Software Process Improvement and Management:
Approaches and Tools for Practical Development

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Chapter 3
The Development of International Standards to Facilitate Process Improvements for Very Small Entities

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ABSTRACT
Industry recognizes that Very Small Entities (VSEs) that develop software are very important to the economy. A Very Small Entity (VSE) is an entity (enterprise, organization, department or project) with up to 25 people. Failure to deliver a quality product on time and within budget threatens the competitiveness of VSEs and impacts their customers. One way to mitigate these risks is to put in place proven software engineering practices. Many international standards and models, like ISO/IEC 12207 or CMMI®1, have been developed to capture proven engineering practices. However, these documents were not designed for VSEs and are often difficult to apply in such settings. This chapter presents a description of the development of process improvement international standards (IS) targeting VSEs developing or maintaining software as a standalone product or software as a component of a system. The documents used by ISO/IEC JTC1/SC72 Working Group 24 (WG24), mandated to develop a set of standards and guides, and the approach that led to the development, balloting of the ISs, and TRs (Technical Reports) for VSEs are also presented. The chapter focuses on the ISO/IEC 29110 Standard3, the development of means to help VSEs improve their processes, and the description of a few pilot projects conducted to implement the processes of ISO/IEC 29110 standard.

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INTRODUCTION

Most software engineering centers, such as the Software Engineering Institute (SEI), dedicate a large portion of their resources to large organizations. Even though there seems to be an awareness of the needs of Very Small Entities (VSEs), a VSE is an entity (enterprise, organization, department or project) with up to 25 people, published software engineering practices are still for the most part difficult to use by organizations with up to 25 people. A few centers around the world are focusing their Software Process Improvement (SPI) activities on small enterprises and VSEs. Some centers and initiatives and their accomplishments in helping VSEs are discussed in (Laporte, Alexandre, & O’Connor, 2008; Laporte, Alexandre, & Renault, 2008; Oktaba et al., 2007; Laporte, April, & Renault, 2005; Habra, Alexandre, Desharnais, Laporte, & Renault, 2008).

Since a standard from the International Organization for Standardization (ISO) dedicated to software life cycle processes was already available, i.e. ISO/IEC 12207 (ISO/IEC 12207, 2008), WG24 decided to use the concept of the ISO Standardized Profile (SP) to develop the new standards for VSEs. A profile is defined as “a set of one or more base standards and/or SPs, and, where applicable, the identification of chosen classes, conforming subsets, options and parameters of those base standards, or SPs necessary to accomplish a particular function” (ISO/IEC TR 10000-1, 1998). From a practical point of view, a profile is a matrix that identifies the elements that are taken from existing standards from those that are not to produce a Standardized Profile. The overall approach followed by WG24 to develop this standard for VSEs consisted of six steps:

- Select, from existing standards, process subsets applicable to VSEs;
- Develop a roadmap to help VSE grow their capabilities;
- Tailor the subset to fit VSE needs;
- Develop International Standard (ISs) and Technical Report (TRs);
- Produce guides which are easy to understand, affordable, and usable by VSEs;
- Develop means to accelerate the adoption and implementation of the ISs and TRs.

In the next section, the standards that have been used by WG24 to develop the ISs and TRs for VSEs are described.

STANDARDS USED TO DEVELOP STANDARDS FOR VSES

ISO/IEC 12207–Software Life Cycle Processes

ISO/IEC 12207 establishes a framework for software life cycle processes and terminology: “It applies to the acquisition of systems and software products and services, to the supply, development, operation, maintenance, and disposal of software products and the software portion of a system, whether performed internally or externally to an organization” (ISO/IEC 12207, 2008). This standard defines two sets of processes (see Figure 1): in one of these, called Software Specific Processes, the final product is a standalone software product or service, and in another, called System Context Processes, the software is part of a larger system. Since most modern systems are controlled by software, this standard has been updated in 2008 to ‘interface’ with the equivalent standard at the systems engineering level: ISO/IEC 15288:2008 Systems engineering – Systems life cycle processes (ISO/IEC 15288, 2008).

Each ISO 12207 process is described in terms of the following attributes, as defined in ISO TR 24774 (ISO/IEC TR 24774, 2010):

- A title, which conveys the scope of the process as a whole. The title of a process is a
short noun phrase intended to summarize the scope of the process.

- A purpose, which describes the goals of the process.
- A set of outcomes, which expresses what is expected from the execution of the process. An outcome is an observable result of the successful achievement of the process purpose.
- A set of activities, which is a list of actions that may be used to achieve the outcomes. Each activity may be further elaborated as a grouping of related lower-level actions (e.g. a task)
- A set of tasks, which is a list of specific actions that may be performed to achieve an activity. Multiple related tasks are often grouped within an activity.

To illustrate the structure and content of the ISO 12207 standard, the software configuration management process is used as an example (see Figure 2).

As has been explained previously, such a high-level description of a ISO 12207 process is almost useless to most VSEs, since these organizations do not have the expertise, the budget to hire an external consultant or the time to transform the processes of ISO 12207 into a set of usable processes.
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ISO/IEC 15289—Content of Systems and Software Life Cycle Process Information Products (Documentation)

This standard is a companion standard to ISO 12207. It is used to identify and plan the information items to be produced during a project. It describes the information content of different types of documents, such as a record or a plan. Table 1 lists the different types of documents described in the ISO 15289 standard (ISO/IEC 15289, 2006).

Since most VSEs are not prone to documenting their project activities, and since most practitioners do not like to produce documentation, we can hardly expect them to develop a set of templates which describes the content and format of documents produced during a project.

In a section below, we will describe a new type of document, called Deployment Package (DP), designed to help VSEs implement some ISO 12207 processes and produce useful project documentation.

