

Enhancing Design Engineering Education in Canada

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1. Introduction

The primary objective of the Canadian Design Engineering Network (CDEN/RCCI) is to support the delivery of world class design engineering education by all Canadian engineering schools. (RCCI is the acronym formed by the network's name in French.) This will be done by (1) developing multi-disciplinary courseware modules, including lectures, case studies, design projects, etc., (2) encouraging Canadian industry to play a role in both the provision of design problems and student project/thesis supervision, and (3) facilitating interactions with other design-oriented programs and initiatives, such as the recently developed government-funded program of Design Chairs in Canada. Seed funding for CDEN has been secured through the National Sciences and Engineering Research Council of Canada (NSERC) for two years; the network has been endorsed by 33 Canadian engineering schools.

CDEN currently runs four projects, intended to lay the foundation of the network proper: (1) network creation and management, (2) database creation, (3) design course creation, and (4) design focus groups. This paper provides a brief overview of the network and some details of these projects.

2. Network Organization

CDEN grew from the recognition at the national level that developing a healthy national design capability is based on the in-depth education of engineers to carry out proper product development processes. Typically, there are only one or two faculty members in a Canadian engineering school with a strong design bent; therefore, though few schools have the capacity to mount substantive design-oriented efforts individually, there is a very significant expertise-base available collectively across the country. CDEN was thus conceived as a "virtual faculty" of sorts, to provide the infrastructure to permit its members to collaborate, share information, and communicate effectively despite the large distances involved. Its primary activities (in the near term) are to (1) gather and organize as much existing educational material as possible on design engineering, and (2) to develop a set of new, modular, and consistent educational units (*modules*). This material will be made available to any member school. Initially, the material will target the junior undergraduate years only. Near-term success of the network will be measured in terms of usage of the materials made available through CDEN in Canadian engineering schools.

The management structure of CDEN is intended to devolve as much responsibility as possible to the "front-line" workers - design engineering instructors and researchers. The role of the various committees in CDEN is to facilitate and coordinate activities taken on by *nodes* (individual schools or groups of schools working in a specific activity). They are not intended to dictate policy, goals, or deliverables. The Steering Committee includes representatives from various schools, and will eventually include members from industry as well. At the end of the initial two-year phase of CDEN, the Steering Committee will hand over responsibility to a Board of Directors.

Below the Steering Committee are two main committees concerned with the activities themselves. The *Program Committee* is responsible for module development and other educational matters at the undergraduate level. The *Research and Development Committee* is responsible for coordinating activities in graduate-level design education and research. Research activities will be further divided in *focus groups*. There are currently three focus groups under development, in the areas of product design, design for the environment, and electronic packaging. Since CDEN's near-term goals are targeted at the undergraduate level, the R&D Committee is developing more slowly than the Program Committee; this will change as CDEN matures.

Each member school has a local CDEN champion, who primarily serves as a communications conduit between the national committees and local committees at each school. The local committee, chaired by the champion, is constituted of faculty members from every engineering discipline, and is charged with overseeing the development and use of educational materials in a school's engineering programs.

3. Undergraduate Curriculum Development

In terms of undergraduate curriculum development, CDEN's near term mandate is the creation of modules of educational material on design engineering. A *module* is envisioned as a unit of educational material requiring approximately 50 minutes to cover properly (under a traditional delivery format). Categorization of modules includes lectures, case studies, and design projects/assignments. Each module will be prepared as a set of PDF documents and (optionally) external downloadable applications and applets. A national team of design educators is currently developing a framework for the modules, which will identify the general topic areas for the modules as well as a standard logical structure and format for each module. This framework will also permit

linking the various units into a *web* of material that can be traversed in various ways. This will encourage educators to experiment with novel presentation techniques, and allow the material to be inserted into virtually any existing program.

Module development will center around a few key design exercises and case studies. Identification of those key modules will take place through consultation with the CDEN membership. Each module will be "awarded" to a node for development, based on proposals to be submitted to the Program Committee. Those nodes will then specify as many as 12 other modules intended to provide supporting material in terms of specific technologies, tools, and scientific and mathematical concepts. The key nodes will coordinate development of the supporting modules. As modules are completed, they will be integrated into a single web-accessible site, and indexed by the CDEN online database [6].

CDEN has committed to prepare 60 modules over its first two years of operation, covering topics ranging from product development process through to project management, particular technologies, and underlying scientific principles (e.g. statics, dynamics, etc.).

In order to prevent duplication of material that is available through other sources, CDEN participants are currently surveying the existing web-based material on design. These include large virtual libraries of teaching materials [1] and case studies [2], existing online courses [3], and research into design learning [4]. Where possible, sharing arrangements will be pursued with these initiatives. CDEN is particularly interested in capturing material that has not yet been transcribed into electronic form and which may eventually be forgotten. Material of this sort available in Canadian universities is currently being searched for, and will be translated into electronic form.

4. Research in Design

We are searching for exemplary international sources of design information for education and research. In the near term, this material will be compiled into a directory of "other sources." In time, some of this material may be incorporated more fully into CDEN. Actual research in design is currently targeted as a long-term goal, to be pursued after the initial two-year startup period. But infrastructure is being put in place even now to facilitate this aspect of CDEN's mandate. The Product Design focus group is being used as a pilot project, to investigate organizational forms that will be most responsive to the needs of industry in this regard. As problem areas are identified, working groups within the focus group will be created and charged with addressing the pertinent research issues. For example, the development of new tools for design of tolerances may be identified as a pertinent research area. A subgroup of the Product Design focus

group would then be set up to pursue research, in collaboration with industry partners, to address that issue.

5. Industry Collaborations

Another component of CDEN's mandate is to involve industry in design education. Since CDEN's near term goals involve only junior undergraduate education, we expect industry collaboration will involve either donations of money, equipment, or information suitable for use as case studies or design projects. In order to increase CDEN's visibility in the industrial sector, the Product Design focus group is working on design-related projects with strong industrial ties. One such example is a project on best design practices for the automotive parts industry, currently being proposed as part of the federally-funded Network of Centres of Excellence on the Automobile of the 21st Century [5]. The results of this project, if successful, will be disseminated to design educators via CDEN.

Other kinds of industry collaborations may include guest lectures by industry representatives, a Designer-In-Residence program (where a design engineer from industry will actively participate in design education for one school year), an international lecture series where top design researchers from abroad will be invited to make presentations to the CDEN membership, and joint "contract" design work to be handled by graduate student design teams.

6. Conclusions

If CDEN is successful in its first two years of operation, further funding will be sought to extend its breadth to include senior undergraduate as well as graduate level teaching of design engineering. Long-term success will be measured by examining the impact of CDEN on Canada's design capabilities (such as hiring practices of participating industries, results of design competitions involving students who used CDEN materials, etc.).

Individuals interested in finding out more about CDEN can visit our web site, <http://www.cden.ryerson.ca>.

REFERENCES

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4. Computer Aided Learning for Engineering Design, <http://www.cad.strath.ac.uk/~ayman/project.html>.
5. The Automobile of the 21st Century, <http://www.uwindsor.ca/auto21/>.
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