Involving Software Engineering Students in Learning and Implementing Software Engineering Standards

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Project Editor of ISO/IEC 29110 Standards for Very Small Entities

World Standards Cooperation - Academic Day - Panel
Links between university education about standardization and initiatives to engage graduate students
August 15th 2014, Ottawa, Canada
Over 7,600 students, 161 professors, 25 general senior lecturers

About 2,400 paid industrial internships in over 800 companies each year (about 11,000 $ per internship)

Undergraduate Programs
- Software Engineering
- IT Engineering
- Construction Engineering
- Production Engineering
- Electrical Engineering
- Mechanical Engineering
- Logistics and Operations Engineering

Graduate Programs
- Software Engineering
- Information Technology
- Other programs

700 students
21 Professors in the department have a mean industrial experience of 10 years
... studies have shown that software specialists spend about 40 to 50 percent of their time on avoidable rework rather than on what they call value-added work, which is basically work that’s done right the first time ...

Laws of Nature

**Hooke’s Law**
\[ \sigma = E \cdot \varepsilon \]

**Newton’s Law**
\[ x(t) = \frac{1}{2} a \cdot t^2 + v_0 \cdot t + x_0 \]

**Ohm’s Law**
\[ V = RI \]

**Boyle-Mariotte’s Law**
\[ p_1 x V_1 = p_2 x V_2 \]

**Gravitational Law**
\[ \vec{F}_{A\rightarrow B} = -G \frac{M_A M_B}{AB^2} \vec{u}_{AB} \]

**Curie’s Law**
\[ E = -\vec{\mu} \cdot \vec{B} \]

**Coulomb’s Law**
\[ F_{12} = \frac{q_1 q_2}{4\pi \varepsilon_0} \frac{r_2 - r_1}{|r_2 - r_1|^3} \]

**Refraction Law**
\[ \eta_1 \cdot \sin(\theta_1) = \eta_2 \cdot \sin(\theta_2) \]
What is a Standard?

‘Set of mandatory requirements established by consensus and maintained by a recognized body to prescribe a disciplined uniform approach or specify a product, that is, mandatory conventions and practices.’ (ISO/IEC/IEEE 24765)
‘What to Do’ Versus ‘How to Do’

• Most standards describe ‘What to Do’
  – e.g. develop a ‘Project Plan’

• Students need documents describing ‘How to Do’
  – e.g. description of tasks, inputs, outputs, roles, content of documents, etc.

<table>
<thead>
<tr>
<th>Role</th>
<th>Task List</th>
<th>Input Products</th>
<th>Output Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM TL</td>
<td><strong>PM.1.1</strong> Review the Statement of Work</td>
<td>Statement of Work</td>
<td>Statement of Work [reviewed]</td>
</tr>
<tr>
<td>PM CUS</td>
<td><strong>PM.1.2</strong> Define with the Customer the Delivery Instructions of each one of the deliverables specified in the Statement of Work.</td>
<td>Statement of Work [reviewed]</td>
<td>Delivery Instructions</td>
</tr>
</tbody>
</table>

ISO/IEC 29110
An Approach to Involve Software Engineering Graduate Students

• Software Quality Assurance and Process Improvement Courses
  – Teams, of 3-4 students, perform an intervention in an organisation (e.g. enterprise, government, not-for-profit)
    1. Identify, with organisational manager, an opportunity for improvement
    2. Perform a short diagnostic using a known framework (e.g. an ISO standard)
    3. Select the software engineering practices to be implemented
    4. Document the new/modified software engineering practices
    5. Perform a short pilot project to test the practices
    6. Provide recommendations to organisational manager
    7. Perform a lessons learned of the intervention
Standards Presented in the SQA Course

- ISO/IEC/IEEE 24765 (Systems and software engineering - Vocabulary)
- ISO/IEC/IEEE 12207 (Systems and software engineering - Software life cycle processes)
- ISO/IEC 25000 (Software engineering - Software product Quality Requirements and Evaluation (SQuaRE) - Guide to SQuaRE)
- ISO/IEC/IEEE 16085 (Systems and software engineering - Life cycle processes - Risk management)
- ISO 9001 (Quality management systems - Requirements)
- ISO/IEC 29110 (Systems and software engineering - Life cycle profiles for Very Small Entities (i.e. enterprises, organisations having up to 25 people))
- ISO/IEC 90003 (Software engineering - Guidelines for the application of ISO 9001:2000 to computer software)
- ISO/IEC/IEEE 15939 (Systems and software engineering - Measurement process)
- ISO/IEC/IEEE 15289 (Systems and software engineering - Content of life cycle information products (documentation))
Size of Enterprises

- European Union
  - 92% are micro enterprises (less than 10 employees)
- Micro enterprises account for 70% to 90% of enterprises in OECD* countries (about 57% in USA)
- Greater Montréal Area - Software Enterprises

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of Software Enterprises</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 25</td>
<td>540</td>
<td>78%</td>
</tr>
<tr>
<td>25 to 100</td>
<td>127</td>
<td>18%</td>
</tr>
<tr>
<td>Over 100</td>
<td>26</td>
<td>4%</td>
</tr>
</tbody>
</table>

About 50% of enterprises have less than 10 employees

Source: Montreal International, 2006

* OECD: Organisation for Economic Co-operation and Development
ISO/IEC 29110 Standards and Guides
For Very Small Entities (VSEs)

- **Entry** - Targets VSEs typically developing 6 person-month projects or start-ups;
- **Basic** - Targets VSEs developing only one project at a time;
- **Intermediate** – Targets VSEs developing multiple projects within the organizational context;
- **Advanced** – Targets VSEs which want to sustain and grow as an independent competitive software development business.

VSEs = Very Small Entities are enterprises, projects or departments having up to 25 people.
Standards and Guides for VSEs in systems and/or software engineering
ISO/IEC 29110 Software Management and Engineering Guide

Customer
- Statement of Work
- Software Configuration

Project Management Process
- Planning
- Evaluation
- Execution
- Closure

Organizational Management

Software Implementation Process
- Initiation
- Analysis
- Design
- Construction
- Integration and tests
- Delivery

Available at no cost from ISO at: http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html
Available in English, French, Spanish, Portuguese

Adapted from (Varkoi 2010)
Some Application of ISO/IEC 29110 in Organisations by Graduate Students

- **Engineering Company**
  - Organisation of 500 employees
  - Developed processes for small and medium scale projects (4-8 people)

- **IT Start-up of 2 People**
  - Developed a web application
  - Project of about 1,000 hours with 13% rework

- **Support Organisation for Notaries**
  - Supports 3,2000 notaries
  - Organisation of 70 people
  - IT staff of 8

- **Geographic Information System Modeling Company**
  - Modeling and mapping software and technology
  - Organisation of 1000 employees
  - IT staff of 6 in Montréal
Countries Teaching ISO/IEC 29110 at the Undergraduate and/or Graduate Levels

- Argentina
- Belgium
- Brazil
- Canada
- Czech Republic
- Finland
- Germany
- Haiti
- Ireland
- Japan
- Mexico
- Peru
- Thailand
- Uruguay
Conclusion

• Graduate students can learn, apply and recommend improvements to software engineering (SW) standards
  • If SW standards are understandable and usable by them
  • Freely available documents are highly desirable in academia
• Most countries have a majority of very small organisations
• ISO/IEC 29110 is specifically developed for entities having up to 25 people
• Many countries are teaching, using the freely available ISO/IEC 29110 documents, at the graduate and/or undergraduate levels

A Systems Engineering ISO/IEC TR 29110 is now available from ISO
Thank You
Contact Information

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