



Teaching Excellence

Ljiljana Trajković
ljilja@sfu.ca

Communication Networks Laboratory
<http://www.ensc.sfu.ca/cnl>
School of Engineering Science
Simon Fraser University, Vancouver, British Columbia
Canada

Simon Fraser University, Burnaby Campus





Roadmap

- Introduction
 - great teachers
- Motivation
- New approaches in teaching methodology
- Case study:
 - Engineering program at Simon Fraser University:
courses in communication networks
- Resources and conclusion



Introduction: great teachers

- “The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires.”

William A. Ward

- “The teacher who is indeed wise does not bid you to enter the house of his wisdom but rather leads you to the threshold of your mind.”

Khalil Gibran

- “A teacher affects eternity; he can never tell where his influence stops.”

Henry Adams



Introduction: great teachers

- “Great teachers do not all have a single style - but they do all have a singular goal: to reach students in ways that have deep and lasting influence on how they think and act throughout their lives and careers.”

Hass School of Business, UC Berkeley

- Great teacher:
 - Communicates a thorough knowledge of and enthusiasm for the relevant field or subject
 - Presents that knowledge coherently and connects it with other allied fields or subjects
 - Challenges students and increases their capacity for independent thought
 - Transforms, enhances, or innovates teaching methodology and practice.

Otis College of Design and Arts



Motivation

- Providing students with a solid theoretical background greatly improves their ability to solve a variety of practical engineering problems.
- National institutions have long recognized the need for improving engineering education.
- Attracting the best students to science, technology, engineering, and mathematics programs and eliciting their interest has been also subject of a number of ongoing debates over the past two decades.

National Science Foundation, Moving Forward to Improve Engineering Education, NSB-07-122, Nov. 19, 2007.



Motivation: background

- School of Engineering Science at SFU offers a **five-year** undergraduate program in engineering.
- The program is **highly ranked** among the comprehensive Universities in Canada.
- However, many students are entering the engineering program **without** having necessary **mathematical background** and **analytical skills** to excel and enjoy the subjects taught.
- **Changing** undergraduate engineering curriculum to adopt **new approaches** to teaching circuits is a difficult task.
- The **curriculum** already contains a **large number** of **required courses**, which leaves little room for implementing desired changes such as, for example, offering separate laboratory courses as a follow-up to lecture-intensive courses.



Motivation: strategy

- **Attracting students** to take engineering courses and motivating them to complete these courses is an essential component of teaching the course.
- **Very early** in the trimester, **simple examples** of are used to **illustrate** concepts to be covered in details during the term.
- **Case studies** are then used to introduce various protocols and technologies.
- **Early exposure** to **software simulation tools** such as OPNET, ns-2, and ns-3 provides a valuable complement to the theory.



Motivation: students feedback

- Feedback received from students indicates that majority of current undergraduate students find basic courses **difficult** and **demanding**.
- Past experiences with choosing a variety of textbooks showed that **almost any of the textbooks would prove adequate**. More important was the delivery of lectures, selection of topics covered, choice of assignments and examination questions, and quality of the laboratory equipment.
- Students overwhelmingly **enjoyed** having **laboratory** exercises and course projects, which they often complete by working in teams of two or three.
- Such laboratories, however, should be **properly maintained** and **equipped**.



Motivation: presentation styles and delivery

- Full circle: from blackboard to overhead projectors to PowerPoint slides and back to the whiteboard.

Communication tools:

- **Web pages**. online notes, electronic handouts, audio recordings of lectures, examples from industry, fun exercises and puzzles. And endless stream of email messages
- Presentation **styles** and **delivery** are often enhanced by good textbook supplements: master slides, tutorial problems, solution manuals.
- Ongoing **demand** for new tutorials, video-taped lectures, educational games, design kits, fun and motivational lectures, and online content.



Motivation: course instructors

- In many engineering departments, introductory courses are considered to be **service courses**.
- They are often **taught** by sessionals and instructors **as a service** to the department.
- These **instructors are** often **unmotivated** and can hardly generate students' enthusiasm.
- More senior faculty teaching service courses often have their **research interests** in areas **not related** to the courses they teach.
- **Lack of industrial experience** often deprives instructors from appreciating the importance of practical applications in science and engineering education.



New approaches in teaching methodology

- They include a number of approaches such as:
 - experiential learning
 - experiential education
 - action learning
 - adventure learning
 - free choice learning
 - cooperative learning
 - service learning
- Experiential learning is the process of making meaning from direct experience.
- In this lecture, we use examples from teaching university courses in computer networks to illustrate experiential teaching and learning approaches in engineering.



