Teaching Dossier

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Contents

1 Biographical background

I have been an assistant professor in the Department of Electrical and Computer Engineering (ECE) at Queen's University since September 2002. From 1999 to 2002 I was an adjunct instructor at the Royal Military College of Canada, and concurrently a teaching fellow at Queen's University from September 2001 to April 2002. Over this time I have instructed three different undergraduate courses, and one graduate course. In 2003-2004 I was awarded the Favourite Professor award for the fourth year Electrical Engineering program, and in 1999 I was awarded 1999 Fourth year teaching assistant of the year in the Electrical and Computer Engineering Department. From 2004-2006 I was appointed an Educational Development Faculty Associate in the Instructional Development Centre, now the Centre for Teaching and Learning (CTL).

2 Philosophy of teaching

My teaching experiences in both university and skill courses have demonstrated to me that teaching is my passion. Not only do I derive a great deal of personal satisfaction in teaching, but I am consistently amazed by how much I can learn from the act of teaching. I value student learning, and so in my teaching I reflect on student feedback. I feel that learning should be the focus, rather than teaching, and that as a teacher my role, in some instances, is to create an environment where learning can take place.

In my discipline of electrical engineering, I try to help my students develop a combination of basic skills necessary for electrical engineers, and higher level critical thinking and creative skills. Engineering students need to develop critical thinking skills, the ability to find and evaluate information, and the ability to communicate and work with others, both in their professional lives and as members of the general community. In terms of Pratt's teaching perspectives, I hold the apprenticeship and developmental perspectives.

Some students have an inherent desire to learn and understand the world around them, and for this select group of learners abstract theory is sufficient to inspire interest. However, most students learn much better if there is a real-world application to the knowledge being presented. I aspire to offer real-world applications for the theory so that students have an incentive to learn the material (aside from simply striving to pass the course!). For example, I often present recent news articles in class that relate to course material (e.g. the Mars Spirit Spirit and Odyssey communication systems, solar power satellites, new mobile phone systems, and recent applied research). Student feedback on surveys consistently includes positive responses to the applications I present in class. This past year I implemented a One-Minute-Engineer session, adapted from a session presented as the ASEE Annual General Conference in 2006, in my fourth year course. This required all students, once per semester, to present a 60-second talk on any engineering topic of their choice. This helped to expose all students to a variety of engineering topics, and helped the students feel more comfortable discussing in class. It also allows the students to place the topic of the course (microwave and RF circuits) in the greater

context of engineering and society.

I feel that it is critical to use engaging activities in formal class time. As engineering instructors, one of our roles is to introduce students to the technical language and accepted practises of our discipline. Studies on retention rates generally find that students retain very little of the content of lectures unless supplemented by other activities. In contrast, group activities and design projects develop practical skills that are retained much longer. Over the past three years I have developed my fourth year course to use a guided project format, where about 20 minutes of each 90 minute class is devoted to an instructor-led discussion, using some lecture and some open ended questions, to overview the objectives of the class. The rest of the class time is used for independent group work, where students complete assignments that contribute to a major project due at the end of the semester. Student surveys indicate overwhelming support for this technique over a straight lecture format, and there are significant discernible benefits in terms of technical literacy and basic skills in microwave circuit design. A description of this teaching method and outcomes was published in the Proceedings of the ASEE Annual Conference, 2007.

I try to use technology as a learning tool. Engineering education has developed to a point where technology plays a significant role in its practise. From an educator's perspective there is often a need to find methods to allow students to visualize concepts that may otherwise be abstract. During lectures I try to use several methods, including Java tutorials, computer animations, computer simulations, and real-time measurements (e.g. computer-based oscilloscope). This also allows me to teach to students with differing learning styles. I was among the first instructors to use the Teaching Studio, an innovative room designed for active learning in the Integrated Learning Centre (ILC). More than half of the class time in my fourth year course is used for in-class assignments, the majority of which require the use of industry-standard computer aided design tools that offer the students a chance to see effects and design circuits that would be difficult or impossible to do by hand. I now use a wiki for course notes in my graduate course, and require graduate students to contribute at least on topic per year. This helps to emphasize the collaborative nature of learning, and expands the available resources for future students.

