Software Process Improvement
in Very Small Organizations[1]

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When many people think of software companies, they think of the large organizations that have become so well known in the marketplace. However, a flow of offerings are also coming from smaller organizations, including *very small entities* (VSEs), which have 25 or fewer employees. Moreover, most products and services from big software vendors depend on third-party components and other forms of collaboration involving VSEs or small units within large organizations. Thus, small and very small organizations—which include most software startups—are the global software industry's dominant force and are crucial to its competitiveness and innovation.

Software process is a leading research area for software-engineering academics. And managing software process is a big challenge for practitioners. Large organizations typically have used traditional software-process-improvement (SPI) models such as CMMI and ISO/IEC 15504 (also called Software Process Improvement and Capability Determination [SPICE]). Smaller organizations generally haven't done so for many reasons, such as the perception that these efforts were developed by and for larger organizations, are costly, require much documentation and bureaucracy, and don't clearly establish software processes.

For many small and very small software companies, implementing software-development management controls and structures is a major challenge. At a time when software quality is a key to competitive advantage, organizations are using only a few of the most popular ISO/IEC systems and software-engineering standards. Research shows that small and very small companies often have difficulty relating ISO/IEC standards to their business needs and justifying their application to their business practices. Most don't see their net benefit; lack expertise; or can't afford the necessary employees, cost, and time.

In 2011, driven by VSEs' increasing importance and growing need for systems and software life cycle profiles and guidelines, the International Organization for Standardization and the International Electrotechnical Commission jointly published a set of ISO/IEC 29110 standards and guides. Other initiatives are devoted to small entities—some from Latin America, such as Competisoft, and others from Europe, such as ITmark. But ISO/IEC 29110 is becoming the widely adopted standard.

ISO/IEC 29110

According to the Organization for Economic Co-operation and Development's *SME and Entrepreneurship Outlook* report small and medium enterprises "constitute the dominant form of business organization in all countries worldwide, accounting for over 95 percent and up to 99 percent of the business population, depending on country." In Europe, for instance, 85 percent of IT sector companies have 10 or fewer employees. With this in mind, ISO/IEC 29110 introduced the term "VSE," defined as "an enterprise, an organization, a department, or a project having up to 25 people."

The standard includes guidelines based on VSE characteristics. For example, recently published ISO/IEC 29110 international standards and technical reports address VSEs' specific software process needs. Working Group 24 of the standardization subcommittee of the ISO's and IEC's Joint Technical Committee 1 (ISO/IEC JTC1/SC7) developed engineering standards and guides (http://standards.iso.org/ittf/PubliclyAvailableStandards/index.html) targeting VSEs with no experience or expertise in selecting a project's appropriate software processes.

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[1] IEEE Software March/April 2016, pp. 85-89.

At the core of ISO/IEC 29110 is a management and engineering guide (ISO/IEC 29110-5) focusing on project management and software implementation. It comprises a set of profile groups, each containing profiles related by process composition (such as activities or tasks), capability level, or both. For VSEs developing noncritical software, there are four profiles: entry, basic, intermediate, and advanced. Each builds on the previous process, adding management and software-implementation tasks, as well as process supports, for more complex projects or growing VSEs.

A series of deployment packages (DPs; available at http://profs.etsmtl.ca/claporte/English/VSE/index.html) defines guidelines and explains ISO/IEC 29110 processes to help VSEs both deploy the standard and implement the management and engineering guide. Deployment packages typically include process descriptions, activities, tasks, steps, roles, products, templates, checklists, examples, tools, references, and a mapping to other standards and models such as ISO/IEC 12207, ISO 9001 and CMMI. DPs enable VSEs to implement ISO/IEC 29110 processes, activities and tasks without having to implement the management and engineering guide's complete framework.

Hurdles and Opportunities

Rather than provide an exhaustive, systematic ISO/IEC 29110 literature review, an effort performed in 2013[7], the authors summarize in Tables 1 and 2, respectively, the most common SPI hurdles VSEs face and the opportunities SPI offers them.