New approaches in teaching methodology

- Teaching new generations of students is a challenging task that calls for new approaches and methodologies that will appeal to current generations of both students and educators.
- Aristotle once said: “For the things we have to learn before we can do them, we learn by doing them.”
- Recent theories of education emphasize learning through “reflection on doing”.
- Adopting these new approaches in teaching and in designing new pedagogical tools is an important step in advancing the art of teaching in science, technology, engineering, and mathematics (**STEM**).



Current engineering programs

- Offer a number of **majors**:
 - electronics, computer engineering, engineering physics, bioengineers, mechatronics
- These programs may need **courses** carefully **tailored** to fit a program's specific curricula.
- The “**cookbook**” approach may not be serving future electrical engineers well.
- Lectures, tutorials, and laboratories are often supplemented by **software tools** such as MATLAB, SPICE, OPNET, ns-2, and ns-3 to enhance understating of the theory taught.



Engineering program at SFU: Communication Networks

- School of Engineering Science offers two undergraduate and two graduate courses in communication networks.
- The undergraduate courses are offered to third and fourth year students.
- There are weekly homework assignments and the midterm and final examinations.
- In addition to three-hour lectures per week, one-hour tutorials offered weekly for the undergraduate courses.
- There is no required textbook. Several textbooks are recommended. A large number of textbooks and references are made available through the University Library reserves.



ENSC 427 Communication Networks

<http://www.ensc.sfu.ca/~ljilja/ENSC427/>

- This course covers the techniques needed to understand and analyze modern data communications networks.
- It covers the basic architecture of packet networks and their network elements (switches, routers, bridges), and the protocols used to enable transmission of packets through the network.
- Quantitative performance analysis and design of data and integrated services networks.
- Re-transmission error recovery schemes, networks of queues, congestion control, routing strategies.
- Multiple access techniques in data networks, design for specified throughput and delay performance.



ENSC 427 Communication Networks

- Wireless networks, routing approaches in mobile networks
- Analysis and design of broadband integrated services digital networks, asynchronous time division multiplexing
- Laboratory work is included in this course
- This is a project oriented undergraduate course. Students will be introduced to OPNET (Riverbed Technologies), ns-2, and ns-3 tools for simulating packet networks
- The course pre-requisite is successful completion of ENSC 327-3 or permission of the instructor



ENSC 427 Communication Networks

Topics:

- Communication networks and services
- Application of layered architecture
- Digital transmission fundamentals (overview only)
- Circuit-switched networks
- Peer-to-peer protocols and data link layer
- Medium access control protocols and local area networks
- Packet-switched networks
- TCP/IP



ENSC 427 Communication Networks

http://www2.ensc.sfu.ca/~ljilja/ENSC427/Projects/ENSC427_Spring2013_projects.html

Sample projects:

- Space Internet: transmission of large files
- Evaluation and comparison of Spanning Tree Protocol and Rapid Spanning Tree Protocol on Cisco switches via OPNET
- Analysis and simulation of VoIP
- BACnet network
- Analysis of RIP, EIGRP, and OSPF routing protocols using OPNET
- Peer to peer networks
- Wireless network simulation
- Comparative performance analysis of LTE versus WiMAX using OPNET simulation modeler



ENSC 427 Communication Networks

Sample projects (cont.):

- Multimedia streaming over WiMAX and LTE networks
- Comparison between LTE and rival wireless technologies
- Analysis and performance evaluation of a Wi-Fi network using ns-2
- Analysis of video conferencing in LTE networks
- An analysis of peer-to-peer traffic over an ad-hoc network
- Analysis of a smart device game protocol
- Evaluation and comparison of wired VoIP systems to VoWLAN
- QoS analysis of wireless ad-hoc network routing protocols



ENSC 835 Communication Networks

<http://www.ensc.sfu.ca/~ljilja/ENSC835/>

- This course covers the techniques needed to understand and analyze modern data communications networks.
- It covers the basic architecture of packet networks and their network elements (switches, routers, bridges), and the protocols used to enable transmission of packets through the network.
- It addresses techniques for collection, characterization, and modeling of traffic in packet networks.
- It covers aspects of traffic management, such as various call admission control and congestion control algorithms in high-speed packet networks and the influence of traffic on network performance.