Finally, I believe in the importance of professional skills in engineering graduates. Industry surveys and alumni experiences recount the importance of communications, design ability, team skills, and project management skills in successful engineers. For the past two years I have coordinated a core first year course APSC-100, *Practical Engineering Modules*. In this role, I develop open-ended design projects to introduce students to engineering as a profession, and have introduced professional skills workshops focusing on engineering design, information literacy, and technical communications.

3 Teaching Responsibilities

3.1 Course Instruction

I have been teaching courses in the Faculty of Applied Science at Queen's University for the past six years. My teaching responsibilities are listed in Table 1. Previous to this, I taught a fourth year elective microwave engineering course at the Royal Military College of Canada from 2000-2003.

Table 1: Courses taught at Queen's University

Course	Course title	Years	Avg. # students/yr	Demographics
APSC-100	Practical Engineering Modules	2005-2007	560	Core engineering course in Faculty of Applied Science
ELEC-252A	Electronics I	2002-2004	110	Second year core course in Dept. of ECE
ELEC-483	Wireless Technology	2001-2007	60	Fourth year elective in Dept. of ECE
ELEC-49x	Electrical and Computer Engineering Project	2002-2007	12	Fourth year capstone course in Dept. of ECE
ELEC-853	Silicon microwave and RF Circuits	2004-2007	9	Graduate elective course in Dept. of ECE

APSC-100 is a core first year course for students entering engineering at Queen's University. It consists of two major modules: (1) an open-ended design project, and (2) a measurement and analysis module. The course is intended to introduce students to engineering issues, and help develop professional skills like design, communications, teamwork, information literacy, project management, and data analysis.

ELEC-252 is the students' first exposure to electronic circuits. It has three lecture hours per week, and one tutorial hour. This course is complemented by a separate laboratory course, ELEC-290.

ELEC-483 is a final year course on wireless technology which includes sufficient detail to allow students to design the high-speed portions of a basic wireless system, such as a cell phone, or wireless LAN. It includes three lectures hours, taught in the Teaching Studio in the Integrated Learning Centre. ELEC-483 includes a significant project component that requires system design using a standard microwave software package.

ELEC-490/492 is the capstone design course for students in the Electrical Engineering program. It requires students, working in groups of three or four, to successfully complete a project that includes budgeting, scheduling, and design. Each group is supervised by a faculty member, and each faculty usually supervises three or four groups. I generally supervise 2-3 groups each year.

ELEC-853 (Silicon Microwave and RF Circuits) is a graduate course that I developed in 2003-2004. It is a new course that covers recent development in my research area. The course includes class discussion, a term-length project that requires the design and simulation of a silicon-based integrated circuit, and a research seminar.

I have also been involved in marking the English Language Written Exam required for all Applied Science students.

3.2 Innovative Course Development

Over the past three years I have completely revamped the delivery of ELEC-483 to make use of a new teaching facility within the Faculty of Applied Science. The Integrated Learning Centre (ILC) in Beamish-Munro Hall includes a Teaching Studio, an experimental facility that provides the opportunity to integrate lecturing and application (in the form of computer simulations or laboratory experiments). The Teaching Studio is an oval-shaped room in which students may (a) face the instructor in the centre of the room, and a flat screen monitor which is controlled by the instructor, or (b) turn around and face a table with a computer and experimental equipment. This allows instructors to unify the theoretical and practical aspects of a course, and allows a "just-in-time" teaching model. This kind of facility has been demonstrated at Rensselaer Polytechnic Institute (RPI) and Worcester Polytechnic Institute (WPI).