A Mexican National Standard, MoProSoft

A Mexican standard has been developed with three levels of decisions in mind, as illustrated in Figure 3: the decisions made by top-level management, those made by middle management, and those made by the people who develop projects.

Processes are grouped into three categories: Top Management, Middle management, and Operations (adapted from (NMX-059-NYCE, 2005)):
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Table 1. Life cycle product types (adapted from ISO/IEC 15289, 2006)

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Sample of recommended output information types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record</td>
<td>Characterized the data retained by an organizational entity</td>
<td>Configuration record, Problem record</td>
</tr>
<tr>
<td>Description</td>
<td>Represents a planned or actual function, design, or item</td>
<td>High level software design description</td>
</tr>
<tr>
<td>Plan</td>
<td>Define when how, and by whom specific activities or tasks, including tools needed</td>
<td>Project management plan</td>
</tr>
<tr>
<td>Procedure</td>
<td>Define in detail when and how to perform certain activities or tasks, including tools needed</td>
<td>Problem resolution procedure</td>
</tr>
<tr>
<td>Report</td>
<td>Describe the results of activities such as investigations, assessment, and tests</td>
<td>Problem report, Validation report</td>
</tr>
<tr>
<td>Request</td>
<td>Record information needed to solicit a response</td>
<td>Change request</td>
</tr>
<tr>
<td>Specificiation</td>
<td>Specify a required function, performance or process (such as, requirements specification, standard, policy)</td>
<td>Software requirement specification</td>
</tr>
</tbody>
</table>

Figure 3. MoProSoft’s process categories (Oktaba et al., 2007)

- **Top management.** Members in this category are concerned with business-management practices, and receive and direct reports from middle management.

- **Middle management.** Members in this category deal with process-, project-, and resource management practices in line with top management’s business goals. They provide elements for the performance of
operations processes receive and evaluate the information those processes generate, and inform top management of the results. The resource management process includes three sub processes: human resources and work environment; goods, services, and infrastructure; and knowledge of the organization.

• **Operations.** Members in this category address the practices of software-development and -maintenance projects. They perform activities using elements provided by management, and deliver reports and the software products generated.

The approach used by WG24 to develop a set of international standards and technical reports is described in the next section.

**THE APPROACH USED BY WG24**

Since WG24 wanted to prepare an initial set of standards as quickly as possible, WG24 analyzed international reference standards and models that could help subset ISO 12207 for VSEs. To create these initial products quickly, WG24 began a search for existing standards or models that could be tailored or adapted to the needs of VSEs. The MoProSoft standard (NMX-059-NYCE, 2005), developed to assist small and medium-sized enterprises (SMEs), was selected to achieve this objective.

WG24 decided to use the notion of the profile to develop standards to meet the needs of VSEs. A profile is a grouping of one or more base standards to accomplish a particular function. The notion of the profile was selected for the following reasons (adapted from (ISO/IEC 29110-2, 2011))

• Standards generally target large enterprises, making initial compliance difficult for VSEs;

• Preparing profiles with progressive capability levels enables a stepwise approach to full compliance;

• SE Standards are generally large, and specify many elements that are not necessarily applicable to VSEs;

• Preparing profiles that subset the base standards facilitates the match between the standards and the targeted VSEs;

• Since the ISO standards do not necessarily cover all the topics needed, profiles can be used to integrate required elements not yet in the ISO standards catalog.

To assemble profiles, WG24 used two types of standards:

• Process standards, such as ISO 12207, which define the activities required to achieve identified objectives or outcomes;

• Product standards, such as ISO 15289, which define the structure and content of artifacts produced by the processes.

WG24 defined the scope of the life cycle processes described in the set of ISs and TRs as follows (adapted from (ISO/IEC 29110-2, 2011): they were not intended to preclude or discourage their use by organizations larger than VSEs. Certain issues faced by larger organizations may not be covered by this set of ISs. The life cycle processes can be used by VSEs when acquiring and using, as well as when creating and supplying, a software system. They can be applied at any level in a software system’s structure and at any stage in the life cycle. The processes described were not intended to preclude or discourage the use of additional processes that VSEs find useful. ISO/IEC 29110 standard is not intended to preclude the use of different lifecycles such as: waterfall, iterative, incremental, evolutionary or agile.
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Specification of a Standardized Profile

A standardized profile (SP) includes the following (adapted from (ISO/IEC 29110-2, 2011)):

- The profile element identification and composition part, which identifies elements in the profile, as listed in Figure 4.

- The profile element relationship specification tables: when a profile contains the specification for a relationship between two elements; for instance, if activity A produces work product W, this relationship is specified by the identification of each element, as described above, separated by a relationship type.

- Profile Relationship Type: the relationship is expressed by a meaningful abbreviation; for instance, INP for uses as input.

- The source document reference table identifies which elements in the source documents have been selected to be part of the profile. These tables are created by adding the columns to the tables specified in the two previous clauses, as described in Figure 5.

When a profile has selected both informative and normative elements from the source documents, then these must be clearly identified to facilitate conformance evaluation and assessment. An example of the application of these specifications is provided in a later section.

Conformance to a Standardized Profile

The purpose of a standardized profile (SP) is to specify the use of sets of specifications to provide clearly defined functionality. Hence, conformance to an ISO 29110 SP always implies conformance...
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to the referenced base standards specifications, if it is referenced in its entirety in the profile. Conformance is specified within each SP published as a separate document, called Part 4. SPs are pre-tailored packages of related software engineering standards, therefore:

- Tailoring of ISO/IEC 29110 profiles is not needed nor allowed;
- Partial compliance is not allowed (except in one case);
- There are no levels of conformance.

