CSI2911 and SEG2911
Professional Practice in Computing
Pratique professionnelle de l'informatique

TOPIC D
Computing Codes of Ethics, Professional Associations, and Computing Failures

Some of the material in these slides is derived from slides produced by Sara Basse, the Author of the “Gift of Fire” textbook, and also other professors who have taught this course including Stan Matwin and Liam Peyton.
Professionalism

Behaving and acting consistently with the norms of a profession
What are Professions?

**Full-time, paid occupations**
- recognized in society
- as requiring advanced knowledge and/or skill,
- with at least one association members can or must join,
- and a code of conduct/ethics.

**Some professions are legally recognized**
- Governments have passed laws recognizing members
- In turn, members have a legal responsibility to uphold the interests of society, above other interests

**Others professions are less formal**
I will use * to mark uses where use of the term will be disputed

A. Professions with practice-restricting licenses in many jurisdictions
   • Practice or aspects of practice are limited to license holders

   • Medicine, Dentistry, Chiropractic, Pharmacy, Law, School Teaching, Engineering (in theory in Canada), Architecture
     – Some licensed professions in Ontario
       http://www.citizenship.gov.on.ca/english/working/career/
     – Licensed professions in New York State
       http://www.op.nysed.gov/title8.htm

   • *Divinity (those licensed can perform marriages, etc), etc.

   • Those requiring less education are commonly called ‘trades’
     – *Truck Driving, (required training and drivers license)
     – *Hairdressing, barbering
Legally recognized professions (2)

B. Professions with signoff-restricting licenses or certifications,

- A licensed/certified person must approve certain types of work done, but may delegate most of the work to others

- Anyone may ‘do certain of the work’, but members have a legal basis to state to others that they are competent

- Engineering (in some places), Financial Analysis (CFA), Chartered Accountancy (CA), Certified Management Accountancy (CMA), Logistics, certain ‘trades’ (*Electrician, *Plumber)

C. Professions with legal standing but where there is no license issued nor legal requirement for signoff of work

- Information Systems Professional (I.S.P.) in Canada
  — Discussed later
Professions without legal recognition

D. Professions with optional certifications that do not have legal weight
   • Software Development (CSDP), Project Management (PMP)
     —Discussed later

E: Professions not generally licensed or certified, but where a degree or diploma provides evidence of competence
   • *Scientist (various types), Journalist

F: Other professions or trades where an apprenticeship model is typically followed
   • *Mason

G. Professions where the limiting factor is simply that you must have sufficient skill or knowledge that someone is willing to pay you enough to do it full time
Key attributes of a profession

**Public recognition**: Others outside profession X understand what a member of profession X does and can do

- So outsiders know who to consult when they want some service
- So outsiders can feel confident they are getting work done by someone competent

To ensure public recognition: There must be

- A. A defined **scope of practice**
- B. A recorded **body of knowledge** (principles, facts, best practices, required procedures such as the building or plumbing code)
- C. A **code of ethics**
  — **consequences** when it is violated
- D. Methods to **educate/train**, **accredit education**, and ensure **continuing education**
- E. Well-understood **criteria for membership**
- F. Organizations to establish and administer the above
So what does it mean to exhibit professionalism?

- Obtain the required education and ongoing education (D)
- Adhere to the code of ethics (C)
- Apply the principles and knowledge properly (B)
- Practice within the scope of your expertise (A, D) and defer to others when boundaries are reached
- Obtain and maintain appropriate credentials (E)
- Participate in the appropriate professional organizations (F)
Other attributes of many professions

Membership and practice may be limited or controlled
  • As opposed to ‘de-facto’

The profession may be self-governing
  • The profession controls all attributes described on the last slide
  • Members are disciplined by their organization

There may be legal recognition and responsibility
  • Includes the concept of malpractice

Being a professional may confer respectability / status / social privilege

Professionals may enter private practice with individual clients

Professionals may enjoy work autonomy
  • You are able to control aspects of how you do your work, even when working for an employer
  • Your responsibility to society and your profession comes first in case of conflict
Specializations / Specialties

Most professions have well-defined specialties, often with their own certifications and associations

- Medicine: Board-certified specialties

- IT/Computing:
  - AI - American Association for Artificial Intelligence
  - Project management Professional [http://www.pmi.org](http://www.pmi.org)
  - Information security (Certified Information Security Manager) [http://www.isaca.org/Template.cfm?Section=CISM_Certification](http://www.isaca.org/Template.cfm?Section=CISM_Certification)
  - Hacking (Certified Ethical Hacker) [http://www.certifiedethicalhacker.com/](http://www.certifiedethicalhacker.com/)
  - Certified Information Technology Professional
  - Vendor-specific certifications (Microsoft, Oracle)
  - Database administration, UI design
  - etc.
Different Types of Professionals in Computing?