The course was designed to follow a guided project format, where class discussion and in-class computer design work contribute to the completion of a final team design project. The class was held in a teaching studio, and half of the three class hours per week were used to allow students to work on computer simulations and design of microwave circuits. Brief multiple choice quizzes at the start of most class sessions encouraged students to complete class readings from the course wiki, allowing in-class time to be used for higher-level discussion and teamwork. A final web-based course survey indicated that over 85% of the students felt that the use of the studio, software, and class discussion were valuable, and were preferable to lectures. Instructor and teaching assistants found the students to have a greater grasp of the technical language, and a much better appreciation of the practical aspects of circuit design. Student assessment of this teaching style was extremely positive, and is presented in section 5.1. This coming year class sessions will be structured to enable students to complete Kolb's learning cycle each class, further linking new knowledge and skills with prior experience.

In APSC-100, I have been developing relationships between the university and a range of community and on-campus agencies, and introduced community service projects the course. These projects expose students to real-world engineering problems, and the need

to communicate with clients. Community service learning has been shown to have a positive effect on interpersonal development, ability to work well with others, leadership and communication skills, applying learning to real world, academic learning, and university relations in the community (J. Eyler et al., "At a Glance: What We Know About the Effects of Service-Learning on College Students, Faculty, Institutions, and Communities, 1993-2000", Learn and Serve America National Service Learning Clearinghouse, 2000). Anecdotally I have found these projects to be very motivating to students, and students indicate that they are genuinely open-ended. To date we have formed projects with Habitat for Humanity, St. Mary's Rehabilitation Hospital, Hotel Dieu Hospital, Limestone District School Board, Thousand Islands Elementary School, Kingston Environmental Advisory Board, the Pump House Steam Museum, Living Energy Lab, and the Integrated Learning Centre.

I have also initiated collaboration with other experts in the university to help incoming students begin to develop professional skills. With Prof. David Strong, holder of the NSERC Design Chair at Queen's, I developed an interactive session to introduce design which required the students to develop an adaptive device. I have worked with the Engineering and Science Library to develop workshops on information literacy for all first year engineering students, which lays the foundation for further development in upper years. I have also worked with the Engineering Communications group in the Faculty of Applied Science to offer an opportunity for APSC-100 teams of four to meet with a writing tutor to improve their communication skills. This initiative is built upon in upper year technical writing programs developed by the Engineering Communications group.

In 2006-2007 I began to develop projects that integrate first year students with upper year students, offering an opportunity for development of both groups. In 2006-2007 I worked with the instructor of a third-year multidisciplinary course to offer a combined project, and we will be offering another combined project this year. I am also going to supervise an integrated product development project between first year students and fourth year electrical engineering students. These projects provide an opportunity for first year students to learn project management skills, as well as technical skills, from upper year students, and helps upper year students learn how to communicate with people of diverse technical backgrounds.

Some of these innovations have been published in international and national conferences on engineering education, and at a variety of teaching-related sessions at Queen's University. Section 6.1 shows the publications related to my teaching.

3.3 Development of Teaching Materials

Appendix A contains examples of some of my course resources and grading rubrics.

3.4 Graduate supervision

Over the past five years I have supervised or co-supervised seven graduate students. Three of the students have been NSERC PGS recipients. I have also supervised three NSERC undergraduate scholarship recipients. Two of my M.Sc. students have graduated and gone on to the Ph.D. program at the University of Toronto. I have also supervised three NSERC undergraduate summer research asummer undergraduate research assistants.

My graduate students have been active in attending and presenting at conferences, and in journal publications. In the past five years, they have co-authored 15 journal and conference publications.

I meet with the graduate students weekly throughout most of the school year to provide guidance and ensure continuous progress. We also meet regularly with other microwave researchers at Queen's University and the Royal Military College of Canada to present ideas and exchange information on collaborative projects.

