

Impacts of the NSERC Chair in Design Engineering at the University of Manitoba

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On January 12, 2001, the Honourable Brian Tobin, Minister of Industry and Minister responsible for NSERC (the Natural Sciences and Engineering Research Council of Canada), announced funding for five Chairs in Design Engineering created under a new program developed by NSERC. One of the original five Chairs was located at the University of Manitoba. Since then additional Chairs have been announced, with an ultimate target of 16 programs in universities across Canada.

Definition of Design Engineering

In the Guide for Applicants issued by NSERC, Design Engineering is defined as;

“. . . the enabler of innovation. It is the activity that creates the concepts and designs, and develops the new and improved products, processes and technologies that are needed in industry and in other sectors of the economy.”

The Guide goes further to note that;

“Design engineering is concerned with the design and development of new and improved products, processes and technologies that satisfy specified requirements in an effective and efficient manner.”

Given those definitions, the stated objectives of the Design Engineering program are:

- *to produce increased numbers of high quality design engineers that have the skills required by future employers;*
- *to emphasize increased productivity and innovation in design research, design practices and design education;*
- *to establish productive and effective collaborations between the chairholder(s), industry and other design faculty and experts across Canada; and*
- *to increase the awareness and appreciation in the community for all aspects of design engineering.*

This is a clear departure from past practice at NSERC. Traditionally they have been associated with the provision of funds to support graduate studies and research in Science and Engineering.

The Design Engineering program is an attempt to encourage and assist universities in the training and development of engineering graduates who will fit the needs of industry. If design engineering education is improved, the competitive position of Canadian industry should also improve.

What form does the assistance take?

Design Chairs are awarded to individuals for an initial period of five years, with an option to renew the Chair for a second five year period. During the initial support period NSERC will provide up to \$1 000 000 to assist in meeting the program objectives. These funds must be matched by funds from a non federal government source. Both cash and in-kind contributions from industry are eligible for matching. Therefore, the annual budget for any given Chair will be at least \$400 000 per year.

The Canadian Design Engineering Network (C-DEN/RCCI) connection

NSERC has also provided funding to establish a national network of design engineering expertise in Canadian universities. The Canadian Design Engineering Network (C-DEN/RCCI) is envisioned as an organization that will address design engineering education and research, promote the sharing of design resources and the awareness of design in partnership with industry, and serve to foster design engineering innovation across engineering disciplines. Design Chairs established at different universities will contribute to and work within C-DEN/RCCI in the promotion of engineering design within their university and across Canada.

Because Design Engineering is seen as a multi-disciplinary undertaking, the Chairs are encouraged to address the process of design rather than the specifics of discipline focussed design. C-DEN/ RCCI will make design education resources available nationally, and should facilitate cross discipline interactions.

Details relating to the program, Section 2A.5.3.3 - Chairs in Design Engineering, from the NSERC's University-Industry Faculty Support material, are reproduced in Appendix A. The web address is included.

Experience leading to a Manitoba Chair Proposal

In the fall of 1998 a new preliminary year curriculum was introduced. It featured two required courses structured to address the distinct, but linked, questions of professional and design education. Introduction to Engineering, a one credit course, explores the Engineering profession from legal, philosophical and practical perspectives. The objective of this course is to provide an understanding of the nature of the profession our graduates will eventually enter. This is followed by Engineering Design, a four credit course that is split between instruction in computer aided drawing and team-based design projects. Lectures in the design component of this course cover the design process, safety, interaction with marketing, and design responsibility. Laboratories involve team-building exercises, creativity projects and four specific

design/build projects. Student response has been positive, and we believe these courses provide a sound base upon which to develop design focussed departmental curricula.

That same year, in the Department of Biosystems Engineering, two design courses (Introduction to Biosystems Engineering and Design Project) were integrated with a third year class (Design Methods for Machines for Biosystems) to form what we have come to call a Design Trilogy. All three courses are taught in the same time slot and the laboratory sessions are held at the same time, in the same “Design Office” space. Each class retains its own character (see www.umanitoba.ca/faculties and click on Biosystems Engineering under the Faculty of Engineering) but all student design teams are encouraged to work together toward the solution of their increasingly complex industry based design projects. Joint brainstorming sessions and informal discussions lead to significant levels of interaction. All design teams are required to “contract” with students registered in a Trilogy course other than their own to obtain services to complement their own team skills. The objective is to create a simulated design office situation in which students teach one another on a need-to-know basis. The final output from each design team is a written and an oral report, as well as an “invoice” for the work completed. Experience gained in the Trilogy prior to submitting the Design Chair proposal led us to believe that this approach could be applied, with modifications, to all of the programs offered in the Faculty.

