MECH 593 Design Theory and Methodology Course Information – Winter 2007

www.mcgill.ca/cden/courses

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Course Outline

Objective: To scrutinize the design process in its entirety, from problem definition to conceptualization to embodiment and realization, in a discipline-independent framework, with the purpose of gaining insight into the process from the most general viewpoint.

Contents:

- I. Introduction: The nature of design as a creative engineering activity. The various models of the design process. History of design and design schools. The role of models in the design process at its various stages: logical and logico-mathematical at the conceptual stage; mathematical at the embodiment and detail stage. The role of optimization in the design process: Stochastic methods at the conceptual stage; mathematical-programming methods at the detail stage. The role of knowledge in design. Knowledge vs. information. Can knowledge be downloaded? Design representation. The role of expert systems in design. Design databases.
- II. Conceptual Design
 - 1. Concept generation: brainstorming; synectics; Inventive Problem Solving (IPS) aka TRIZ, its initials in Russian ("Teoriya Resheniya Izobretatelskikh Zadatch").
 - 2. The polarity of the design concepts: disorder vs. order; complexity vs. simplicity. Information, entropy and noise. Measures of complexity.
- III. Embodiment Design: steps; rules; and principles.
- IV. Detail Design: steps; document preparation; product structure; drawing production, standards and organization; part lists; part identification; part-numbering; part characteristics; design communication; data-management; change-management; CAD and CAE tools.

Operation: While the course is the responsibility of one single professor, invited speakers will address specific topics, some of which are discipline-dependent, as a means to concretize the rather abstract concepts in the syllabus.

Evaluation: The course is evaluated with a final project, that is conducted by the students individually. Projects are suggested by the instructor, but the students are encouraged to propose their own projects. Project proposals will be discussed early in the term, to allow

students an early start. Progress reports are due periodically both in writing and by means of oral presentations. The final project is also reported in writing and orally.

Bibliography:

Pahl, G. and Beitz, W., 1996, *Engineering Design: A Systematic Approach*, 2nd Edition, Wallace, K.M. (editor); Blessing, L., Bauert, F. and Wallace, K.M. (translators), Springer-Verlag, London (**Text**).

Recommended reading:

Adams, J.L., 1974, Conceptual Blockbusting, Stanford University Press, Stanford.

Cherry, C., 1982, On Human Communication. A Review, a Survey, and a Criticism, MIT Press, Cambridge, MA.

Cross, N., 2000, Engineering Design Methods. Strategies for Product Design, Wiley, New York.

Dym, C.L., 1994, *Engineering Design. A Synthesis of Views*, Cambridge University Press, Cambridge, UK.

Fey, V. and Rivin, E., 2005, *Innovation on Demand*, Cambridge University Press, Cambridge.

French, M.E., 1985, *Conceptual Design for Engineers*, 2nd Edition, Design Council Books, London.

French, M.E., 1992, Form, Structure and Mechanism, Macmillan, London.

Hubka, V. and Eder, W., 1996, $Design\ Science,\ Springer-Verlag,\ London.$ Available online¹.

Shannon, C.E. and Weaver, W., 1998, *The mathematical Theory of Communication* (first published in 1949), University of Illinois Press, Urbana and Chicago.

Suh, N.P., 2001, Axiomatic Design. Advances and Applications, Oxford University Press, Oxford.

Taguchi, G., 1993, Taguchi on Robust Technology Development. Bringing Quality Engineering Upstream, ASME Press, New York.

Marking Scheme: The final mark is based on the two progress reports (20% the first one, 35% the second one) and the final report (45%).

¹http://www.cden.ryerson.ca/DesignScience/

Notes:

- In order to protect the environment, students are encouraged to submit their written reports in either double-sided sheets (preferable) or recycled paper.
- McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the code of student conduct and disciplinary procedures².

²For more information see www.mcgill.ca/integrity