

Project Management Methodology for Measurement and Control Systems

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Abstract – Project management, measurement and control systems are the issues that the paper below focuses on. The article includes following topics: the importance of project management (Chapter II), the concept of the new project management methodology (Chapter III), four pillars of the methodology (team organization, life cycle, time management, processes) (Chapter IV), description of the experiment that has been conducted (Chapter V) with use of presented project management methodology and TDD methodology and assessment of the result (Chapter VI). The experiment proved that the methodology to be highly usable in measurement and control systems environment.

Keywords — project management; measurement and control systems; software engineering; TDD

I. INTRODUCTION

Software engineering, methodology of IT project management, software development methodology or even project – these notions are often confused, even by people associated with project management. A project is disposable, unique, time limited, created for concrete estimated enterprise, in which different people from different departments contribute [1]. Software engineering describes a software life cycle and methods used during each phase of the life cycle. Project management methodology focuses on aspects strictly related to the organization of the project – phasing, team forming, document creations. Software development methodology concentrates on facilitating, accelerating or improving the quality of the developed software, and includes the phases of designing, implementing and testing [2], [3].

Very often the boundary between the methodology of creating a software product and the project management methodology is thin, because the approach to the whole process becomes more and more complex and includes more than it might result from their definitions. Some software development methodologies enforce using specific elements of project organization in some cases, like specific team structure or time intervals organization, and they can be considered as a project management methodology in limited versions.

Among many articles about project management, lack of descriptions of experiences with project management in measurement and control systems environment might be seen. There are plenty of books and papers about software engineering in this environment, however, any of them

includes description of any project from other than technical perspective. It seems obvious that the measurement and control systems should be supported by a dedicated solutions, but it is different and any related articles were found. This article focuses on this problem and presents the authors' approach and their experiences. The purpose of this article is both to present own concept of the methodology, as well as to highlight the importance of the issue.

II. IMPORTANCE OF PROJECT MANAGEMENT

Project management has become very popular trend nowadays. There are many institutes and other organizations which activities are concentrated on analyzing and standardizing approach to the project management. Large companies like France Telecom Group or IBM have special departments that work on methodologies and try to fit it into corporate needs. Smaller companies use common known approaches like PRINCE2 or PMBOK in order to fulfill their customers' requirements and to improve their work.

Project management methodology is one of the elements of the project. There are many examples when projects were successful without using any of mentioned methodologies and there are many which failed despite using standardized approach. Project management does not guarantee success and it is not remedy for all project difficulties. The aim of project management methodology is to simplify each project by using the same mechanisms and to make it repetitive – the same duties but different tasks, the same project roles but different people, etc.

Such approach benefits for all project members, because it saves time (people do not need to learn new duties) and make that project participants feel safely (they know what should they do and how they can react if something unplanned happens). It has also some disadvantages – it requires strictly following the procedures and time, that is spent on formalities, might be significant.

Most of the methodologies provide standardized mechanisms to problems dealing. Problem can be divided in four groups – problems with scope, deadline, budget and conflicts between project participant. First three are boundaries of project – exceeding any of them is seen as a risk and may invoke the ending of an enterprise. Technical issues affect them strongly. Problems with hardware, need

to order new devices – almost every problem puts off deadline, cuts the requirements or extend budget and project might be outdated (completion might have already released similar product or product is no longer attractive to customer), too expensive (its cost are higher than expected incomes) or limited because of them. Each of these changes can result in closing the project.

Project management methodology simplifies controlling of all stages of project – from the beginning, through implementation and testing, to closing the project. Each stage requires acceptance to start the next one. This prevents project from changing the scope or reducing the tests. It enables to monitor risk and perform action to deal with problems.

III. THE CONCEPT OF THE METHODOLOGY

The reason of creating a new methodology was the need to use a standardized approach in every project we took part in. When we realized that nothing like this had been developed before, we started to think how such approach should look like, from which templates it should contribute, which new trends are really useful to follow and how we can compromise IT standards with measurement and control systems reality. In our opinion, the methodology should enable to manage project in a standardized and universal way, with use of predefined processes, the standard team structure, and time and document management. None of project specifics (e.g. the way of creation of the software or the vary size of the project) should be limitation for the methodology.

A high quality product is expected as the final result of the project. In order to avoid confusion: high quality is a relative term, separately definable for each project. The methodology should take into account the possibility of utilization of software engineering, including the agile methodologies, like Test-Driven Development (TDD), Feature-Driven Development (FDD), incremental programming or simple using so called best practices [4], [5].

However, that is not all. One of the key question is: how do we want to work? Will our way of working be accepted? What does customer want and what can we offer him? To find proper approach we should concentrate on our experience and recall us working on a very difficult project. What problems did we encounter? How was the project managed? What could be done better? What methodology was used – normal, agile or none?