It is acceptable for an implementation to incorporate functionality beyond what is defined in the specification of the profile. This is called an extension. If a profile allows extensions, each implementation shall fully support all the required functionality of the profile specification exactly as specified, and the extensions shall neither contradict the functionality defined in the profile specification, nor cause its non-conformance.

Generic Profile Group

WG24 decided to develop an initial profile group, titled Generic Profile Group (GPG). A profile group (PG) is defined as a collection of profiles related either by composition of processes (i.e. activities, tasks), or by capability level, or both. A GPG contains profiles which are applicable to a vast majority of VSEs that do not develop critical software and which are characterized by typical situational factors. Critical software is defined as software whose failure could have an impact on safety, or could cause major financial or social losses (IEEE Std 610.12, 1990). Membership in this PG does not imply any specific application domain; however, it is envisaged that new domain-specific profiles, such as the medical domain, may be developed in the future (Laporte, 2009)

WG24 decided to develop a set of four profiles for the GPG to provide VSEs with a roadmap to improve their processes and their capabilities. The following profiles have been defined: Entry, Basic, Intermediate, and Advanced. In the next section, the Basic Profile, which was developed first, is presented. The Entry profile, which has been developed using the Basic profile, is presented in a subsequent section.

OVERVIEW OF THE BASIC PROFILE AND ITS DEVELOPMENT

The purpose of the Basic Profile is to define software implementation and project management elements for a subset of processes and outcomes of ISO12207 and ISO15289 products, appropriate for a set of common VSE characteristics. The main reason to include project management is that the core business of VSEs is software development, and their financial success depends on successful project completion within schedule and on budget, as well as on making a profit. The Basic Profile describes the development of a single software application by a single project team with no special risk or situational factors. The project may be to fulfill an external or internal contract. This profile drew on sections from the following standards:


The preparation of the Basic Profile followed these five steps, as illustrated in Figure 6:

- The recognition of VSE characteristics related to: finance, resources, customer interface, internal business processes, learning, and growth.
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Figure 6. Basic VSE profile preparation steps (ISO/IEC 29110-4-1, 2011)

- The identification of VSE needs and suggested competencies that derive from those characteristics.
- The specification of the Basic Profile elements proper to respond to the VSE needs and suggested competencies, according to the ISO/IEC 29110-2 Lifecycle profiles for Very Small Entities (VSEs): Framework and Taxonomy (described below).
- The selection and link of the subset of the Basic Profile elements that map to the ISO/IEC 12207 processes and outcomes elements and ISO/IEC 15289 product elements related to the Basic VSE Profile elements.

The diagram is to be interpreted as follows: the rectangle represents the VSE elements; the ellipse represents standards or subsets of its elements; solid arrow is a labelled relation; and circle with a dashed arrow is a number of the preparation step.

In the next section, the authors describe the set of ISO/IEC 29110 documents developed for the GPG and the Basic Profile. Then, a detailed description of the Basic Profile is presented.

DESCRIPTION OF THE SET OF ISO/IEC 29110 DOCUMENTS TARGETED BY AUDIENCE

A set of documents, targeted by audience, has been developed to improve product, service quality, and process performance (see Table 2).

If a new profile is needed, ISO/IEC 29110-4 and ISO/IEC 29110-5 can be developed without impacting existing documents, becoming ISO/IEC 29110-4-m and ISO/IEC 29110-5-m-n respectively through the ISO/IEC process. Figure 7 describes the ISO/IEC 29110 series and positions the parts within the framework of reference. Overviews and guides are published as Technical
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Table 2. ISO/IEC 29110 target audience (ISO/IEC 29110-5-1-2, 2011)

<table>
<thead>
<tr>
<th>ISO / IEC 29110</th>
<th>Title</th>
<th>Target audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>Overview</td>
<td>VSEs</td>
</tr>
<tr>
<td>Part 2</td>
<td>Framework and taxonomy</td>
<td>Standards producers, tool vendors and methodology vendors. Not intended for VSEs</td>
</tr>
<tr>
<td>Part 3</td>
<td>Assessment guide</td>
<td>Assessors and VSEs</td>
</tr>
<tr>
<td>Part 4</td>
<td>Profile specifications</td>
<td>Standards producers, tool vendors and methodology vendors. Not intended for VSEs</td>
</tr>
<tr>
<td>Part 5</td>
<td>Management and engineering guide</td>
<td>VSEs</td>
</tr>
</tbody>
</table>

Reports (TRs), and profiles are published as International Standards (ISs).

**Request to Make the ISO/IEC 29110 Technical Reports Freely Available**

One of the requirements collected from the international survey was as follow: the guides should be available free of charge on the Web. In 2009, the Editor of WG24 made such a request to ISO. The request was approved at the ISO Joint Technical Committee 1 Plenary meeting in Israel and forwarded to ISO for final approval. The request has since been approved. By making the most useful documents to VSEs freely available, it means that not only the VSEs will have a free access

Figure 7. Set of ISO/IEC 29110 documents targeted by audience (ISO/IEC TR 29110-5-1-2, 2011)
to these documents but people from academia too. Academia will have access to documents to allow them to prepare teaching material and use them in class. The ISO/IEC 29110 technical reports are available at no cost from ISO at: http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html

The Overview Document

The first document, titled Overview, is an ISO TR. It introduces the major concepts required to understand and use the suite of documents. It introduces the business aspects, characteristics, and requirements of VSEs, and clarifies the rationale for VSE-specific profiles, documents, standards, and guides. It also introduces life cycle concepts, improvement, capability and assessment concepts, standardization concepts, and the ISO 29110 set of documents. It targets both a general audience interested in the set of documents and, more specifically, users of the set of documents. The Overview is identified as a TR as follows: ISO/IEC TR 29110-1–Life cycle profiles for Very Small Entities (VSEs)–Part 1: Overview.