**Computer Scientist**

- **Conceptually:** Researches/develops new techniques in computing
- **In practice:** Develops software, often specializing in some areas of practice such as particular types of architecture

**Software Engineer**

- **Conceptually:** Has deep skills in the areas of the SE lifecycle: Requirements, design, implementation, plus management
  - Focus on systems where safety or other areas of public interest are of concern
- **In practice:** Very little difference from a computer scientist
  - just one of several computing specialties that employers consider to largely overlap
- **But:** A software engineering graduate has a straight-forward path to the P.Eng

Also: Computer Engineer, programmer, technician, business analyst, database administrator, technical writer, user-support specialist, cognitive scientist, engineer or scientist developing software, etc.
General Professional Associations for Computer Professionals

CIPS - Canadian Information Processing Society
• The national society for computing in Canada
  — Affiliated with Réseau Action TI (Québec)

Two US-based associations with international membership
• ACM - Association for Computing Machinery
• IEEE Computer Society

And if you want to also say you are an engineer
• PEO
  — Computer scientists can also obtain their P.Eng if they have a certain set of SE courses, significant software engineering experience and are willing to undergo a more rigorous evaluation process that may involve more exams
Some Activities of CIPS

Presents professional development and social-networking events

Certifies individual practitioners
  • I.S.P - Discussed on next slides

Accredits academic institutions
  • CSAC - Computer Science Accreditation Council
    —Head (2008-): Tim Lethbridge

Adopts standards of practice

Advocates on behalf of the profession
CIPS Wants Us to Become Trusted Professionals

**Trusted Competence**

- Mastery of a defined body of knowledge evaluated in one of several ways
  - Includes a set of best practices
- A considerable period of experience

**Trusted intentions**

- Adhering to a code of ethics
The Information Systems Professional (I.S.P.) Certification

http://www.cips.ca/isp

The terminology is a little bit outdated

Français: EATI: Expert agréé en technologies de l'information
  • anciennement IPA ou Informaticien professionnel agréé

Goals
  • Protection of the public
  • Professional credibility
  • Personal integrity and competence
  • Enhanced customer confidence
  • Enhanced professional profile
  • Increased value to employer
The I.S.P

A provincially-administered national standard

• Recognized by statute in 6 provinces as a self-regulating profession
  - And http://local.cips.ca/ontario/

• Mutual recognition with other countries

Unlike the P.Eng. does not grant an exclusive license

• But you have the same types of responsibilities
• Many computing professionals don’t want a licensing model

Areas of ISP/P.Eng. overlap of scope of practice have yet to be resolved

• In Alberta they are actively working on this
Routes to the I.S.P

**Education plus experience**
- An accredited degree makes this faster
- Both CSI and SEG programs at Uottawa are accredited

**Exam based**

**Professor at a university**

**Industry leader / Senior established professional**
New Certification With Enhanced International Recognition: ITCP

Information Technology Certified Professional

- [http://www.ipthree.org/](http://www.ipthree.org/)
- [http://on.cips.ca/ITCPEvents](http://on.cips.ca/ITCPEvents)
- Certifies a higher level of knowledge than the I.S.P
  — SFIA level 5 (we will discuss this shortly)
- IP3: International Professional Practice Partnership
  — A body that uses accreditation standards (IP3P) to certify national professional certifications like ITCP
  — Sponsored by IFIP
    - The International Federation for Information Processing
- A variety of countries have IP3-accredited certifications
  — Australia
  — UK
  — US (IEEE Computer Society is working on it)
The CSDA and CSDP certifications: IEEE Computer Society

CSDA - Certified Software Development Associate
- [http://www.computer.org/portal/web/csda/home](http://www.computer.org/portal/web/csda/home)
- Designed to be passable by a recent grad who has studied a few software engineering courses
- Suitable for CSI, SEG and CEG grads
- Outline of topics and sample questions: [http://www.computer.org/portal/web/csda/samplettest](http://www.computer.org/portal/web/csda/samplettest)