All these issues lead us to one solution – prepare own methodology taking separate elements from existing solutions. Time management and team concept were modeled on SCRUM (name stands for the figure in rugby) [6], however, the team naming used in the methodology is similar to those from PRINCE2 [7]. In our opinion naming from PRINCE2 is much more popular and those from SCRUM might not be accepted by some people. During the establishing of team roles, the special emphasis was placed on finding a balance between customer

requirements and the software contractor potentiality, which resulted in a combination of SCRUM and DSDM (Dynamic Systems Development Method) [8] approaches. The project management methodology concentrates on the client, as we found that to be right idea. Customer, in some methodology is called “sponsor”, is the most important person in project. He finances it and accepts the final effect, so all efforts should be concentrated on realizing his needs. However, opinion of the software developer should be taken into account because in the case of the measurement and control systems some ordered features may not be feasible or cost extends the budget of a project.

IV. DESCRIPTION OF THE METHODOLOGY

The methodology is based on four pillars - the organization of the team, life cycle and time management, processes and documents, carefully selected and re engineered from other solutions as mentioned before. First three parts are described in the article.

A. Team Organization

Choosing the right people and the appropriate allocation of responsibilities is a key to success. People involved in the project can be divided into three hierarchical groups - supervisory, managerial (or simply management) and executive. Executive group is responsible for the managerial one, managerial - for the supervisory. The tasks of the supervisory group is to make key decisions in the project. The group consists of the Supervisory Team (ST), elected by the board of the company, and President of ST who must fulfill following criteria: availability during the project, reputable and competent, which might be understood as an experience in software implementation projects and technical knowledge.

The President of ST selects the Project Manager (PM), Technical Consultant (TC) and the Chief Architect (CA). PM is a representative of the managing group and has competence in IT project management. CA and CT are those people who have knowledge of the measurement and control systems. CA is a representative of the contractor and his responsibilities which are creating the vision of the system and solving technical issues. TC is the person from external software vendor. He is responsible for issues related to proper functionality of the system and satisfying the design requirements.

The cooperation of these three mentioned people is the key to the success of the project. Division of competencies forces to compromise, makes the project possible and in result functionality of received system is in line with expectations.

The executive group consists of Team Leaders (TL) and Team Members (TM). TL are managed by PM. They are responsible for explaining technical issues with the CA. TL should combine the ability of team management and technical expertise as well. His competence is choosing team members and presenting them the CA. The

team is composed of programmers and testers which perform the assigned tasks. No function in a team or assignment to a particular group need not be permanent.

B. Project Life Cycle

The intention of the presented methodology is not to define best way of software development, but to focus on the project managing. For this reason, the methodology does not impose a model of the software life cycle, allowing realization of any concept. Determination of the exact timing is difficult and practically impossible to schedule. The project is dynamic, has its own characteristics and problems. Time management should remain in the competence of PM. His experience and support of CA leads in most cases to better time management than imposed schematics and limitations. The project should have its own rhythm, so the suggestion is to divide time into equal periods named stages. The length of the stages should depend on the scale of the project, faced problems and other factors. One week, two weeks or even months - such time division make project easier to control over the progress and task to allocate.

During entry project organization so called milestones should be defined. Milestone stands for a particularly important moment in a project. The example of a milestone can be performance of first measurement, communications between nodes of the system or other important launched functionality. Also it includes the duties of management and determination of milestones and having them accepted by supervisory group. Milestones do not have to be achieved at equal time intervals. Number of steps needed for their implementation may be different and it is up to PM and CA to determine when they should be obtained.

C. Processes

Due to the diversity of each project and the inability to foresee all situations that may occur, different processes should be run in every project. Process is an isolated part of time in a project related to some preceding events and invoking others. The reason for introducing processes is standardization of decision making and organization of project progress - if processes are standardized, each project member knows what happens in every situation and he knows his responsibilities and impact on the project.

Running of the process has two main advantages - it is transparent and easier to manage and control. They are used when it is necessary to ensure continuity of the project, and to make it more formalized and maximize efficiency. The advantage of this approach is particularly visible in the case of large projects that require close monitoring. The resignation from the processes can lead to chaos, which in long turn can lead to failure.

Processes are divided into four groups (Fig. 1), which define sub processes contained in them. Their names are: Initial and Final Processes, Planning and Control, Administration of the Stage and Critical Processes. The

division of processes and sub processes is intuitive and transparent, in opposite to popular PRINCE2. Also avoided redundancy process functions is very important advantage.