The Standardized Profile Documents

The second set of documents consists of two ISO standards. Preparing standardized profiles is a process involving the production of two types of documents, a framework and taxonomy, and a profile specification:

- **Framework and Taxonomy**—The Framework and taxonomy document establishes the logic behind the definition and application of profiles. It specifies the elements common to all standardized profiles (structure, conformance, assessment) and introduces the taxonomy (catalog) of ISO 29110 profiles. It targets authors and reviewers of SPs, authors of other document parts, as well as the authors of other VSE-targeted profiles. The Framework and Taxonomy is applicable to all profiles and is identified as follows: ISO/IEC 29110-2 Software engineering–Life cycle profiles for Very Small Entities (VSEs)–Part 2: Framework and taxonomy.

- **Profile Specifications**—There is a profile specification document for each profile. Its purpose is to provide the definitive composition of a profile, provide normative links to the normative subset of standards (e.g. ISO/IEC 12207) used in the profile, and provide informative links (references) to input documents. It targets the authors/providers of guides and the authors/providers of tools and other support material. There is one profile specification document for each profile, identified as ISO 29110-4-m, where m is the number assigned to the profile. The profile specification for the Basic Profile is identified as follows: ISO/IEC 29110-4-1 Software engineering–Life cycle profiles for Very Small Entities (VSEs)–Part 4-1: Profile specifications: Generic profile group.

The Assessment and the Engineering and Management Guides

The third set of documents entitled Guides, are ISO TRs. They contain implementation guidelines (domain-specific) on how to perform the processes to achieve the maturity levels (e.g. recommended activities, measures, techniques, templates, models, methods). Guides are developed for process implementation and for assessment based on the domain’s issues, business practices, and risks. Guides target VSEs, and should be VSE-accessible, both in terms of style and cost. There are two guides, an assessment guide and a management and engineering guide:
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- **Assessment Guide**—This guide describes the process to follow to perform an assessment to determine process capabilities and organizational process maturity, that is, when an organization wants an assessment carried out in order to obtain a process capability profile of the processes implemented, as well as an organizational process maturity level assigned to it. It is also applicable to the situation where a customer asks for a third-party assessment in order to obtain a capability level profile of the process implemented by the software development and maintenance provider. It is also suitable for self-assessment. The Assessment Guide is applicable to all profiles and is identified as follows: ISO/IEC TR 29110-3–Software engineering - Life cycle profiles for Very Small Entities (VSEs)–Part 3: Assessment Guide.

- **Management and Engineering Guide**—The management and engineering guides provide guidance on process implementation and the use of a profile. It targets VSEs (management and technical staff), VSE-related organizations (technology transfer centers, government industry ministries, national standards, consortia and associations, academic use for training, authors of derived products (software, courseware, and acquirers and suppliers. There is one management and engineering guide document for each profile, identified as ISO 29110-5.X, where x is the number assigned to the profile. This number matches the number assigned to the profile specification. The management and engineering guide for the Basic Profile is identified as follows: ISO/IEC TR 29110-5-1-2 Software engineering–Life cycle profiles for Very Small Entities (VSEs)–Part 5-1-2: Management and Engineering Guide: Generic profile group: Basic Profile.

The final step of the approach consisted of developing guidelines explaining the processes defined in the profile in more detail. At the Moscow meeting, the authors proposed the development of a series of deployment packages as additional guidelines. A deployment package (DP) is a set of artifacts developed to facilitate the adoption and implementation of a set of practices of the selected framework in a VSE. The table of contents of a DP is illustrated in Figure 8.

Table 3 shows the list of DPs developed to date for the Basic Profile and the developing partners. These DPs are freely available, as Microsoft Word documents, on the Internet8 (Laporte, 2010).

### Implementation Guides

In addition to the DPs, a set of “Implementation Guides” have been developed. The guides explain, step-by-step, how to help implement a specific process supported by a specific tool. The guides are also freely available from (Laporte, 2010).

- **Version Control with CVS or with SVN**
- **Project Management with GForge**

<table>
<thead>
<tr>
<th>Deployment Package Title</th>
<th>Developed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement Analysis</td>
<td>Belgium, Canada</td>
</tr>
<tr>
<td>Architecture and Detailed Design</td>
<td>Canada</td>
</tr>
<tr>
<td>Construction and Unit Testing</td>
<td>Mexico</td>
</tr>
<tr>
<td>Integration and Test</td>
<td>Columbia</td>
</tr>
<tr>
<td>Verification and Validation</td>
<td>Canada</td>
</tr>
<tr>
<td>Version Control</td>
<td>Thailand</td>
</tr>
<tr>
<td>Project Management</td>
<td>Ireland</td>
</tr>
<tr>
<td>Product Delivery</td>
<td>Canada, Thailand</td>
</tr>
<tr>
<td>Self-Assessment</td>
<td>Finland</td>
</tr>
</tbody>
</table>
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Figure 8. Table of contents of a deployment package (ISO/IEC TR 29110-5-1-2, 2011)

1. Introduction
   Purpose of this document
   Key definitions

2. Why this topic is important

3. Overview of the main tasks
   3.1 Tasks
   3.2 Roles and artefacts
   3.3 Activity life cycle and examples of lifecycles

Appendix A Templates
Appendix B Checklists
Appendix C Coverage Matrices (ISO 12207, ISO 9001, CMMI)
Appendix D Tools
Appendix E Training Material
Appendix F Deployment Package Evaluation Form

- Issue tracking with GForge
- Software Process Improvement with OpenOffice Calc

DETAILED DESCRIPTION OF THE BASIC PROFILE

VSEs are subject to a number of characteristics, needs, and desirable competencies that affect the content, nature, and extent of their activities. The Basic Profile addresses the VSEs that are described through the following characteristics, needs, and desirable competencies, classified into four categories: Finance and Resources, Customer Interface, Internal Business Processes, and Learning and Growth. The four categories and their needs and desirable competencies are as follows (ISO/IEC 29110-4-1, 2011):

Finance and Resources characteristics

- Small number of engineers (e.g. the cost of a payroll up to 25 people)
- Potential for short-term cash flow problems
- Low-budget projects, which last a few months and involve only a few people developing small products
- Dependent on successful project completion within schedule and budget
- Preference for separate projects to perform corrective post delivery maintenance
- Limited internal resources to perform management support and organizational processes like: risk management, training, quality management, process improvement, and reuse.

