INNOVATION and ENTREPRENEURSHIP in SOFTWARE ENGINEERING for a BIG DATA WORLD

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Software Engineering (uOttawa)

- First program in Canada (1997)
  - Used as a template for CEAB guidelines and the ACM/IEEE curriculum guidelines of 2004
- Fully bilingual 100% COOP (since 2014)
- Elected to the IEEE CSEE hall of fame in 2017 as leaders in the creation of software engineering programs (Carnegie Mellon – graduate, Rutgers – undergrad, uOttawa – undergrad)


- I was a “Customer” for the first SEG capstone project course as uOttawa (2000-2001)
- Part-time Prof for SEG capstone course 2001-2002
- Joined uOttawa in 2002 as a full-time professor
The Communication Revolution

- **We are at the **beginning** of a third communication revolution that is transforming our world!**
  - Electronic Digital Communication (~1960s, Internet, Satellites, Cellular)
  - Written Communication (~3600 BC, http://www.ancient.eu/timeline/writing/)
  - Oral Communication (maybe a million years ago? http://www.historyworld.net/wrldhis/PlainTextHistories.asp?historyid=ab13)

- **We are transitioning from the Industrial Age to the Information Age** (From People to Machines to Virtual)
  - **Industrial Age** (Automate)
    - mass production: standardization, **repeatable processes**
  - **Information Age** (“Informate” – Big Data)
    - mass customization: constant feedback, **constant change**
Our Big Data World

Shoshan Zuboff,

- the duality of information technology as an informating and an automating technology

  https://en.wikipedia.org/wiki/Shoshana_Zuboff

- Three Laws:

  Everything that can be automated will be **automated**.

  Everything that can be informated will be **informated**.

  Every digital application that can be used for surveillance and control will be used for **surveillance and control**.

- Big Data is a metaphor for the new reality of our world
Big Data – Original Technical Definition

- High Volume
  - Terabytes of data
  - Tables/Files
  - Distributed

- High Velocity
  - Batch
  - Real/near-time
  - Processes
  - Streams

3Vs of Big Data

- Structured
- Unstructured
- Semi-Structured

High Variety

Veracity

Value
My Current Favorite Definition of Big Data

7V’S FOR BIG DATA SUCCESS

Technical: Focus on automating

Organizational: Focused on informating

Transformational Change

Vision

- See article by Vit Soupal at https://www.linkedin.com/pulse/7vs-successful-big-data-project-vit-soupal
- **Variability (constant change) from abstract for talk was replaced by Vision! 😊**
Software Engineering

- Different from Engineering Disciplines? (Traditional vs Modern)
  - Exploratory vs Manufacturing Processes
  - Immersive (New “natural” environment where we work, live and play)
  - Physical vs Virtual (Physical => Signal => Symbol <= Image <= Cognition)
  - Model-Driven versus Model Described
  - Disruptive Complexity

- Different from Computer Science, Information Technology? (Culture)
  - User Driven vs Algorithm or Tool Driven
  - Project Size (Team Size, Lines of Code)
  - System Focus (Business, Government, Societal Considerations)
  - Requirements, Quality Assurance, Design, Project Management
  - Disruptive Complexity
SEG Curriculum – No Change to Core 2005-2015

- **1st year**
  - Intro to Computing, Maths, Digital Logic, Sciences, Technical Writing

- **2nd year**
  - **Intro to Software Engineering** - Model-Driven, UML, Petri Nets, Parsers,
  - Data Structures, Databases, Computer Architecture, Professional Ethics

- **3rd Year**
  - Requirements, Quality Assurance, Design, User Interfaces
  - Operating Systems, Analysis of Algorithms, Networks & Data Communications

- **4th Year**
  - Project Management, Real-Time Embedded Systems
  - Capstone Project ***

- **Culture**: Emphasis on iterative development, teamwork and projects

- **Evolution**: mobile apps, cloud computing, agile process, tools and frameworks
## Needed to keep pace with Rapidly Changing Technology