CSDP - Certified Software Development Professional
- [http://www.computer.org/portal/web/certification](http://www.computer.org/portal/web/certification)
- Designed for a professional with several years software development experience

Both are international and exam based
Both based on the Software Engineering Body of Knowledge
- SWEBOK (discussed in coming slides)
Some Benefits of Professional Status in Computing (I.S.P, ITCP, CSDA, CSDP)

Social and societal standing
- Computing professionals have similar responsibilities to society as engineers, doctors, lawyers, accountants, financial analysts, etc.
- Other professionals, members of the public and the media need to know who to consult

Legal reasons
- Judges and lawyers need to know who can be considered an expert witness in a court case involving computing or IT
- The Chief Information Officer (CIO) of a corporation needs to know who has the expertise to certify that the corporation has adhered to laws and regulations
  - Privacy acts like PIPEDA
  - Corporate regulatory compliance
    - E.g. Sarbanes Oxley Act in the US
Some Benefits of Professional Status in Computing 2

We need better software and IT services, hence better people to develop and deliver these

- Professional status comes with a requirement to maintain competence
- The more professionals there are, the more clients and employers will decide to insist on hiring a certified professional
  — It will give them extra confidence
- As a result, the quality of products and services should rise
Bodies of Knowledge in Computing

We will look briefly at two

- Software Engineering Body of Knowledge — SWEBOK
- Skills Framework for an Information Age — SFIA
Knowledge areas

- Requirements
- Construction (detailed design)
- Maintenance
- Software Engineering management
- Tools and methods
- The upcoming version will have:
  - Engineering economics
  - Computing foundations (core computer science)
  - Mathematical foundations (discrete math and statistics)
  - Engineering foundations (cost benefit analysis, etc.)
SFIA: Skills Framework for the Information Age

Developed in UK, but used worldwide

- [http://www.sfia.org.uk/](http://www.sfia.org.uk/)

Basis for IP3 accreditation

Seven levels

- Level 1: New entrant
- Level 5: Senior professional (e.g. ITCP)
- Level 7: Director

At different levels

- Basics of additional knowledge categories should be learned
- Greater depth in certain categories needed
SFIA Knowledge Categories

1-21 Strategy and architecture
  • Information, Business/IT, Technical

22-31 Business change implementation and management
  • Project management, business analysis and modelling

32-48 Solution development and implementation
  • Systems development (requirements; software/network/data design; programming; safety engineering; information content authoring; testing)
  • Human factors (ergonomics, usability requirements and evaluation)
  • Installation and Integration (installation, porting, decommissioning)

49-66 Service management
  • Service strategy (IT management, financial management for IT, capacity and availability management)
  • Configuration, change and release management
  • Service operation (system software; security; support of applications, network, database; service desk and problem handling)

67-82 Procurement and management support
  • Supply, quality, resource and learning management

83-86 Client interface: Marketing and client support
Codes of Ethics for Computer Professionals

We will look at two

- CIPS Code of Ethics
- IEEE/ACM Software Engineering Code of Ethics
Summary of the CIPS Code of Ethics

http://www.cips.ca/ethics

1. Protect the Public Interest and Maintain Integrity

• Work with due regard for health, safety and the environment
• Report problems that may injure persons, organizations, property or the economy
• Not discriminate on any grounds, such as race, sex, sexual orientation, nationality, social origin, family status or disability
• Not bring the profession into disrepute
Summary of the CIPS Code of Ethics

2. Demonstrate Competence and Quality of Service

- Serve client in conscientious, diligent and efficient manner
- Not undertake a task unless you have competence or can become competent without delay, risk or expense to the client
- Exercise uncompromised judgment
- Be honest and candid when providing service
- Maintain competence (constantly update knowledge)
- Be aware of and compliant with legislation, standards and bodies of knowledge
- Respect rights of third parties, such as giving credit where it is due
- Respect property rights
Summary of the CIPS Code of Ethics

3. Maintain Confidential Information and Privacy
   • Duty of Secrecy: Clients have a right to expect that anything disclosed, seen or overheard will remain confidential
     —Do not even disclose having been retained by the client
   • Respect PIPEDA (Privacy Act) and other laws

4. Avoid Conflict of Interest

5. Uphold Responsibility to the IT Profession
   • Use courtesy and good faith when dealing with other professionals
   • Participate in professional societies
   • Support others in their professional development
The IEEE/ACM Software Engineering Code of Ethics - 1

See http://www.acm.org/about/se-code

Short version:

1. Software engineers shall act consistently with the public interest.

2. Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.

3. Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.

4. Software engineers shall maintain integrity and independence in their professional judgment.
Short version continued:

5. Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.

6. Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.

7. Software engineers shall be fair to and supportive of their colleagues.

8. Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.
1. Public Interest

- Accept responsibility for your work
- Approve software only if you have a well-founded belief that it is
  - Safe
  - Meets specs
  - Passes its tests
  - Does not
    - Diminish quality of life
    - Harm privacy
    - Harm the environment
1. Public Interest continued
   - Disclose any actual or potential danger
   - Co-operate to address matters of public concern
   - Be fair and avoid deception
   - Consider issues that limit access to software
     — Disabilities
     — Allocation of resources
     — Economic disadvantage
   - Volunteer for good causes
     — In particular, public education about the discipline
SE Code of Ethics
Some details of the long version

2. Client and employer
   • Provide service in your area of competence
     — Disclose limitations of your education or experience
   • Do not use software obtained illegally or unethically
   • Use client’s or employer’s facilities only as authorized
   • Respect privacy and confidentiality
     — Except where this violates the public interest of law
   • Identify and report when a project is likely to fail, to prove too expensive or have other problems
   • Avoid conflict of interest
SE Code of Ethics
Some details of the long version

3. Product

- Strive for achievable goals, high quality, acceptable cost and reasonable schedule
  - Ensure everyone understands the tradeoffs
  - Use quantitative estimates and state the level of uncertainty
- Use appropriate methods and standards
  - Depart from them only when ethically or technically justified
- Ensure requirements are clear and meet the user’s needs
- Ensure adequate testing
- Document decisions
- Maintain the integrity of data
- Treat maintenance with the same professionalism as new development
SE Code of Ethics
Some details of the long version

4. Judgment

• Temper technical judgment by the need to support and maintain human values
• Only endorse items
  — you have supervised
  — you agree with
  — and in your area of competence
• Maintain professional objectivity
  — E.g. avoid promoting bad ideas to please others
• Avoid deceptive financial practices
• Avoid associating with anybody that is in a conflict of interest
SE Code of Ethics
Some details of the long version

5. Management
• Insure software engineers are informed of standards before being held to them
• Ensure everybody knows policies and procedures for such things as security and privacy
• Be fair in assigning work
  — Assign work accounting for the person’s level of education and experience, as well as their need to further this
• Ensure everybody knows the conditions of employment
• Offer fair and just remuneration
• Do not ask anyone to do anything inconsistent with this code
• Do not punish anyone for expressing ethical concerns
SE Code of Ethics
Some details of the long version

6. Profession

• Promote public knowledge of software engineering
• Participate, as appropriate, in professional organizations
• Support others in following this code
• Obey all laws unless, in exceptional circumstances, they are inconsistent with the public interest
• Where reasonable, express concerns to people breaking this code
  — Otherwise report violations of the code to authorities
SE Code of Ethics
Some details of the long version

7. Colleagues

• Assist colleagues in professional development
• Credit the work of others and refrain from taking undue credit
• Review the work of others in a fair way
• Listen to the opinions, concerns or complaints of others
• Do not interfere in the career of others unless concern for the employer, client or public interest suggests otherwise
• Call on other professionals in areas outside your own competence
SE Code of Ethics
Some details of the long version

8. Self
• Improve your
  —Knowledge in all areas of software development
  —Ability to produce safe, reliable and useful software at reasonable cost and within a reasonable time
  —Communication ability
  —Understanding of
    - Technology
    - Standards
    - Relevant law
    - This code
Accreditation of Computing Programs

Provides evidence that computing education meets the standards of the profession

Performed in Canada by the CIPS agency **CSAC**

- Computer Science Accreditation Council
- Accredits CS and SE Programs in Canada
- Analogous to CEAB that accredits engineering
- SE programs accredited by both CSAC and CEAB

CS Accredited programs: [http://www.cips.ca/node/288](http://www.cips.ca/node/288)
SE Accredited programs: [http://www.cips.ca/node/289](http://www.cips.ca/node/289)
Accreditation of Computing Programs - 2

International recognition of CSAC accreditations through the Seoul Accord

- Analogous to the Washington Accord for engineering and Canberra Accord for architecture
- US, Korea, Australia, UK, Canada, Hong Kong, Taiwan, Japan
  