3.5 Administrative and committee work

In addition to my teaching responsibilities, I was appointed to the Dept. of ECE curriculum committee for 2003-2004 and 2004-2005. I was also on the subcommittees looking into improvements for the signals and systems stream, and the electronics stream, and in 2005 I chaired a sub-committee to look into improvements for the final year project courses (ELEC-49x) taken by all students in the department. I have been one of three year advisers for the electrical engineering program.

As described further below, I was also a member of the search committee for the university-wide Coordinator of Community Service Learning, and on the organizing committee for a new Master's in Engineering Education program. I also was part of two of the Instructional Learning Center (ILC) Working Groups

In the summer of 2007 I co-supervised, with Prof. Stan Simmons of the ECE Department, an initiative to develop a tutorial and work flow for printed circuit board (PCB) design to be used by undergraduate students in the department.

4 Educational Leadership

4.1 Educational Development Faculty Associate

In January 2004 I was appointed a Educational Development Faculty Associate (EDFA) within the Instructional Development Centre. The responsibilities of this position included:

- Working with colleagues from across the campus to encourage the improvement of learning and teaching at Queen's

- Designing and developing innovative programs that would lead to improved learning and teaching;
- Initiating projects aimed at improving teaching and learning
- Acting as a liaison on teaching issues with Faculties and Departments in the area of subject expertise
- Peer consultation

The position also came with $6000/year in funding to be used for teaching development.

4.2 Master's in Engineering Education Program

I was invited to be a member on the organizing committee for a new Queen's-University program granting the degree Masters of Science in Engineering Education. This initiative has passed the Faculty Board, and will be presented to Queen's University Senate in the 2007/2008 academic year. In the proposed program, I will be one of five core faculty members, responsible for supervising graduate research projects in engineering education.

4.3 Project based and Community Service Learning

Based on my work in developing community service learning in APSC-100, I was asked to be a member of the search committee for a university-wide Coordinator of Community Service Learning. The position was filled in July 2007. In 2006 I was consulted, in my role as APSC-100 coordinator, by engineering professors at the University of Victoria as part of their initiative to revise their first year engineering program. This course was subsequently highlighted in their survey paper on engineering design courses across Canada.

4.4 Teaching and Learning Forums and Workshops

I have been involved as a presenter in several educational forums at Queen's University, including the Cross Faculty Teaching Forum (2006, 2007), and as an invited panelist in the ILC Lunch Series (2007). For the past three years I have facilitated sessions at the Professional Development Day for Teaching Assistants.

4.5 Educational Outreach

I have been involved as a volunteer presenter at Sweet's Corners Public School in Lyndhurst and Thousand Islands Elementary School in Lansdowne. I have done science

presentations on chemistry and electricity and magnetism for grade 6 and 7 students. I was also involved in the "World In Motion" project sponsored by the *Society of Automotive Engineers* being implemented at Sweet's Corners School and Thousand Islands Elementary School. This program is intended to introduce students to the field of engineering by building small gliders and powered vehicles with the assistance of an engineer.

Over the past two years, I have initiated science-outreach community service projects into APSC-100. Over fifty first year engineering students have been involved in designing apparatus to help elementary students learn science and technology concepts. These pilot projects have been featured three times in the Gananoque Reporter, which covers the school involved.

5 Teaching effectiveness

5.1 Feedback from Students

Table 2 below summarizes the QUEST or USAT responses to "Instructor's effectiveness" for my undergraduate courses. As can be seen from the bolded text, my scores in the most recent year of teaching ELEC-483 and ELEC-252 are considerably above average. The response for ELEC-483 was above average the first year I taught it, but dropped below average for some of the years after beginning to develop innovative teaching approaches. The implementation of course projects, and studio-style teaching techniques required some significant adjustment for me, and led to some student dissatisfaction. However, this past year my USAT results were significantly above average.

Similarly, the student feedback for ELEC-252 improved almost every year I taught it as I become more familiar with the material, and in the final year was considerably above average.