<table>
<thead>
<tr>
<th>2005</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich Client PC</td>
<td>Sensors, Watches, Phones, Tablets, Raspberry Pie, Arduino</td>
</tr>
<tr>
<td>Thin Client Web Applications</td>
<td>AJAX, Web Services, Cloud VMs, Cloud Apps, SDN, CMS</td>
</tr>
<tr>
<td>HTML, JSP, PHP, ASP</td>
<td>Many, Many Frameworks</td>
</tr>
<tr>
<td>Single language</td>
<td>Multi-Language</td>
</tr>
<tr>
<td>Java, C/C++/C#, VB</td>
<td>Python, Scala, Go, Javascript,…</td>
</tr>
<tr>
<td>SQL Databases</td>
<td>ORM, NoSQL, OLAP</td>
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<tr>
<td></td>
<td>data/text mining, BI, Dashboards</td>
</tr>
<tr>
<td>Build Scripts (ANT, Make)</td>
<td>Continuous Integration (dozens), Virtualization</td>
</tr>
<tr>
<td>CVS Server</td>
<td>Cloud Hosted Dev Environments (dozens)</td>
</tr>
<tr>
<td>Junit, Test Automation</td>
<td>Dozens for every language and/or framework</td>
</tr>
<tr>
<td>RUP, XP</td>
<td>SCRUM, Super Agile (Jira, ICEScrum, …dozens)</td>
</tr>
<tr>
<td></td>
<td>App Stores</td>
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<tr>
<td></td>
<td>Social Media (facebook, twitter, etc)</td>
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<tr>
<td></td>
<td>Google (Search, maps, analytics, …)</td>
</tr>
<tr>
<td></td>
<td>Ecommerce (Paypal, Stripes …)</td>
</tr>
</tbody>
</table>
Entrepreneurial Principles

- Engineer/Create/Discover the **compelling user experience** that defines the fundamental value proposition of the project
- **Build scenarios and real customer data** that fully define this experience for verification and validation
- **Quantify Quality** – with comprehensive test report
- **Test, code, design**
- Iterate quickly and continuously in order of **highest risk and highest value first**
- **Constantly re-evaluate priorities with a focus on fundamental value proposition**
- **Stay current** with latest tools and technologies and techniques
- **Communicate** effectively and continuously
Agile Methodologies – Manage Project Noise Level

Scrum

Far from Agreement

Close to Agreement

Close to Certainty

Far from Certainty

Requirements

Technology

Simple

Complicated

Complex

Anarchy

Source: Strategic Management and Organizational Dynamics by Ralph Stacey in Agile Software Development with Scrum by Ken Schwaber and Mike Beedle.
SCRUM Overview

- Product Backlog
- Sprint Backlog
- Daily Scrum Meeting
- 24 Hours
- 2-4 Weeks
- Potentially Shippable Product Increment

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**The Gap**

- Students **with work experience** thrived
  - Current and eager to learn latest technologies and innovations
  - Easily mentored

- Students **without work experience** struggled … and it was **too late to fix the lack of**:
  - teamwork
  - agility
  - value-creation
  - communication skills
  - professionalism
  - self-directed learning

- **Need to understand how to manage complexity, constant change, and the exploratory nature of software**
  - Fail early, fail often … (fail cheap, learn and adapt quickly)
Changes to the SEG Program since 2014

- **SESA (Software Engineering Student Association)**
  - Industry/Alumni collaboration/events; hackathons; workshops; “courses”
  - Professional Culture of networking (jobs) and mentoring (courses, interviews)

- **100% COOP**
  - 2 terms of work experience before starting CAPSTONE
  - 3-6 work terms (up to 3 count as electives for course credit of 3 units each)

- **SEG2900 Professional Communication & Responsibility (1st semester)**
  - CULTURE, Team work, Self-directed learning (no lectures), Github, Web Programming
  - Pitch Competition + resume, interview, communication skills / attitude mentoring
  - Tas are 4th year SEG coop students or recent graduates (Masters students)

- **SEG3904 Innovation Research Project**
  - PEng Professor and SEG Coordinator approve project proposal and provide grade
  - 135 hours self study; clearly identified tasks and deliverables (grade breakdown)
Thank You!