Needs and desirable competencies of the Finance and Resources characteristics:

- Projects carried out within budget and the product delivered on schedule
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• Close communication maintained with the customer to manage risks

Customer Interface characteristics:

• Usually one customer per project at a time
• Customer satisfaction dependent on:
• Fulfillment of specific requirements that may change during the project;
• Information received in a timely fashion during product development;
• Delivery on schedule;
• Low-level of defects found post-delivery; and
• Close communication and prompt response to any changes.
• Quantitative quality requirements not usually defined by customers
• A VSE usually not in charge of the management of the system, or of software integration, installation, or operation

Needs and desirable competencies for the customer interface characteristics:

• Fulfillment of customer requirements
• Management of changes to customer requirements during the project
• Provision of close communication and timely update information to the customer during product development
• Delivery of the product with a low level of defects

Internal Business Process characteristics

• The main process is designed to develop custom software systems written in-house on contract.
• The software product is elaborated progressively and has to be consistent with customer requirements.
• Products are developed or maintained through projects with a single line of communication between implementation group and customer.
• There are a small number of engineers (e.g. up to 25 people) in the organization, and therefore most of the communication, decision making, and problem resolution can be performed promptly, face-to-face.
• VSEs have lean project management budgets and conduct focused software implementation activities.
• The Infrastructure Management, Project Portfolio Management, and Human Resources Management Processes are performed through informal, face-to-face mechanisms.
• Products generated in projects are software items which may have more than one version and have to be saved and controlled.

Needs and desirable competencies for the Internal Business characteristics:

• Version control and storage of the products generated during a project
• Progressive elaboration of the software product, achieving consistency with customer requirements

Learning and Growth characteristics:

• Awareness of the importance of standards
• Lack of human resources to engage in standardization
• Lack of information of ISO/IEC standards
• Lack of knowledge of software process improvement and process evaluation

Needs and desirable competencies for the Learning and Growth characteristics:

• Guidelines which are flexible and easy to use for beginners on the adoption of practices of international standards focused on
Perform the projects within budget and deliver the product on schedule. To respond to this need and suggested competencies, Basic VSE Profile processes, objectives, and work products are the following:

**Project Management Process**
- **PM.O1.** The Project Plan for the execution of the project is developed according to the Statement of Work and validated with the Customer. The tasks and resources necessary to complete the work are sized and estimated.
- **PM.O2.** Progress of the project is monitored against the Project Plan and recorded in the Progress Status Record. Corrections to remedy problems and deviations from the plan are undertaken when project targets are not achieved. Appropriate treatment is applied to correct or avoid the impact of risk. Closure of the project is performed to obtain Customer acceptance, which is documented in the Acceptance Record.

**Software Implementation Process**
- **SI.O1.** Tasks of the activities are performed through the accomplishment of the current Project Plan.

Work Products: Statement of Work, Progress Status Record, Project Plan, Correction Register, and Acceptance Record.

Maintain close communication with the customer to manage risks. To respond to this need and suggested Competencies, the Basic VSE Profile processes, objectives, and work products are the following:

**Project Management Process**
- **PM.O5.** Risks are identified as they develop and during the conduct of the project.

Work Product: Project Plan.

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**Figure 10. Project management objectives (ISO/IEC 29110-4-1, 2011)**

- **PM.O1.** The Project Plan for the execution of the project is developed according to the Statement of Work and validated with the Customer. The tasks and resources necessary to complete the work are sized and estimated.
- **PM.O2.** Progress of the project is monitored against the Project Plan and recorded in the Progress Status Record. Corrections to remedy problems and deviations from the plan are undertaken when project targets are not achieved. Appropriate treatment is applied to correct or avoid the impact of risk. Closure of the project is performed to obtain Customer acceptance documented in the Acceptance Record.
- **PM.O3.** Change Requests are addressed through their reception and analysis. Changes to the software requirements are evaluated for cost, schedule, and technical impact.
- **PM.O4.** Review meetings with the Work Team and the Customer are held. Agreements are registered and tracked.
- **PM.O5.** Risks are identified as they develop and during the project.
- **PM.O6.** A software Version Control Strategy is developed. Items of Software Configuration are identified, defined, and baselined. Modifications and releases of the items are controlled and made available to the Customer and Work Team, including the storage, handling, and delivery of the items.
- **PM.O7.** Software Quality Assurance is performed to provide assurance that work products and processes comply with the Project Plan and Requirements Specification.
processes to support their software development projects needs

To use the Basic VSE Profile, it is assumed that the VSE fulfills the following entry conditions:

- Project contract or agreement with a statement of work
- Cost, technical, and schedule feasibility assessments performed before the start of the project
- Project work team, including project manager, assigned and trained
- Goods and infrastructure services available

Now that the characteristics of the Basic Profile have been defined, the next step consists of identifying the process elements, from the base standards, that will be used to define the Basic Profile specifications. To illustrate this step, Figure 9 lists the needs and suggested competencies derived from the finance and resources characteristics. In this figure, the acronym PM stands for project management and the acronym SI stands for software implementation.