I also use formative evaluation midway through the course to re-evaluate the success of my teaching strategies. Further evidence of my teaching effectiveness is available in Appendix B, which contains comments from unsolicited emails from two of my students.

In ELEC-483 for the past three years I have asked students to complete a web-based survey which asks students how they think the studio style/guided project style format contributed to their learning. Several of the questions asked them to compare use of studio-style instruction and guided projects to more traditional lecture-based instruction. The survey includes the following question:

Do you feel that holding the course in the Teaching Studio, and using the studio format, helped or hindered your learning compared to the traditional lecture format?

A chart of the responses is shown in Figure 1. The response was extremely positive in the first year, and improved every year as I learned what ideas worked and what did not. Appendix D includes a recently published ASEE conference paper entitled "Guided Projects for Active Learning in an Upper Year ECE Course" which analyzes the student responses in more detail.

Table 2: QUEST and USAT responses to "Instructor's Effectiveness". **Bold** denotes the most recent year teaching the course.

Course	Year	Score	Dept. mean
ELEC-483	**2006-2007**	**4.5**	3.8
ELEC-483	2005-2006	3.6	3.9
ELEC-483	2004-2005	3.9	3.9
ELEC-483	2003-2004	3.4	3.7
ELEC-483	2002-2003	3.4	3.7
ELEC-483	2001-2002	3.9	3.7
ELEC-252	**2004-2005**	**4.5**	3.8
ELEC-252	2003-2004	4.2	3.9
ELEC-252	2003-2004	4.2	3.9
ELEC-252	2002-2003	3.5	3.7
ELEC-252	2001-2002	4.0	3.8

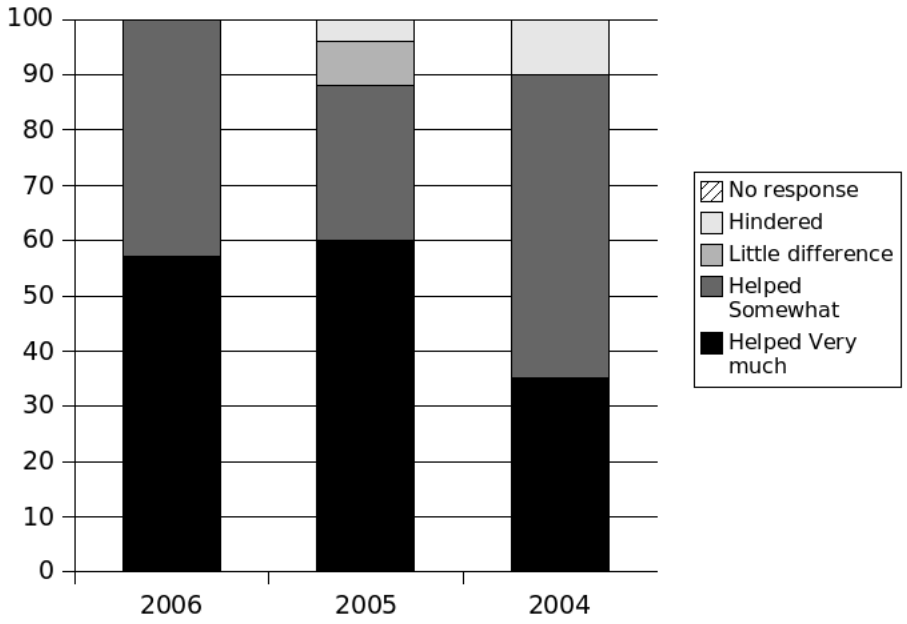

Figure 1: Student responses to "Do you feel that holding the course in the Teaching Studio, and using the studio format, helped or hindered your learning compared to the traditional lecture format?".

There is no university-wide evaluation form for graduate courses, but the Department of Electrical and Computer Engineering has graduate course evaluations to provide feedback to instructors. In the four academic years from 2003-2007 the form includes the

question "Overall, do you consider that the lecturer, as a teacher is:", and offers the options *excellent*, *very good*, *good*, *marginal*, and *unsatisfactory*. Over these years, I received *excellent* on 14 evaluations, *very good* on 6, and *good* on one.