In July 1999, Dr. Doug Ruth was appointed Dean of the Faculty of Engineering at the University of Manitoba. One of his stated objectives as Dean was to make the University of Manitoba a recognized leader in design education. To provide the necessary Faculty wide support for this goal, he created a new position, Associate Dean (Design Education). In July 2000, the author was appointed to this position. A proposal to NSERC for funding under their Design Engineering Chair program was developed as a means of supplementing the resources needed to reach Dean Ruth’s goal.

The University of Manitoba Chair - the proposal

The Design Engineering initiative proposed for the University of Manitoba was to have a Faculty wide focus. It responded to all four NSERC targets; training, design and development, collaboration and promotion. It had a proposed schedule, but it was recognized as a design project in itself, and the uncontrollable elements that are characteristic of the design process were recognized as a delivery constraint.

Specific components of the proposal included:

1. Improving the design experience base within the faculty.

To accomplish this, it was proposed to appoint Engineers-in-Residence. These persons would be drawn from one of two pools of talent within the engineering profession. Recently retired engineers would be appointed as E-i-Rs and located at the university during the academic year. Other engineers would be seconded from industry to provide specific current input during design course laboratory periods. The goal was to appoint at least dozen retired E-i-Rs (two per program) and as many seconded E-i-Rs within the first two years of the program.

Retired E-i-Rs were to be asked to provide leadership for student technical society design groups, to provide links between students and industry and to develop working relationships with academic staff. They were not intended to carry the responsibility for the delivery of courses but they would present specific lectures in classes where their experience was appropriate. Obviously, because these persons were retired, the nature of their appointments would vary. But basically they were to provide a body of design experience that both staff and students could call upon.

Seconded E-i-Rs were to be drawn from industry. They were to be working design engineers who would participate in every laboratory period in a specific course. In general this meant about 40 hours of input over 13 weeks. They were to be selected on the basis of their technical experience and their compatibility with the course instructor. Again, there was no intention that they be responsible for laboratory content or delivery, but rather that they become a design resource to complement the academic input upon which the course was based. From the university's perspective, this would bring current design expertise into our design laboratories. From the company's perspective, it would give them access to students and that would facilitate the hiring process following graduation.

2. Impacting the design environment both on and off campus.

This was to be accomplished by improving our communications abilities. As a community, engineers have never been overly successful in making themselves understood beyond their own circles. Rather than repeat past failures, we proposed to appoint a Communications Specialist to a position within our group.

Within the Faculty, academic programs are the responsibility of the individual departments. To make a Faculty wide initiative work, we proposed to set up a series of departmental design education groups under the leadership of a departmental champion. The champions would form the Faculty Design Education Team. In structuring this system the C-DEN/RCCI Node model was to be utilized. This would allow us to avoid unnecessary duplication. In addition to the departmental champions, the faculty team was to include a representative from Management, academics who teach technical communications, the CAD instructor, the Communications Specialist and the Administrative Assistant. It was to be, in essence, an administrative body that facilitates communication with respect to Design Engineering activities within the broader academic structure.

One of the specific tasks to be assigned to the Communications Specialist, under the direction of the Faculty Design Education Team, was to create and facilitate a communication strategy to take the message of Design Engineering to the various communities we wished to influence. Specifics of this strategy were intentionally left undefined.

3. Impacts on undergraduate education in design.

In spite of the faculty base for the Chair initiative, impacts on undergraduate education were to be based on courses within the specific academic programs. However, a core common to all

programs would include:

- The existing first year design courses
- A group of courses, in the core of each program, that provides the “soft” support structure for design activities.
- A course in the third year of a four year schedule that contains at least 75% design by the CEAB Academic Unit allocation. Each program will have their own course and will emphasize the aspects of design that are unique to the particular discipline.
- A capstone design course in each program. The feasibility of having a common capstone design course across the faculty was to be explored as part of the Chair Program.

4. Impact on graduate studies

Traditionally graduate studies has been based on research. Two specific actions were proposed to influence, but not change, the traditional approach. It was proposed to develop a graduate course on design philosophy as well as to introduce Industry Based Design Units (IBDU). M.Eng. students would be encouraged to pursue their design based studies in the IBDUs that would address pre-competitive design/development work. E-i-Rs were to provide guidance for students and engineers from the cooperating company or industry association were to treat the students as junior engineers working under their supervision.