Similar lists have been developed for the other characteristics, e.g. customer interface characteristics. The final list of the Basic Profile elements is composed of PM and SI processes with their corresponding objectives (identified as PM.O1, PM.O2, etc.; and SI.O1, SI.O2, etc.), and

Figure 11. Project management work products (ISO/IEC 29110-4-1, 2011)

- Statement of Work,
- Progress Status Record,
- Project Plan,
- Change Requests,
- Meeting Record,
- Correction Register,
- Verification Results,
- Validation Results Project Repository,
- Project Repository Backup
- Acceptance Record.

Figure 12. Software implementation objectives (ISO/IEC 29110-4-1, 2011)

- SI.O1. Tasks of the activities are performed through the accomplishment of the current Project Plan.
- SI.O2. Software requirements are defined, analyzed for correctness and testability, approved by the Customer, baselined, and communicated.
- SI.O3. Software architectural and detailed design are developed and baselined. Their software items and internal and external interfaces are described. Consistency and traceability to software requirements are established.
- SI.O4. Software components defined by the design are produced. Unit tests are defined and performed to verify their consistency with requirements and the design. Traceability to the requirements and design are established.
- SI.O5. Software is produced integrating software components and verified using Test Cases and Test Procedures. Results are recorded on the Test Report. Defects are corrected and consistency and traceability to Software Design are established.
- SI.O6. A Software Configuration that meets the Requirements Specifications as agreed with the Customer, which includes user, operation, and maintenance documentation, is integrated, baselined, and stored in the Project Repository. The need for change to the Software Configuration is detected and related Change Requests are initiated.
- SI.O7. Verification and Validation tasks of all required work products are performed using the defined criteria to achieve consistency among output and input products in each activity. Defects are identified and corrected; records are stored in Verification/Validation Results.
The Development of International Standards to Facilitate Process Improvements

The work products are listed below. The Project Management Objectives are listed in Figure 10. The Project management Work Products are listed in Figure 11. The Software Implementation Objectives are listed in Figure 12. The Software Implementation Work Products are listed in Figure 13.

**Basic Profile Specifications**

The Basic Profile specifications are a set of tables containing the information. The following tables are defined in clause 7 of ISO/IEC 29110 Part 4-1:

- A table for Process Specifications containing the following information:
  - Process definition and composition specification:
  - All processes are mandatory.
  - All activities are mandatory.
  - All tasks are optional.

  For illustration purposes, a subset of the table listing the Project Management Tasks is reproduced in Table 4.

- A table for Objective Specifications containing the following information:
  - Process objective specifications:
  - All objectives are required.

- A table for Work Product Specifications containing the following information:
  - Work product specifications:
  - All work products are required.

- A table for Input/Output Specifications containing the following information:
  - Activity input and output specifications:
  - All outputs are required.
  - All inputs are optional.

**Table 4. Subset of the table listing the project management tasks (ISO/IEC 29110-4-1, 2011)**

<table>
<thead>
<tr>
<th>Profile Process Identification and Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Conf. Lev</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>MAN</td>
</tr>
<tr>
<td>OPT</td>
</tr>
<tr>
<td>OPT</td>
</tr>
<tr>
<td>OPT</td>
</tr>
</tbody>
</table>
The Development of International Standards to Facilitate Process Improvements

Table 5. Source elements from ISO/IEC 12207 for the project management activities

<table>
<thead>
<tr>
<th>Source Element from ISO 12207</th>
<th>Project Management Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3.1</td>
<td>Project Planning</td>
</tr>
<tr>
<td>6.3.2</td>
<td>Project Assessment and Control</td>
</tr>
<tr>
<td>6.3.4</td>
<td>Risk Management</td>
</tr>
<tr>
<td>6.3.7</td>
<td>Measurement</td>
</tr>
<tr>
<td>6.4.8</td>
<td>Software Acceptance Support</td>
</tr>
<tr>
<td>7.1.2</td>
<td>Software Requirement Analysis</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Software Configuration Management</td>
</tr>
<tr>
<td>7.2.3</td>
<td>Software Quality Assurance</td>
</tr>
<tr>
<td>7.2.6</td>
<td>Software Review</td>
</tr>
</tbody>
</table>

Basic Profile Base Document References

The last step in the specification of a profile is the development of a set of tables referencing the base standard selected for the Basic Profile, the ISO/IEC 12207 and ISO/IEC 15289 standards. Table 5 lists the source elements from ISO 12207 which have been used as project management activities for this profile.

For illustration purposes, one table of ISO/IEC 29110 Part 4-1, for Project Management activities, is presented in Table 6.

Table 6. References for the project management activities (ISO/IEC 29110-4-1, 2011)

<table>
<thead>
<tr>
<th>Profile Process Identification and Composition</th>
<th>Process Source Document Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile Element Type</td>
<td>Profile Element ID</td>
</tr>
<tr>
<td>Activity</td>
<td>PM.1</td>
</tr>
</tbody>
</table>
The Development of International Standards to Facilitate Process Improvements

Figure 14. Basic profile process relationship (ISO/IEC TR 29110-5-1-2, 2011)

Table 7. Software requirements analysis tasks (ISO/IEC TR 29110-5-1-2, 2011)

<table>
<thead>
<tr>
<th>Identification of Task</th>
<th>Description of Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI.2.1</td>
<td>Assign tasks to the work team members in accordance with their role, based on the current Project Plan</td>
</tr>
<tr>
<td>SI.2.2</td>
<td>Document or Update in the Requirement Specifications</td>
</tr>
<tr>
<td>SI.2.3</td>
<td>Verify the Requirements Specifications</td>
</tr>
<tr>
<td>SI.2.4</td>
<td>Validate the Requirements Specifications</td>
</tr>
<tr>
<td>SI.2.5</td>
<td>Document the preliminary version of the Software User Documentation or update the present manual</td>
</tr>
<tr>
<td>SI.2.6</td>
<td>Verify the Software User Documentation</td>
</tr>
<tr>
<td>SI.2.7</td>
<td>Incorporate the Requirements Specifications and Software User Documentation into the Software Configuration in the baseline</td>
</tr>
</tbody>
</table>

and detailed design, software construction, and software integration and test, and product delivery activities. To remove a product’s defects, verification, validation, and test tasks are included in the activities workflow.