5.2 Teaching Awards

In 1999-2000 I was the departmental 4th year teaching assistant of the year. In 2003-2004, I was awarded the Favourite Professor Award for the fourth year Electrical Engineering program.

5.3 Feedback from Colleagues

Appendix C contains letters written by colleagues regarding my teaching and educational innovation. The letters are from:

- Prof. Tom Harris, former Dean of the Faculty of Applied Science.
- Prof. James Mason, Associate Dean (Program Development) in the Faculty of Applied Science.
- Prof. David Strong, NSERC Design Chair in the Faculty of Applied Science.
- Prof. Joy Mighty, Director of the Centre for Teaching and Learning (CTL)
- Ms. Sharon Murphy, Head Librarian, Science and Engineering Library

6 Professional development

Upon my appointment at Queen's University I enrolled in Teaching Matters, a year-long program run by the Instructional Development Centre (IDC) for recently-appointed faculty members in the Faculty of Applied Science. Among other things, as part of this program I attended seminars organized by IDC staff, and invited the acting director of the IDC, Dr. Susan Wilcox, to my lectures several times to obtain feedback on my teaching strategies. I completed this program a year after my appointment. I also attended several of the sessions that are part of Focus on Foundations program offered by the CTL. I regularly attend education-related events at Queen's University, including the CTL Lunch Series and Cross Faculty Teaching Forums.

I also attend educational conferences to see the current state of the teaching art and learn of innovative strategies that I can to incorporate into my teaching. I have attended the following conferences related to teaching and learning in higher education:

- Canadian Design Engineering Network (CDEN) and the Canadian Congress on Engineering Education (CCEE) (2007)

- American Society for Engineering Education Annual Conference (2006, 2007)
- Engineering Projects in Community Service (EPICS) Annual Conference (2005).
- Eastern Ontario Symposium on Educational Technology (2005)
- Society for Teaching and Learning in Higher Education (STLHE) Conference (2004)

This past year I completed a 12-week correspondence program entitled *Introduction to Teaching in Higher Education: Transforming Teaching, Learning and Self*, offered by the Institute for the Advancement of Teaching in Higher Education. It focused on topics such as knowing our students, promoting academic integrity, assessment, curriculum development, active learning, and technology for learning.

6.1 Teaching Scholarship

I have presented at a range of educational venues, including international and national conference on engineering education, and in a variety of sessions at Queen's University. Recently I presented a session on using a guided project format in ELEC-483 at the ASEE Annual Conference, the largest engineering education conference in the world. A listing of my conference publications related to engineering education is show below. **Bolded** names refer to graduate students I am supervising.

6.1.1 International and National Conferences (peer-reviewed)

- B. Frank, "Making the switch: Reflections on integrating community service learning into a first year design project course", Canadian Design Engineering Network (CDEN)/Canadian Congress on Engineering Education (CCEE) 2007 Conference, July 22-24, 2007
- B. Frank, **J. Carr**, "Guided Projects for Active Learning in an Upper Year ECE Course", 2007 American Society of Engineering Education Annual Conference, Honolulu, Hawaii, June 2007
- B. Frank, **J. Carr**, "Evolution of a Microwave Engineering Course to 'Studio' Format using Computer Simulations", 2006 International Conference on Interactive Computer Aided Learning, September 2006, Villach, Austria

6.1.2 Regional conferences

- B. Frank, "Studio-Style Teaching Using Computer Simulation", Eastern Ontario Symposium on Educational Technology, Trent University, May 2005
- B. Frank, "Computer Simulations for Studio-Style Classes" (invited presentation), Ontario University Computing Conference, June 2005

6.1.3 Book contributions

- B. Frank, "Studio-style Instruction for Science, Mathematics and Engineering". A case study in D. Stockley & J. Mighty (editors) *Teaching More Students: Labs and Practicals*. Centre for Teaching and Learning, Queens University, Kingston, Ontario, 2007, pp. 59-66.

