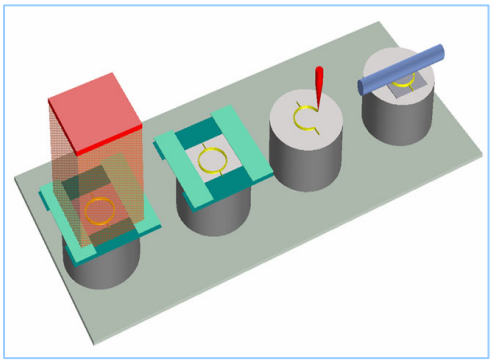
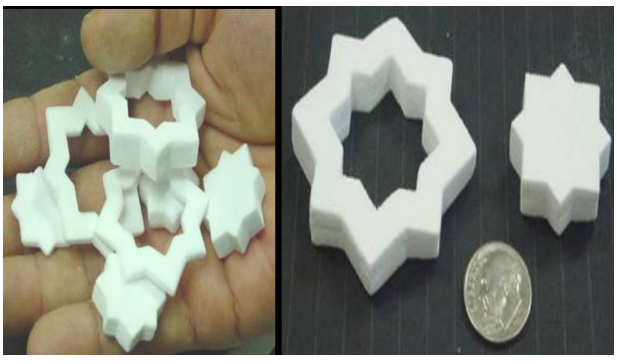
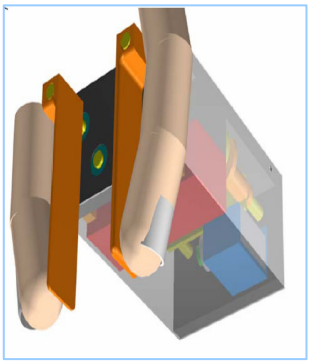
CR/ No CR rating is more appropriate for this course because of the following reasons:

- The course attempts to awaken and utilize the creative power in students. Credit/No Credit grading allows a wider margin of risk taking than letter grading. This wider margin encourages spontaneity and risk taking – two important aspects of creativity.
- Being concerned about the teacher's evaluation of their work, students tend to lose confidence in the self evaluation and judging of their own work. This lack of confidence in the self evaluation of the virtues and shortcomings of one's creation seriously inhibits creativity.
- The course is largely based on team projects and attempts to promote the spirit of cooperation rather than competition. Precise grading practice puts the students in a competitive mode that inhibits the growth of team creativity.

The School of Engineering adheres to the University's policies and procedures governing academic integrity as described in SCampus. Students are expected to be aware of and to observe the academic integrity standards described in SCampus, and to expect those standards to be enforced in this course.

"Any Student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213)740-0776."

Some of the case studies developed by the instructor