Software Project Management in Very Small Entities with ISO/IEC 29110

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Abstract. The recently published ISO/IEC 29110 standard Lifecycle profiles for Very Small Entities has at its core a Management and Engineering Guide [1] which are targeted at very small entities (enterprises, organizations, departments or projects) having up to 25 people [2], to assist them unlock the potential benefits of using standards which are specifically designed to address their needs. This paper discusses the role and structure of Project Management in the emerging ISO/IEC 29110 standard Software Process Lifecycles for Very Small Entities as well as its practical implication. This paper will also focus on the design and development of project management support documentation and their associated usage in early trials of ISO/IEC 29110.

Keywords: VSE, ISO/IEC 29110, ISO, Standards, Project Management

1 Introduction

Projects are the cornerstone of all business activities in small and very small companies. Firms must complete various projects to achieve their financial goals and obtain information. Business owners and managers have only one attempt executing a project successfully. Hence, the process must be carefully thought out and planned. In their study into why software projects fail [3] 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

Administering software development is usually achieved through the introduction of a software project management process. However, implementing software project management controls in very small software companies is a major challenge. This paper introduces the project management practices in the newly published ISO/IEC 29110 [1] standard Software Process Lifecycles for Very Small Entities. The following sections discuss the role of project management in general, the structure of ISO/IEC standard and its project management practices. Finally the paper focuses on the design and development of project management support documentation and their associated usage in early trials of ISO/IEC 29110.

2 Software Project Management

Many software products fail not because there is no market, but because the cost of creating the software far outstrips any profit. Currently approximately half a million project managers worldwide are responsible for in the region of one million software projects each year, which produce software worth USD$600 billion. It is now accepted that many of these projects fail to fulfill customers' expectations or fail to deliver the software within budget and on schedule [4]. Putnam suggests that about one-third of projects have cost and schedule overruns of more than 125% [4].

Software project failure is often devastating to an organization. Schedule slips, buggy releases and missing features can mean the end of the project or even financial ruin for a company. Some of the major reasons for projects failing are [3]: Unclear objectives; Unrealistic or unarticulated project goals; Inaccurate estimates of needed resources; Poor reporting of the project's status; Unmanaged risks; Poor communication among customers, developers, and users; Poor project management. Many of these clearly relate to project management.

While there are many reasons why software projects fail, one of the most important is incorrect management of the project. Good project management cannot guarantee project success, however bad project management usually results in project failure. Furthermore, software is delivered late, costs more and fails to meet its requirements. Clearly, by using effective project management techniques a project manager can improve the chances of success.

A study by Capers Jones [5] of approximately 250 software projects between 1995 and 2004 shows an interesting pattern. When comparing projects that successfully achieved their cost and schedule estimates against those that ran late, were over budget, or were cancelled without completion, six common problems were observed: poor project planning, poor cost estimating, poor measurements, poor milestone tracking, poor change control, and poor quality control. By contrast, successful software projects tended to be better than average in all six of these areas. Perhaps the most interesting aspect of these six problem areas is that all are associated with project management rather than with technical personnel.

There are many ways to make large software systems fail. There are only a few ways of making them succeed. It is commonly agreed that project management is the key factor that tends to push projects along either the path to success or the path to failure. Among the most important project management practices leading to success are those of planning and estimating before the project starts, absorbing changing requirements during the project, and successfully minimizing bugs or defects.

Successful projects always excel in these critical activities: planning, estimating, change control, and quality control. By contrast, projects that run late or fail typically had flawed or optimistic plans, had estimates that did not anticipate changes or handle change well, and failed to control quality [5].

With the low-cost tools available today for small-scale project management, and the value of project management being increasingly recognized by many in the government and in corporate sectors, many small and very small organizations choose not to take advantage of formal project management techniques and tools. [6]. Given the competitive nature of the current business environment, it may be argued that the

need to initiate the right projects and achieve the desired results is just as critical if not more critical for the small business, as it is for the large business. Furthermore it can be argued that project management offers value for any size business, and does not require a large investment of cash capital to establish. In order to minimize risk and set a small business up for success, we contend that such businesses can benefit from some form of formal project management.