The customer provides a statement of work as an input to PM process and receives a software configuration as a result of SI process execution.

Description of the Project Management Process

The purpose of the Project Management process is to establish and carry out the tasks of the software implementation project in a systematic way, which allows compliance with the project’s objectives in terms of expected quality, time, and costs (see Figure 15).

Description of the Software Implementation Process

The purpose of the Software Implementation process is to achieve systematic performance of the analysis, design, construction, integration, and test activities for new or modified software products according to the specified requirements (see Figure 16).
For illustration purposes, the tasks of the software requirements analysis activity are listed in Table 7.

The description of the Analyst’s role is presented in Table 8.

Table 9 illustrates the definition of a work product: the Change Request.

DESCRIPTION OF THE DRAFT ENTRY PROFILE

At the Berlin meeting, the delegates from Belgium and Canada proposed the elaboration of a profile targeting start-up VSEs and short-intensity projects of about 6 person-months of effort. At the Mexico meeting, the delegate from Canada
presented a set of practices that could be embedded in this future profile. After discussion, the members of the working group agreed to the practices listed in Figure 17.

Although a consensus on the practices targeting VSEs was reached during the interim meeting in Lima (Peru), the working group had to formally define characteristics, needs, and desirable competencies, as it was done for the Basic Profile.
The Development of International Standards to Facilitate Process Improvements

At the May 2010 meeting in Niigata (Japan), the working group agreed on a set of characteristics, objectives for the project management and software implementation processes. The following paragraphs describe these elements.

Characteristics of the Targeted VSEs:

- Primarily involved in the design and/or coding of minor software package
- Do not have significant experience with large software development projects, and so do not attract contract jobs from larger software firms
- Personnel often relatively inexperienced

Table 8. Description of the analyst’s role (ISO/IEC TR 29110-5-1-2, 2011)

<table>
<thead>
<tr>
<th>Role</th>
<th>Abbreviation</th>
<th>Competency</th>
</tr>
</thead>
</table>
| 1. Analyst    | AN           | Knowledge and experience in eliciting, specifying, and analyzing the requirements  
                 | Knowledge in designing user interfaces and ergonomic criteria               |
                 |              | Knowledge of revision techniques and experience in software development and  |
                 |              | maintenance                                                              |
                 |              | Knowledge of editing techniques and experience in software development and  |
                 |              | maintenance                                                              |

Table 9. Description of the change request work product (ISO/IEC TR 29110-5-1-2, 2011)

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change Request</td>
<td>It may have the following characteristics:</td>
<td>Software Implementation</td>
</tr>
<tr>
<td></td>
<td>Identifies the purpose of the change</td>
<td>Customer</td>
</tr>
<tr>
<td></td>
<td>Identifies the request status (new, accepted, rejected)</td>
<td>Project Management</td>
</tr>
<tr>
<td></td>
<td>Identifies the requestor’s contact information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identifies the impacted system(s)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impact on operations of existing system(s) defined</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impact of associated documentation defined</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critically of the request, deadline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The applicable statuses are: initiated, evaluated, and accepted</td>
<td></td>
</tr>
</tbody>
</table>

At the May 2010 meeting in Niigata (Japan), the working group agreed on a set of characteristics, objectives for the project management and software implementation processes. The following paragraphs describe these elements.

Characteristics of the Targeted VSEs:

- Primarily involved in the design and/or coding of minor software package
- Do not have significant experience with large software development projects, and so do not attract contract jobs from larger software firms
- Personnel often relatively inexperienced

Figure 17. Proposed practices for the entry profile (ISO/IEC PDTR 29110-5-1-1, 2011)
• Often lack discipline in product development tasks: focus mostly in coding activities
• Lack of tangible process assets
• Limited access to investments and loans
• May lack credibility and need for a reference (e.g. from a previous customer)
• Customers may impose a software development process

Objectives of the Entry Profile

• The Entry Profile should provide a foundation for a migration to the Basic Profile Processes.
• The Entry Profile could be used by VSEs to help them implement a start-up management-and-implementation process.

Project Management and Software Implementation Objectives of the Entry Profile

Since the Entry Profile has been developed using the Basic Profile (see Figures 18 and 19), to illustrate what has been added or deleted/modified the following convention is used:

• Information added or modified to the Basic Profile is shown in Underline while information deleted is shown like this: strike out.

The objectives of the Project Management (PM) Process of the Entry profile, listed in the draft ISO/IEC PDTR 29110 Part 5-1-1, are:

The objectives of the Software Implementation (SI) Process of the Entry profile, listed in the draft ISO/IEC PDTR 29110, Part 5-1-1 are:

---

Figure 18. PM objectives for Entry Profile developed using the Basic Profile (ISO/IEC PDTR 29110-5-1-1, 2011)
The delegates from Thailand prepared a first draft of the engineering and management guide, i.e. Part 5, for review for the Fall 2010 meeting in Washington. Two deployment packages, a project management DP and a software implementation DP, have been developed to experiment with the draft Entry Profile.