6.1.4 Queen's University Presentations and articles

- B. Frank, "Teaching and Learning in Science and Engineering", *Professional Development Day for Teaching Assistants*, Queen's University, September 2007
- B. Frank, "Leading Labs in Science and Applied Science", *Professional Development Day for Teaching Assistants*, Queen's University, September 2007, 2006, 2005
- B. Frank, "Inquiry by Design: Information Literacy and Communications through Community Service Learning", *Cross Faculty Teaching Forum*, Queen's University, May 2007
- B. Frank, "Learning Electronics Actively!", Department of Electrical and Computer Engineering, Queen's University, November 6, 2006, *http://www.ece.queensu.ca/undergraduate/news/elec483.html*
- B. Frank, "Queen's Engineering Reaches Out", Faculty of Applied Science Newsletter, July 2006
- B. Frank, "Community Service Projects in First Year Engineering", *Cross Faculty Teaching Forum*, Queen's University, May 2006
- B. Frank, "Delivery, Content, and Culture", *Queen's Gazette*, May 5, 2005
- B. Frank, "Leading Labs and Tutorials in Science and Applied Science", *Professional Development Day for Teaching Assistants*, Queen's University, September 2004

6.2 Professional Association Memberships

- *Institute of Electrical and Electronics Engineers*: member of Education, Microwave, and Solid-State Circuits Societies
- *American Association for Engineering Education*: member
- *Association of Professional Engineers of Ontario*: member

A Examples of Course Materials

Figure 2 shows an example of a page on the ELEC-483 wiki, which provides notes and hyperlinks to relevant material.