  — Your degree will be recognized for certifications in these countries

All accreditation agencies are themselves accredited

- AAAC: Association of Accrediting Agencies of Canada
- [http://www.aaac.ca](http://www.aaac.ca)
Overview of Criteria for Computing Program Accreditation

**Elements assessed**

• Faculty
• Students
• Resources

• Curriculum for CS and SE programs
  — 15 courses in CS/SE/CE
    - SE programs require specific SE topics
  — 5 in math
  — 10 non-technical

• Curriculum for interdisciplinary programs
  — 10 courses in CS/SE, 3 in math
Seoul Accord Expected Graduate Attributes

1. Academic Education
2. Possess knowledge for solving computing problems
   • Computing fundamentals, math, science, domain knowledge
3. Ability to analyse complex computing problems
4. Ability to design and develop solutions
   • Systems, components or processes
   • Consideration of public health, safety, culture, environment
5. Ability to create, use and adapt modern computing tools
6. Ability to work both in teams and individually
   • As a member or leader, and in a multidisciplinary context
7. Communication skills (written and presentation)
8. Professionalism
9. Understand and commit to principles of ethics
10. Commitment to life-long learning
Failures and Errors In Computer-Based Systems

Computer system failures have caused

- Much death and destruction
- Hundreds of billions of dollars in economic loss
  - $70B/year in avoidable loss just due to poor project management
  - Several individual systems have had multi-billion dollar losses
- Much general inconvenience

It is the job of the profession and professionals to work to reduce this loss
An Excellent Website: The Risks Digest

http://catless.ncl.ac.uk/Risks/

We will look at a couple of situations today

• More next time I teach you
Failures and Errors in Computer Systems

Most common high-level causes of computer-system failures

• Lack of clear, well thought out goals and specifications
• Poor management and poor communication among customers, designers, programmers, etc.
• Pressures that encourage unrealistically low bids, low budget requests, and underestimates of time requirements
• Use of very new technology, with unknown reliability and problems
• Refusal to recognize or admit a project is in trouble
Failures and Errors in Computer Systems 2

Most computer applications are so complex it is virtually impossible to produce programs with no errors
  • The cause of failure is often more than one factor

Computer professionals must study failures to
  • Learn how to avoid them
  • Understand the impacts of poor work
Denver Airport Fiasco

Baggage system failed due to real world problems, problems in other systems and software errors

Main causes:
• Time allowed for development was insufficient
• Denver made significant changes in specifications after the project began
The Therac-25

**Therac-25 Radiation Overdoses:**
- Massive overdoses of radiation were given; the machine said no dose had been administered at all
- Caused severe and painful injuries and the death of three patients
- Important to study this to avoid repeating errors
- Manufacturer, computer programmer, and hospitals/clinics all have some responsibility
The Therac-25 (cont.)

**Software and Design problems:**
- Re-used software from older systems, unaware of bugs in previous software
- Weaknesses in design of operator interface
- Inadequate test plan
- Bugs in software
  - Allowed beam to deploy when table not in proper position
  - Ignored changes and corrections operators made at console
Why So Many Incidents?

• Hospitals had never seen such massive overdoses before, were unsure of the cause

• Manufacturer said the machine could not have caused the overdoses and no other incidents had been reported (which was untrue)

• The manufacturer made changes to the turntable and claimed they had improved safety after the second accident.

  —The changes did not correct any of the causes identified later
The Therac-25 (cont.)

Why So Many Incidents? (cont.)

• Recommendations were made for further changes to enhance safety; the manufacturer did not implement them
• The FDA declared the machine defective after the fifth accident
• The sixth accident occurred while the FDA was negotiating with the manufacturer on what changes were needed
The Therac-25 (cont.)

Observations and Perspective:

- Minor design and implementation errors usually occur in complex systems
  — they are to be expected
- The problems in the Therac-25 case were not minor and suggest irresponsibility
- Accidents occurred on other radiation treatment equipment without computer controls when the technicians:
  — Left a patient after treatment started to attend a party
  — Did not properly measure the radioactive drugs
  — Confused micro-curies and milli-curies
Case Study: The Therac-25
Discussion Question

If you were a judge who had to assign responsibility in this case, how much responsibility would you assign to the programmer, the manufacturer, and the hospital or clinic using the machine?