ENSC 835 Communication Networks

<http://www.ensc.sfu.ca/~ljilja/ENSC835/>

- This is a project oriented graduate course. Students will be introduced to various algorithms and software tools for simulating packet networks:
 - OPNET (Riverbed Technologies),
 - ns-2 and ns-3 network simulators (Lawrence Berkeley Labs)
 - Ptolemy (UC Berkeley)
 - AutoClass (NASA)
 - S-PLUS (Insightful) tool for statistical analysis
- The course pre-requisites is successful completion of ENSC 427-3 or permission of the instructor



ENSC 835 Communication Networks

Topics:

- Computer networks and the Internet
 - history and networking principles
 - network services and organization
 - network protocols (Ethernet, Internet, Token rings, FDDI)
 - circuit-switched networks
 - packet-switched networks (wired, wireless, Internet, ATM)
 - switching, scheduling, naming, and addressing, routing, error control, flow control.
- Introduction to simulation tools for evaluating network performance
 - OPNET: tutorial and case studies (GPRS, M-TCP)
 - ns-2: tutorial and case studies (mapping the Internet)



ENSC 835 Communication Networks

Topics:

- Application Layer
 - case study: Gnutella
- Transport Layer
 - case study: modeling TCP/RED
- Network Layer
 - case study: analysis of BGP
- Link Layer and Local Area Networks
- Analyzing Internet topology
- Wireless and Mobile Networks
 - case study: M-TCP, TCP+
- Traffic collection, characterization, and modeling



ENSC 835 Communication Networks

http://www.ensc.sfu.ca/~ljilja/ENSC835/Projects/ENSC835_Spring2013_projects.html

Sample projects:

- Performance of video conferencing over dual band WiFi network
- Comparison of OPNET simulations between PAN network and WiMAX
- Simulation of GPRS network
- Evaluation and improvement of BitTorrent implementation in ns-3
- Implementation of ITR and ETR devices in the ns-3 network simulator



Online resources

- The entire course material is available **online**.
- Course **web pages** contain links to homework assignments, laboratory exercises, and supplementary references.
- Topics to be covered in class are **posted weekly**
- Each course lecture is **audio** recorded and these **recordings** are made available shortly after each lecture to students enrolled in the course.
- Puzzles and games

Resources

- Stanford University: <http://ctl.stanford.edu/>
Center for Teaching and Learning
Effective Teaching, Effective Learning, Effective Speaking



- In its broadest terms, our purpose is to promote excellence in teaching at all ranks and excellence in student learning inside and outside the classroom.
- Our goal is to see teaching equally valued with research as a professional commitment of faculty and teaching assistants and to provide the training and resources to make excellent teaching possible.
- Effective teaching encompasses more than just the transmission of subject matter, however.



Resources

- Excellent teaching, first of all, gains the students' attention and convinces them of the importance of what is being taught and learned.
- It goes on to communicate not only information and concepts but to develop powers of analysis, synthesis, judgment, and evaluation, all in a context of considered values.
- When teaching has truly succeeded, students leave with an ability to learn, question, and commit on their own.
- Our goals for student learning are complementary—that students not settle for just learning the “stuff” or enough “stuff” for a decent grade.
- They should be training their minds and sensibilities for a lifetime responsibility of critical, independent thought and commitment to personal and community goals.
- They should have high expectations of their own efforts and of their teachers' efforts.
- They should see learning as extending far beyond the classroom to most of what they experience.



Resources

- University of California Berkeley
Center for Teaching and Learning
<http://teaching.berkeley.edu/lecturing>
<http://teaching.berkeley.edu/large-lecture-classes>
- A Berkeley Compendium of Suggestions for Teaching with Excellence
(first published in 1983)
<http://teaching.berkeley.edu/compendium/>
Barbara Gross Davis
Lynn Wood
Robert C. Wilson



Resources

- Carnegie Mellon University
<http://www.cmu.edu/teaching/designteach/>
- How to Prepare to Teach a Course
<http://www.wikihow.com/Prepare-to-Teach-a-Course>



In closing and looking forward

If we wish to generate interest among the incoming students, we need to do a better job of promoting the profession by:

- providing **bettens teaching tools** and delivery methods
- **combining** theory courses **with laboratory** exercise
- **illustrating** the **applications** in fields relevant to environment, biotechnology, and medicine
- **recognizing** and **rewarding teaching**
- doing a better job in **sharing our enthusiasm** for the engineering profession.