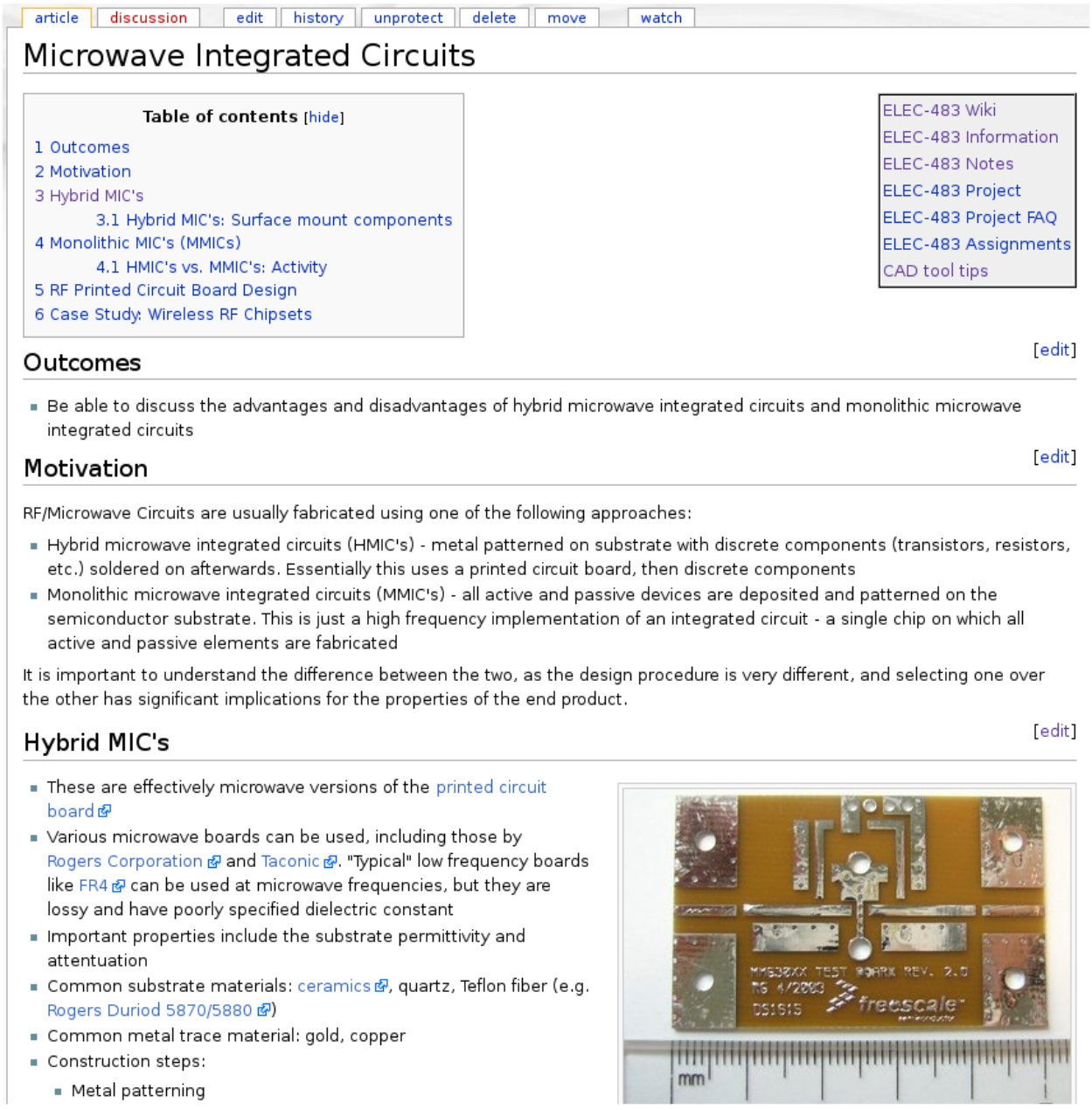

Figure 2: Screenshot of wiki used as resources in ELEC-483.

B Student Feedback

The following are some comments on course evaluation forms over the past six years.

- Brian is always on time, well organized, concerned about our learning; he teaches to the class (not the board), he presents us with material that challenges us and makes us think. The class has extremely good flow and provokes an interest in the subject matter. Brian shows a positive attitude and presents a good humour in class. It has been a pleasure to be in his class. Brian is by far the most interesting teacher who motivates us to go to class. Brian is the best teacher I've had!
- Class format is excellent. Webpage format (wiki) also seems an excellent choice as a collection of lecture materials.
- Prof Frank really tries his best and it shows ...
- Excellent course! Lecture style, how the professor handled the questions were excellent especially.
- the instructor presented current research which applied concepts learnt in class to everyday application. the instructor seemed enthusiastic about the subject being presented (always a good thing when instructors seem like they enjoy teaching)
- The instructor was very good. He was always prepared, tried to show us how it could be applied in real life, and really knew what he was talking about.

The following is an unsolicited email from a student in my fourth year elective course.

Email

I was wondering if you were planning on attending the Iron Ring Ceremony on Sunday. I have a huge amount of respect for you based on my interactions with you as well as your interactions with my peers and if you are planning on being present at the ceremony on Sunday, I would be honoured if you could be the one to ring me. Please let me know if this is possible.

C Peer and Administrator Feedback

Attached are five letters from peers and administrators regarding my teaching and educational innovation:

- Prof. Tom Harris, former Dean of the Faculty of Applied Science.
- Prof. James Mason, Associate Dean (Program Development) in the Faculty of Applied Science.
- Prof. David Strong, NSERC Design Chair in the Faculty of Applied Science.
- Prof. Joy Mighty, Director of the Centre for Teaching and Learning (CTL)
- Ms. Sharon Murphy, Head Librarian, Science and Engineering Library

D Engineering Education Publications

The following are my recent conference publications and articles on engineering education. Three articles about the science outreach program in APSC-100, which appeared in the Gananoque Reporter, are also provided.