3 ISO/IEC 29110 Standard

The ISO/IEC 29110 standard "Lifecycle profiles for Very Small Entities" [1] is aimed at addressing the issues identified above and addresses the specific needs of VSEs [7, 8, 9] and to tackle the issues of poor standards adoption by small companies [10, 11, 12]. The approach [2] used to develop ISO/IEC 29110 started with the pre-existing international standard ISO/IEC 12207 dedicated to software process lifecycles. The overall approach consisted of three steps: (1) Selecting ISO/IEC 12207 process subset applicable to VSEs of up to 25 employees; (2) Tailor the subset to fit VSE needs; and (3) Develop guidelines for VSEs.

The basic requirements of a software development process are that it should fit the needs of the project and aid project success [13]. And this need should be informed by the situational context where in the project must operate and therefore, the most suitable software development process is contingent on the context [14]. The core situational characteristic of the entities targeted by ISO/IEC 29110 is size, however there are other aspects and characteristics of VSEs that may affect profile preparation or selection, such as: Business Models (commercial, contracting, in-house development, etc.); Situational factors (such as criticality, uncertainty environment, etc.); and Risk Levels. Creating one profile for each possible combination of values of the various dimensions introduced above would result in an unmanageable set of profiles. Accordingly VSE's profiles are grouped in such a way as to be applicable to more than one category. Table 1 illustrates a Profile Group which contains three profiles (labeled A, B and C) that are mapped to nine combinations of business models and situational factors.

Table 1. Allocating VSE characteristics to profile groups

	Profile Situational Factors		
Business Models	**Critical**	**User Uncertainty**	**Environment Change**
Contract	*Profile A*	*Profile A*	*Profile A*
In-House	*Profile C*	*Profile B*	*Profile A*
Commercial	*Profile B*	*Profile A*	*Profile A*

Profile Groups are a collection of profiles which are related either by composition of processes (i.e. activities, tasks), or by capability level, or both. The "Generic" profile group has been defined [9] as applicable to a vast majority of VSEs that do not develop critical software and have typical situational factors. This profile group does

not imply any specific application domain, however, it is envisaged that in the future new domain-specific sub-profiles may be developed in the future. Table 2 illustrates this profile group as a collection of four profiles, providing a progressive approach to satisfying the requirements of profile group.

Table 2. Graduated profile of the Generic profile group

	Generic Profile Group		
Entry	Basic	Intermediate	Advanced

To date the Basic Profile [1] has been published, the purpose of which is to define a software development and project management guide for performing one project at a time.

3.1 Engineering and management guide

At the core of this standard is a Management and Engineering Guide (ISO/IEC 29110-5) [1] focusing on *Project Management* and *Software Implementation* as illustrated in figure 1. The purpose of the *Project Management* process is to establish and carry out in a systematic way the tasks of a software implementation project, which complies with the project's objectives in terms of quality, time and cost. *Project Management* generates a *Project Plan* to direct the software project. During the execution of the project *Change Requests* may cause revisions to the *Project Plan*. The project is the subject of *Project Assessment and Control* during the lifetimes of the project until the *Software Implementation* is complete and *Project Closure* occurs. Software Implementation (SI) produces a specified software system implemented as a software product or service. This process starts with the establishment of *Software Requirements*, after which *Architectural and Detailed Design* are produced. Software is the *Constructed* and verified using *Integration and Test* procedures. The final staged being *product d*elivery to the customer.

Within ISO/IEC 29110, the purpose of the Project Management process is to establish and carry out in a systematic way the Tasks of the software implementation project, which allows complying with the project's Objectives in the expected quality, time and costs. It is intended to be used by the VSE to establish processes to implement any development approach or methodology including, e.g., agile, evolutionary, incremental, test driven development, etc. based on the VSE organization or project needs.