We proposed to develop a post graduate certificate program that will provide a means of recognizing “informal” study beyond the bachelor’s degree. As well, we proposed to increase the availability of professional update courses.

5. To assure that the focus of the Chair does not become academic, we proposed to appoint an Advisory Board of persons from major industries within Manitoba.

Progress toward meeting our goals

The Chair has now been in existence for one year. During that time the bureaucratic process of establishing the office has been completed and the Faculty Design Education Team has been established. Appointments to the Advisory Board have been complicated by a major fund raising initiative associated with the Engineering Building renovation. Persons who would logically serve on our Board are currently serving on the fund raising committee. Because Chair initiatives are being used as features in the fund raising campaign, we intend to “morph” this group into our Advisory Board once they complete their current commitment.

As of January 2002, three retired E-i-Rs have been appointed. All appointees are registered professional engineers, and all bring extensive design experience to their appointments. Two of the three appointees are fulfilling E-i-R roles as they were originally envisioned. They are now involved in supervising student technical society design teams and introducing them to the many details of design in industry. The SAE teams, in particular, have gained from this relationship. However, the third E-i-R has taken on the responsibility of teaching the first year design course and the capstone design course in Civil Engineering. We intend to make this an alternate format for E-i-R appointments.

One difficulty associated with using E-i-Rs to teach is the existence of a unionized faculty. Fortunately there is a classification within the union agreement that allows us to make the type of appointment that will allow such activity.

A difficulty we have come to recognize with our retired E-i-R proposal is the lack of retired female engineers. Our available supply of retired engineers is, for the most part, male. It has been suggested that women who have temporarily left the profession to become full time mothers might be interested in a “retired” E-i-R appointment as a means of maintaining professional contact without committing to a full time position. This idea is being explored to see if it is workable for the university and the female engineers.

The current industry slow down has interfered with the appointment of seconded E-i-Rs. While it would seem reasonable to expect that engineers would have more time available to participate, the reality is that layoffs have reduced the size of engineering staffs, and those still employed are very busy. Recently unemployed engineers are not in a position to make commitments over a thirteen week period. However, three appointments are being negotiated as this paper is being prepared.

The appointment of a Communications Specialist has resulted in an increase in our visibility. This appointment is shared with the Faculty of Engineering. The current campaign in support of the renovation of the Engineering Building has been a focus of effort, but the influence of someone who understands media is very apparent. Material that is sent from the Design office, whether it is a brochure or a slide presentation, now looks significantly less like a lecture in fracture mechanics.

The Chair now authors a regular column on design in the *Keystone Professional*, the communications publication of the Association of Professional Engineers and Geoscientists of Manitoba. Public speaking engagements involving professional groups have been arranged and a monthly speakers series will begin in early 2002.

In October 2001, Dr. Billy Vaughn Koen was featured as a guest speaker at the Annual Meeting of the Association of Professional Engineers and Geoscientists of Manitoba as well as speaking to students and staff. Dr. Henry Petroski has been nominated as the 2002 Knight Distinguished Speaker for the University of Manitoba and he will present his views on engineering and design to the profession and the community. By bringing these distinguished speakers to Manitoba, the profile of the profession is raised.

The common first year design course is now being taught by an E-i-R. This brings practical design experience into the classroom for students at the beginning of their careers. A second Technical Communications professor has been appointed as a member of the Design Group with teaching responsibilities in the undergraduate program. The search for industry based projects required for the capstone design courses in each program has always been a time consuming effort. Funding, over and above Design Chair funding, has now been obtained to support this

effort.

Negotiations are now well advanced for the development of an Aerospace Design Studio initiative that will span the third and fourth years of study in the Mechanical Engineering Aerospace option. This will create what amounts to a two year laboratory experience founded on the operation, design, modification and maintenance of radio controlled craft. The laboratory will be established using the corporate model so students will gain experience in both the technical and managerial features of an engineering facility. Engineers and managers from the Manitoba Aerospace industry are actively involved in the development of this concept. Once in operation, the system will be dependant on both academic support, and E-i-R input.

