

## An Industrially Relevant 4<sup>th</sup> Year Capstone Design Project Paradigm

M. John D. Hayes

Chair: CSME Committee for Student Affairs  
Department of Mechanical and Aerospace Engineering, Carleton University  
Ottawa, ON, K1S 5B6

In February 2003, the CSME and the Department of Mechanical and Industrial Engineering at Concordia University in Montréal co-hosted the *International Conference on the Future of Engineering Education* (CSME-ICFEE 2003). The objective was to create an opportunity for frank discussion between engineers in academia and those in industry. Topics ranged from issues facing women in engineering to a panel discussion on *Interdisciplinary Engineering Programmes* and another on *Re-Engineering the Aerospace Curriculum*. All of the sessions were productive, but the two panel discussions were particularly so.

Filippo Salustri, from the Department of Mechanical, Aerospace, and Industrial Engineering at Ryerson University, led the discussion on interdisciplinary engineering programmes. The panel members were all academics and the discussion focused on how such programmes can be developed at Canadian universities. The most generally accepted idea was that modern engineering design challenges require a multidisciplinary paradigm, rather than an interdisciplinary team approach.

The panel on re-engineering the aerospace curriculum was chaired by Hany Moustapha from Pratt & Whitney Canada. The majority of panel members were from the aerospace corporations in the Montréal area, including CAE, Bell Helicopter, and Bombardier. There was general agreement that students graduate with sufficient technical skills, but lack key *soft skills*. The outcome of the discussion was a *wish list* of soft skills the aerospace industry members wanted the aerospace, and by extension the mechanical engineering, curriculum to impart to new graduates. This wish list was nicely summarised by Gerhard Serapins from CAE. There is a need for students to experience working in a *virtual enterprise* environment. Among other soft skills, they need to experience a design project matrix. That is, experiencing having to prioritise among multiple supervisors and multiple tasks; communicating in a large multidisciplinary team; develop verbal and written communication skills, but also develop the capacity for unbiased listening.

For the last ten years the paradigm for the 4<sup>th</sup> year capstone design projects in the Department of Mechanical and Aerospace Engineering at Carleton University has evolved such that it satisfies the major requirements agreed upon by both panel discussions. That is, a compromise has been found that meets the academic requirements for accreditation, while focusing on industrially relevant design issues.

Each project is technically challenging and generally based on ambitious end objectives. Projects are industrially relevant in two senses - technically and administratively. The technical relevance of projects facilitates obtaining financial support and interaction between students and engineers in industry. The combined industrial and educational environment exposes students to industrial project management with greater tolerance for

mistakes along the learning curve. The support provided by industry is partly due to the fact that these projects provide a pool of highly qualified personnel who are already familiar with technical and interpersonal aspects of large projects, and with potential technical solutions to difficult problems. Publicity with students and the public at large, and an opportunity to contribute to engineering education are additional factors. Continuity results from both the size of project teams and the multi-year nature of the projects. A typical project now involves approximately 25 students, five lead engineers, mostly faculty members, and a project manager, each contributing a minimum of 200 hours (sometimes much more) to the project each year. This results in a project budget in excess of 30,000 engineering hours over five years - representative of a large engineering project. The large number of participants and long duration allow for efficient parallel developments as well as long serial developments such as design iteration. While annual student turn-over necessitates more learning time than would otherwise be required, it provides many new perspectives and a continuous evaluation of previous design decisions. One result is that the projects are currently strong and are also evolving - quality is improving, student involvement at the graduate level and from programs external to Mechanical and Aerospace Engineering is growing, industrial interest and participation is increasing, and greater financial resources are becoming available.

The six current design projects are: 1) Carleton University Simulator Project (CUSP), a multi-functional simulator; 2) Air-launched Earth-observing Ground Information System (AEGIS) satellite; 3) zero-emission micro gas turbine; 4) autonomous underground mining vehicle; 5) formula SAE; 6) unmanned air vehicle. The spectrum is broad and covers virtually all aspects of mechanical and aerospace engineering. It is evident that industrially motivated needs provide challenging capstone design projects, and result in lasting benefits in terms of student education, potential products, and research opportunities.



4<sup>th</sup> year student Andrew Bruce in CUSP testbed.



The CUSP platform.