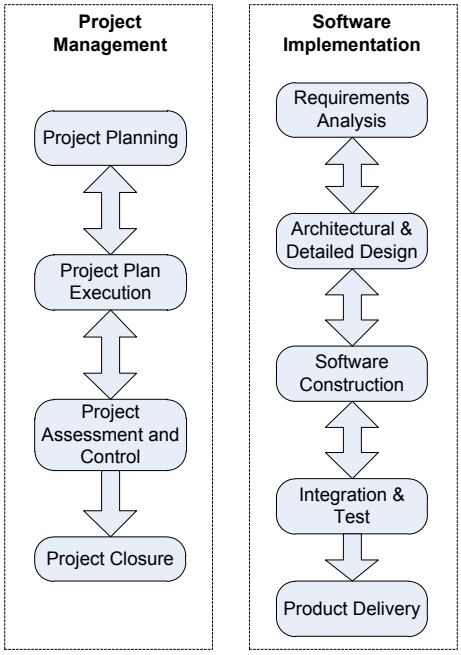

Fig 1. ISO/IEC 29110 Basic profile Process Diagrams

3.2 ISO/IEC 2910 Project Management Objectives Practices

Figure 2 shows the flow of information between the Project Management Process activities of the Basic profile including the most relevant work products and their relationship.

The objectives of the ISO/IEC 29110-5-1-2 Project Management Process are:

- The *Project Plan* for the execution of the project is developed according to the *Statement of Work* and reviewed and accepted by the *Customer* and the *Tasks and Resources* necessary to complete the work are sized and estimated.
- Progress of the project is monitored against the *Project Plan* and recorded in the *Progress Status Record*. Corrections to remediate problems and deviations from the plan are taken when project targets are not achieved. Closure of the project is performed to get the *Customer* acceptance documented in the *Acceptance Record*.
- The *Change Requests* are addressed through their reception and analysis. Changes to software requirements are evaluated for cost, schedule and technical impact.
- Review meetings with the *Work Team* and the *Customer* are held and agreements are registered and tracked.
- Risks are identified as they develop and during the conduct of the project.

- A software *Version Control Strategy* is developed, where items of *Software Configuration* are identified, defined and baselined, and releases of the items are controlled and made available to the *Customer* and *Work Team*.
- *Software Quality Assurance* is performed to provide assurance that work products and processes comply with the *Project Plan* and *Requirements Specification*.

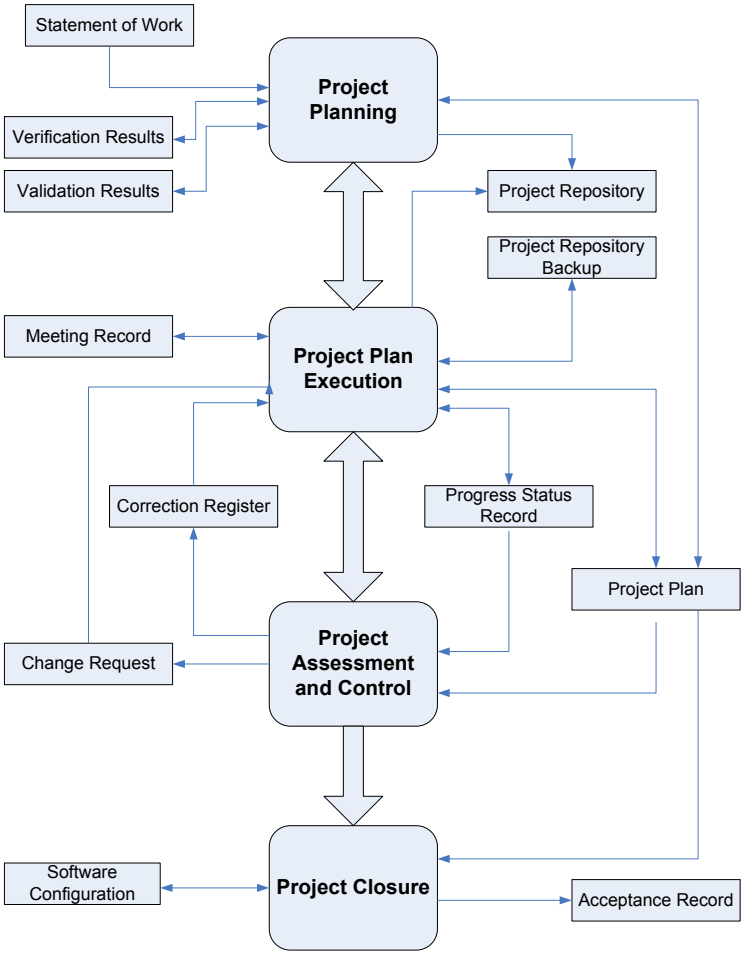

Fig 2. Overview of ISO/IEC 29110 Project Management Practices

The four activities of the Project Management Process of ISO/IEC 29110-5-1-2 are:

- **Project Planning** - The primary objective of this process is to produce and communicate effective and workable project plans. This process determines the scope of the project management and technical activities, identifies process outputs, project tasks and deliverables, establishes schedules for

project task conduct, including achievement criteria, and required resources to accomplish project tasks".