Conducting Pilot Projects and Developing Additional Support Tools

Further research should be related to the study of SPI success in VSEs. We advocate the use of pilot projects as a mean to accelerate the adoption and utilization of SPI initiatives by VSEs. Pilot projects, which could also be used as case studies to promote the adoption of the ISO/IEC 29110 standard, are an important mean of reducing risks and learning more about the organizational and technical issues associated with the deployment of new software engineering practices (Palza, Levano, & Mamani, 2010). A successful pilot project is also an effective means of building adoption of new practices by members of a VSE. In particular, with pilot project we would be able to collect, as a minimum, the following data:

- Effort and time to deploy by the VSE
- Usefulness for the VSE
- Verification of the understanding of the VSE
- Self-assessments data - A self-assessment at the beginning of the pilot and at the end of the pilot project

The feasibility study of a pilot project should be also evaluated and documented. Some elements...
to be considered about how conducting and implementing pilot projects could be the followings:

- Assess the opportunity,
- Plan and Execution of activities,
- Evaluate the results
- Document all results

The members of WG24 requested a set of guidelines such that pilot projects are conducted similarly around the world. Canada agreed to provide a DP to describe a process to conduct pilot projects. The purpose of this DP is to provide tailorable and usable guidelines and materials in order to select and conduct pilot projects in VSEs. The high-level tasks of this DP are:

- Assess the opportunity to conduct a pilot project,
- Plan the pilot project,
- Conduct the pilot project, and
- Evaluate the results of the pilot project.

Some initiatives about how to implement performance indicators in projects (pilots projects) for organizations (small and others) is found in (Palza, Abran, & Fuhrman, 2003), (Palza, Sanchez, Abran, & Mamani, 2010), (Palza, 2005).

Others initiatives regarding templates and activities using OpenUP and EPFC (Eclipse Process Framework Composer) for VSEs are underway. OpenUP is an open source software development process developed as part of the Eclipse Process Framework Project. A group of students at Universidad Peruana Union (UpeU) has been developing “Plug-ins” based on OpenUP and EPFC Composer (Palza & UpeU, 2010) for the standard ISO 29110. Other “Plug-ins” are being developed, by graduate students of École de technologie supérieure, to support the set of DPs of the draft Entry Profile and the Basic Profile (Laporte, 2010). As an example, pilot projects are being conducted to develop and implement software processes used by graduate students of a telecommunication research laboratory and of a medical imagery research laboratory. Finally, senior undergraduate software engineering students are experimenting with the draft Entry Profile by developing processes for two start-up VSEs.

**FUTURE WORK**

Even if the ISO/IEC 29110 Set of Documents for the Basic Profile has been published, there is still much work yet to be done. The main remaining work item is to finalise the development of the three other profiles of the Generic Profile Group: (a) the Entry Profile; (b) the Intermediate Profile—with additional practices for the management of more than one project and (c) the Advanced Profile—with additional practices for business management and portfolio management. In addition the development of additional Profile Groups for other domains such as profiles for the medical domain.

Some means to accelerate the adoption and implementation of standards by VSEs have been described. A target audience, and an often forgotten one in the area of software engineering standards comprise undergraduate and graduate students studying software engineering, computer engineering or computer science. At the Hyderabad meeting (India), the delegate from Canada proposed the establishment of an informal interest group about education. The main objective of this interest group is to develop a set of courses for software undergraduate and graduate students such that students learn and apply the ISO standards for VSEs before they graduate. To date, four of the six proposed courses, at the Hyderabad meeting, have been developed and are freely available on Internet. Finally, work is underway on the development of self-learning course modules to support the ISO/IEC 29110 ISs, TRs and DPs.
The Development of International Standards to Facilitate Process Improvements

CONCLUSION

The documents used by WG24 and the approach that led to the development of the International Standards and Technical Reports for VSEs were presented. The approach taken by WG24 corresponds to the mixed economy approach, where the intent is to help VSEs succeed in business by providing them with a set of software engineering practices tailored to their needs, in the form of international standards, technical reports and deployment packages.

It is expected that some VSEs will use the technology developed on their own, other VSEs will get some help from government organizations, such as training or coaching, and some large organizations will impose the ISO/IEC 29110 standards on the VSEs that supply components for their products. A few countries have opted for the ‘survival of the fittest’ strategy for their VSEs, i.e. an approach where a government does not intervene in the marketplace and lets the market decide which VSEs will survive. At the same time, a number of government agencies, universities, research centers and associations are working to determine how to help VSEs. They share some of the following assumptions about the needs of VSEs:

- VSEs require low-cost solutions;
- VSEs require readily usable processes supported by guides, templates, examples and tools;
- VSEs require additional effort in communications and in standardizing vocabulary;
- VSEs require a staged approach to help them grow their capabilities;
- VSEs require ways to identify potential quick wins;
- VSEs require guidance in the selection and implementation of software practices.

REFERENCES


The Development of International Standards to Facilitate Process Improvements


ENDNOTES

1 SEI CMMI (Capability Maturity Model Integration). http://www.sei.cmu.edu/cmmi/
2 ISO/IEC JTC 1/SC7 stands for the International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1/Sub Committee 7, which is in charge of the development and maintenance of software and systems engineering standards.
3 To be published in 2011.
5 Adapted from ISO/IEC 15289:2006, Systems and Software Engineering—Content of systems and software life cycle process information products (Documentation)
6 Adapted from ISO 29110 Part 1, ISO 2009d and ISO 29110 Part 5.
7 Adapted from ISO 29110 Part 4.
8 http://profs.etsmtl.ca/claporte/English/VSE/index.html
9 This section is adapted from (ISO 29110 Part 5)
10 Adapted from ISO 29110 Part 4.
11 This profile was discussed at the meetings in Lima (Peru) in November 2009, in Niigata (Japan) in May 2010 and in Paris (France) in May 2011
12 www.upeu.edu.pe