We based this on our experience in the field, including involvement in ISO working groups, conference series such as SPICE and European System and Software Process Improvement and Innovation (EuroSPI[2]), and ITmark, and other certification initiatives. In addition, our conclusions are based on decades of software-industry experience in multiple countries:

- During the past five years, we've spent approximately a combined 4,000 hours in SPI-related industry consulting for small and very small companies.
- In the past five years, we've collaborated on more than 20 industry-based SPI research projects with VSEs.
- We've supervised 30 PhD and master's degree SPI research projects related to small companies.
- Among us are the lead editor of the ISO/IEC 29110 initiative, the editor of the ISO/IEC 29110-2-1:2015 and ISO/IEC 29110-2:2011 standards, and national-delegation heads and members of ISO/IEC JTC1/SC7 working groups.
- We are involved in several certification activities including those related to ISO/IEC 29110 and ITmark.
- Some of us are key contributors to SPI initiatives such as the *SPI Manifesto* (www.iscn.com/Images/SPI_Manifesto_A.1.2.2010.pdf) and the forthcoming *SPI Education, Training and Professionalism Manifesto*.
- We've produced more than 100 scientific works related to SPI and small software companies for leading journals, conferences, books, and workshops.

Table 1. Common VSE barriers to software process improvement.

Type	Name	Description
Financial	Deployment costs	There is no consensus on SPI's cost, which includes effort; tool support; and consultancy work on, for example, accreditation and certification.
	Resource prioritization and business continuity	Everyday activities are affected by SPI efforts. If resources are tight, SPI projects could be threatened by inadequate prioritization.

Skills	Accurate external support	Users need specific technical and general VSE-related skills, which are uncommon, to apply these kinds of models in real settings.
	Internal support	VSEs are reluctant to devote efforts to train employees how to implement SPI initiatives.
	Sponsor	A lack of continuity in VSE key leaders can threaten the stable sponsorship necessary to provide the leadership and shared vision that assures a successful deployment.
	Business knowledge	SPI initiatives must be adapted to each VSE business domain to help VSEs with domain specific with regulatory, safety-critical SPI requirements
Culture	Organizational behavior	SPI initiatives must manage cultural impact and change resistance.
Reference models	Model diversity	Many reference models could be applied to a VSE in a specific domain, but selecting what is applicable isn't always straightforward.
	Model adaptation	Correctly interpreting models and requirements (functional and technical) to VSE settings is a keystone.
	Model complexity	One of ISO/IEC 29110's main purposes is reducing current reference models' complexity, but complexity can still be an obstacle because of limited resources.

Table 2. Common opportunities that software process improvement offers VSEs.

Type	Name	Description
Financial	Return on investment	Benefits, which are more visible in the short term, shouldn't just be measured economically. For instance, reduced waste improves employee engagement.
Culture	Organizational behavior	Compared to other standards ISO/IEC 29110 represents a simpler guide (say by comparison to CMMI or ISO/IEC 15504) to process implementation and so will help organizations smoothly transition.
Reference models	Personalized models	VSEs can develop reference models fitting their requirements.
	Ease of access	ISO/IEC 29110's deployment packages are easy to use and enable flexible process deployment, which facilitates the rollout.
	Progression to advanced standards	ISO/IEC 29110's entry profile is a stepping stone to Basic, Intermediate, and Advanced profiles, each of which are going to be published as separate Management and Engineering guides by ISO/IEC. The Entry and Basic profile have been published in 2012 and 2011 respectively. The Intermediate profile is expected to be published in late 2016/early 2017. The Advanced profile is expected to be published in 2017 The ISO/IEC29110 family is a stepping stone to other standards.
Market	Clear recognition	ISO/IEC29110 provides a management and engineering guide that clarifies terms and is easier for VSEs to use than a heavyweight reference model.
	Supply chain	ISO/IEC 29110's life cycle processes provide guidance to negotiating and agreeing on a service or product to be provided.
	Deployment timeline	ISO/IEC 29110 represents a minimal set of required work products and thus reduces deployment time and implementation.