- **Project Plan Execution** - To implement the actual work tasks of the project in accordance with the project plan. Ideally when the project plan has been agreed and communicated to all teams members, work of the development of the product, which is the subject of the project, should commence.
- **Project Assessment and Control** - purpose is to determine the status of the project and ensure that the project performs according to plans and schedules, within projected budgets and it satisfies technical objectives. This process includes redirecting the project activities, as appropriate, to correct identified deviations and variations from other project management or technical processes. Redirection may include re-planning as appropriate.
- **Project Closure** - typically involves releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating project closure to all stakeholders. Often a final step is to undertake a Post Implementation Review (post-mortem) to identify the level of project success and note any lessons learned for future projects.

4 Deployment assistance

In order to assist with the deployment of ISO/IEC 29110 and to provide guidance on the actual implementation of ISO/IEC 29110-5 in VSEs a series of *Deployment Packages* and *Implementation Guides* have been developed to define guidelines and explain in more detail the processes defined in the ISO/IEC 29110 profiles [15].

A set of *Deployment Packages* (DP) (which are freely available from [16]) are a set of artifacts developed to facilitate the implementation of a set of practices, of the selected framework, in a VSE. A DP is not a process reference model (i.e. it is not prescriptive). The elements of a typical DP are: description of processes, activities, tasks, roles and products, template, checklist, example, reference and mapping to standards and models, and a list of tools. Packages are designed such that a VSE can implement its content, without having to implement the complete framework at the same time. The table of content of the project management deployment package is illustrated in figure 3.

In addition a series of *Implementation Guides* have been developed to help implement a specific process supported by a tool and are freely available from [16]. To date a small number of implementation guides have been developed. These include:

- Version Control with CVS
- Version Control with SVN
- Project Management with GForge
- Issue tracking with GForge
- Software Process Improvement with OpenOffice Calc.

1. Technical description
    Importance of project management
    Project management success and failure
2. Definitions (generic and specific definitions)
3. Relationships with ISO/IEC 29110
    Project management process
    Tasks and roles
4. Detailed description
    Roles, products and artifacts
5. Templates
    WBS, Project status template, etc.
6. Examples
    Project management lifecycle practices, etc.
7. Checklists
    Project plan review checklist, etc.
8. Tools
9. Reference to other standards and models
    ISO 9000, ISO/IEC 12207 and CMMI for Development
10. References
11. Deployment package evaluation form

Fig. 3. Table of Content of a Project Management deployment package.

5 Pilot projects

The working group (ISO/IEC JTC1/SC7 WG 24) behind the development of this standard is advocating the use of pilot projects as a mean to accelerate the adoption and utilization of ISO/IEC 29110 by VSEs around the world. Pilot projects 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. A successful pilot project is also an effective means of building adoption of new practices by members of a VSE. Pilot projects are based on the ISO/IEC 29110-5 Management and engineering guide [1] and the deployment package(s).

To date a series of pilot projects have been completed in several countries utilizing some of the deployment packages developed. For example in Canada a pilot study has been conducted with an IT department with a staff of 4: 1 analyst and 3 developers, who were involved in the translation and implemented 3 DPs: Software Requirements, Version Control, Project Management. In Belgium a VSE of 25 people started with a process assessment phase aiming to identify strengths and weaknesses

in development related processes. This company is now working on improvement actions mainly based on the following Deployment Packages: Requirement Analysis, Version Control, and Project Management. In France, a pilot study [17] was conducted with a 14-people VSE that builds and sells counting systems about the frequenting of natural spaces and public sites. In addition a further series of pilot projects are currently underway in Canada, Ireland, Belgium and France, with further pilot projects planned in the near future.