Our first outreach program was conducted in Cooperation with the Office of Energy Efficiency of Natural Resources Canada. In the fall of 2001, two groups were provided with hands-on training in the use of Energy Efficiency Building Design software. Sixteen practising engineers attended a Friday seminar and twenty two graduate students attended the same seminar on Saturday. We have been asked to repeat this seminar, and its success has raised our profile as a source of professional update programs.

Appointments are not always an indication of progress, but they at least indicate activity and the availability of human resources to carry out programs. A coordinator has been appointed with responsibility to develop the non-traditional post graduate programs associated with the Chair. An Intern Design Engineer has been appointed with our first IBDU. The IBDU is in cooperation with a Centre of Excellence on the University of Manitoba campus. His responsibilities relate to the design and construction of test components for fibre reinforced polymer (frp) materials. These tests, and the components they require, form the basis for the development of design procedures using this unconventional material. Negotiations with other potential IBDU sponsors are ongoing.

In Summary

The Design Engineering Chair at the University of Manitoba has provided an exciting opportunity to change the way our students are educated. One year into the project, there have been some exciting developments, some disappointing delays and a considerable amount of “redesign”. Notwithstanding the current industrial climate, support from industry has been enthusiastic. But change within an academic environment does not happen quickly. We still believe, however, that by using the resources of the engineering and industrial communities as well as those resident on campus, our faculty can meet Dr. Ruth’s goal of producing Design-Ready Engineers in the mould that industry requires without losing the strengths of our current offerings. It is not so much a revolution as an evolution.

Appendix A

Reproduced from the NSERC Web Site at <www.nserc.ca/programs/resguide/2a533_e.htm>

2A.5.3. University-Industry Faculty Support

2A.5.3.3 Chairs in Design Engineering

Objective

The Chairs in Design Engineering program was established to improve the level and quality of design engineering activity within Canadian universities. Chairs funded under the program are expected to:

- establish a creative and innovative undergraduate/ graduate training program that gives engineering students the opportunity to experience a functioning design environment and provides them with the skills and knowledge required by the profession;
- design and develop innovative products, processes and technologies;
- establish effective multi-disciplinary design partnerships, teams and networks; and
- act as advocates for design engineering, generating an increased awareness and appreciation in both the research and outside communities for all aspects of design engineering.

Description

Chairholders are appointed for a five-year term, renewable for a second five years if progress is satisfactory and support from the sponsoring organizations continues. The Chair award provides funding for the Chairholder's salary and design-related activities, including costs associated with training, partnerships and promotion. Chairholders must have significant design capabilities, industrial collaborative experience and demonstrated ability in training design engineers.

NSERC will match contributions from sponsoring private and public organizations up to a maximum of \$200,000 per year or \$1 million over the five-year term of the Chair.

Application Procedures

The applicant must be the Dean of Engineering (or equivalent) with direct responsibility for the Chair. There is no application form for this competition. A Guide for Applicants containing detailed instructions is posted on the NSERC Web site.

Review Procedures

All eligible applications will be sent out for external review. A Selection Panel, comprised of design experts from academia and industry, will rank the proposals and make the final recommendations to NSERC.

Selection Criteria

Applications will be evaluated on the basis of the quality of the candidate, the impact of the university design strategy, and the relevance and creativity demonstrated by the action plan in achieving the program goals. Detailed criteria are described in the program's Guide for Applicants posted on the NSERC Web site.

Reporting

The Chairholder, university and sponsoring organizations are required to submit progress reports at 18, 36 and 48 months. Private and public contributions to the Chair must be confirmed annually.

Renewal

The decision to renew a Chair for a second five-year term will be based on a review of the Chair's progress during the first 48 months and the proposed action plan for the following five years. If the evaluation of the first term is positive and industry and other supporting organizations are willing to contribute financial support for a second term, NSERC's contribution over the five-year period will be based on a declining percentage of its contribution in the first term: 90%, 75%, 50%, 25%, and 10%. The total funding provided by the sponsoring organizations during that same period must be equal to or greater than NSERC's support.

Contact

Applicants are encouraged to contact NSERC program staff for further details and up-to-date deadline information.

Biographical Information

M.G.(RON) BRITTON holds degrees from the Univ. of Saskatchewan, the Univ. of Manitoba and Texas A&M Univ. He has practiced Engineering with Shell Oil, the Canadian plywood industry and Beaver Lumber, in Canada and the United Kingdom. He is registered as a P.Eng. in Manitoba and is past-President of APEGM. He holds the NSERC Chair in Design Engineering.