Toward an Experience Factory

We're using our study of VSEs to build an *experience factory* that will help them start SPI initiatives. For example, we analyzed 74 VSEs based on the ISO/IEC 29110 Basic profile. As Figure 1 shows, the results for the companies meeting ISO/IEC 29110 requirements. This indicates that most VSEs already have processes in place that satisfy some basic requirements and shouldn't face much difficulty in fully complying. The areas posing the most problems are software implementation, verification and validation, test cases, test procedure, software components, and software architecture and detailed design.
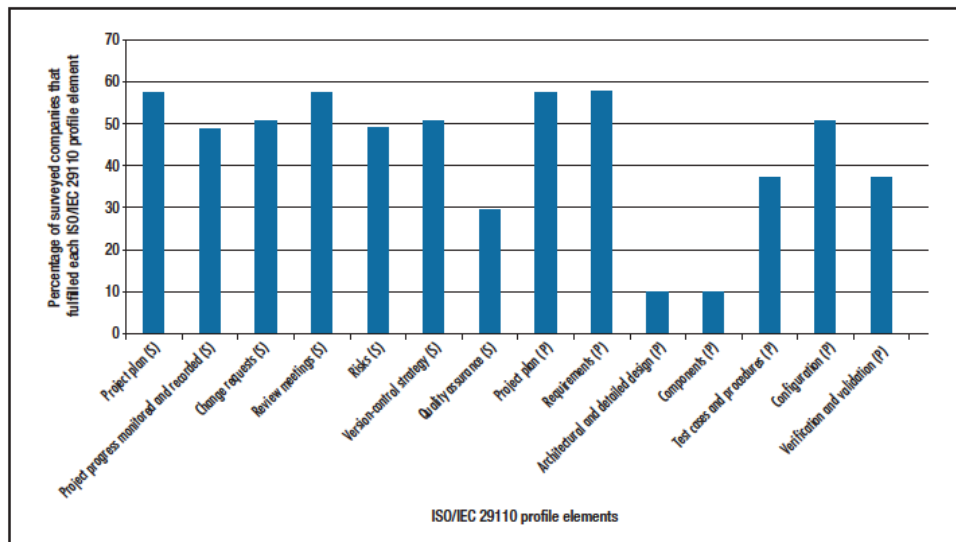

Figure 1: Results of ISO/IEC 29110 assessments of 74 VSEs

While work on the experience factory is under way, VSEs can benefit from best practices and performance indicators that we've found so far (http://profs.etsmtl.ca/claporte/english/VSE/ and at http://it-mark.eu/wordpress/?lang=en).

VSEs must first identify an objective for their SPI initiatives. They can then choose traditional or more innovative approaches, depending on factors such as their needs and current industry trends.

Our experience factory, containing industrial experiences from multiple VSEs, could help companies launch and promote their chosen SPI practices. Being part of a community, VSEs could share experiences and practices to take advantage of others' experiences and knowledge. They could then select the deployment packages that best meet their needs.

References

1. C. Giardino et al., "What Do We Know about Software Development in Startups?" *IEEE Software*, vol. 31, no. 5, 2014, pp. 28–32.

2. I. Richardson and C.G. von Wangenheim, "Why Are Small Software Organizations Different?" *IEEE Software*, vol. 24, no. 1, 2007, pp. 18–22.

3. M.L. Sánchez-Gordón and R.V. O'Connor, "Understanding the Gap between Software Process Practices and Actual Practice in Very Small Companies," *Software Quality J.*, 2015, pp. 1–22; http://link.springer.com/article/10.1007/s11219-015-9282-6.

4. G. Coleman and R. O'Connor, "Investigating Software Process in Practice: A Grounded Theory Perspective," *J. Systems and Software*, vol. 81, no. 5, 2008, pp. 772–784.

5. H. Oktaba et al., "Software Process Improvement: The Competisoft Project," *Computer*, vol. 40, no. 10, 2007, pp. 21–28.

6. C.Y. Laporte, S. Alexandre, and R.V. O'Connor, "A Software Engineering Lifecycle Standard for Very Small Enterprises," *Software Process Improvement*, R.V. O'Connor et al., eds., Springer, 2008, pp. 129–141.

7. E. Moreno-Campos et al., "Towards Measuring the Impact of the ISO/IEC 29110 Standard: A Systematic Review," Systems, Software and Services Process Improvement, B. Barafort et al., eds., Springer, 2014, pp. 1–12.

8. E. Moreno-Campos et al., "Towards Measuring the Impact of the ISO/IEC 29110 Standard: A Systematic Review," Systems, Software and Services Process Improvement, B. Barafort et al., eds., Springer, 2014, pp. 1–12.

9. R.V. O'Connor, A. Mitasiunas, and M. Ross, eds., *Proc. 1st Int'l Workshop Software Process Education, Training, and Professionalism* (SPETP 15), 2015.

10. C. Wohlin et al., *Experimentation in Software Engineering*, Springer, 2012.

11. X. Larrucea and I. Santamaria, "ITmark as an ISO 29110 Profile: Building an Experience Factory," *Systems, Software and Services Process Improvement*, Springer, 2015.

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