5.1 Trials to date

To date we have published [17] the final conclusions and results of one pilot project that conducted with a 14-person VSE based in France, which successfully implemented ISO/IEC 29110 processes practices utilising the available Deployment Packages. From which we have identified some potential additional infrastructure and support process activities and suggestions for future evolution of ISO/IEC 29110 Process Profiles. A further series of pilot projects are currently underway in research laboratories and enterprises in Canada, Ireland, Belgium and France, with further pilot projects planned in the near future.

	Small Project	**Medium project**	**Large project**
Duration of project	Less than 2 months	Between 2 and 8 months	More than 8 months
Size of team	Equal or less than 4 people	Between 4 and 8 people	More than 8 people
No. of engineering specialties involved	One specialty	More than one specialty	Many specialties
Engineering fees	Between 5,000$ and 70,000$	Between 50,000$ and 350,000$	Over 350,000$

Fig. 4. Three categories of engineering projects

At the ETS (École de technologie supérieure, www-eng.etsmtl.ca), a 6,000 student engineering school of Montréal, graduate and undergraduate students have used the project management process of the Basic profile to start-up VSEs and have implemented the activities in existing VSEs. As an example, a graduate student currently employed as a professional engineer in an engineering firm having over 400 engineers, is developing a project management process, using the basic profile, for the very small projects of his enterprise. In his enterprise, projects are divided in three categories as illustrated in figure 4. A formal project management process was already used for medium-size and large-size projects, but only an informal process was used for the small-size projects. The task of the graduate project is to define a project management process for the small-size projects using the basic profile, obtain approval by the vice-president of the engineering firm and help deploy the new process.

In another pilot project, a website is developed by a VSE of 2 people to help travelers throughout the life cycle of a trip from its initial planning to sharing the experience of the traveler with friends. The site will be able to build a custom profile

for each user in order to propose relevant items such as travel activities or accommodations. The set of proposed roles of the basic profile has been allocated, as illustrated in figure 5, to the two-people VSE. Where one member of the VSE, team member B, plays the role of the project manager.

Role	Name of team member
Analyst	A
Designer	B
Programmer	A/B
Project Manager	B
Technical Leader	A
Work Team	A/B

Fig. 5. Allocation of roles in a two-people VSE

The project manager uses the project management process of the basic profile to manage the project and produce or review the documents listed in figure 6.

Name of document	Main author	Reviewer (if applicable)
Change Request	A	B
Correction Register	B	A
Maintenance Documentation	B	A
Meeting Record	A	
Product Operation Guide	B	B
Progress Status Record	B	
Project Plan	B	A
Project Repository	B	
Project Repository Backup	B	
Requirements Specification	A	B
Software	A/B	
Software Components	A/B	
Software Configuration	A/B	
Software Design	B	A
Software User Documentation	A	B
Statement of Work	A	B
Test Cases and Test Procedures	A	B
Test Report	A	
Traceability Record	B	A
Verification Results	A/B	
Validation Results	A/B	

Fig. 6. Allocation of documents in a two-people VSE

As the VSE grows, the set of roles will be attributed amongst all people of the VSE using the same project management and software implementation processes of the basic profile. If this VSE eventually decides to work on more than one project at a time, it will then use the project management process of the intermediate profile of ISO/IEC 29110.

6 Discussion

As ISO/IEC 29110 is an emerging standard there is much work yet to be completed. The main remaining work item is to finalize the development of the remaining three profiles: (a) Entry – a six person-months effort project or a start-up VSEs; (b) Intermediate - Management of more than one project and (c) Advanced - business management and portfolio management practices. In addition the development of additional Profile Groups for other domains such as critical software, game industry, scientific software development are being studied

Recently, working group 24 was mandated to develop a standard for VSEs developing systems. A system may include material, computer programs, firmware and technical documentation. The new standard for VSEs will use ISO/IEC 15288 System life cycle processes standard [18] as the main framework. The objective of the working group is to develop a systems engineering basic profile which will match the software engineering basic profile. The working group will use the actual project management process of the software basic profile as the baseline to modify or add new tasks required by systems engineers. As an example, since most systems have material components, the project manager of a VSE must decide if the material components will be developed and built internally or subcontracted. This 'make or buy' task was not a task of the software project management process, it will therefore be added to the systems basic profile [19].

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