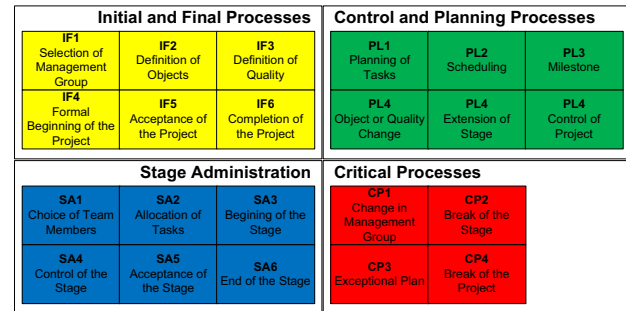


Figure 1. Processes and sub processes of project management methodology

The use of processes is similar to dominoes stacking. For example, a project is started by selection of supervisory groups (PP1), then objectives and the quality (PP2) and the approach (PP3) are defined, and project can be formally started up (PP4). The next process is task planning (PK1) and scheduling (PK2). At this point, it is possible to begin the first stage - select team members (AE1), assign tasks (AE2), etc. The project ends with success (PP6) or defeat (PK4).

The proposed methodology takes into account the specificity of designing the measurement and control systems. On one hand, there is insufficient number of people with good technical knowledge, which is the reason to use their creativity and experience to the optimum extent. On the other hand, all the teams do not always have access to the equipment at any time they want. A proper management of resources will avoid waiting for access to the devices. In result, it will reduce the duration and costs of the project. Resource management takes place in several sub processes, including the Scheduling (PK2) and Selection of team members (AE1).

In opposite to traditional methodologies, strong emphasis is put on the software developing. Engineers create the final product, so their role should not be marginalized. Their experience is important and sometimes the scope of the project might be limited or changed due to their suggestions.

The situation, when project is managed spontaneously and informally relations dominate over formal ones, should not occur. On the other side, too many procedures with many decision makers can interrupt project and lead to the situation, when more time is spent on procedures than on work. The presented methodology is definitely more formal than agile ones and it is an attempt to find balance between two radically different approaches.

D. Documents

Each project requires to prepare documentation. The amount of required documents may vary dependently on

project size, product sophistication or supervisory group demand. The most important documents are created in final stages of projects, e.g. Final Report, prepared at the end of project during IF6, but, as it was mentioned in second part, the project needs to be controlled continuously and documents can be used to control the progress. They can also be presented to supervisory group as the result of particular stages or as a material to make a decision.

However, the creation of a document takes time and that is why documents have to be re useable. If document cannot be used for making the decision or for further purposes, its creation is not necessary. Our methodology limited their amount to minimum. Moreover, each of them is created in proper sub process and requires other documents in some cases. And, what has seemed to be common practice, almost all created documents are used in Final Report. Such approach has also psychological background – project participants see that their work is not wasted and this has positive influence on the atmosphere.

V. USING THE METHODOLOGY IN THE DESIGN OF MEASUREMENT AND CONTROL SYSTEMS

Usefulness of the methodology has been proved in practice. The task was to develop measurement and control systems. LabVIEW, the most popular and most advanced software development environment for such purpose, was chosen, however, the methodology is independent from software environment. Moreover, Test-Driven Development (TDD) [9], an agile approach, was chosen as method of software creating.

The process of creating an application in accordance with the TDD is as follows: first, the test is written and the program does not pass it. Afterwards the program is developed and it is expected to pass all prepared tests (Fig. 2). The advantage of such approach to the software development is limited number of bugs, high resistance to errors and monitoring of the progress. In theory, the program does not need to be further tested after the completion of creation. The disadvantage is the necessity to overcome psychological barriers (the program is created in a way completely different from the commonly used methodologies). Also dedicated programming tools have to be used. The only tools, supporting TDD and dedicated to LabVIEW, are NI Unit Test Framework and JKI VI Tester. During the project both tools were used.

Fifteen people took part in the experiment. They served as a President of ST, PM, GA and two teams, each consisting of TL and five programmers. The task for both teams was to write an measurement and control system in LabVIEW consisting of a client and a server on which measures should have been executed. Systems should have worked on standard PC and connect over GPIB to HP's function generator (HP33120A) and digital multimeter (HP34401A). The results of the tests were expected to be available from external data base.

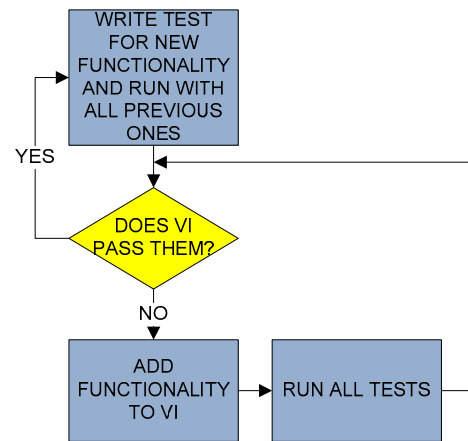


Figure 2. A graphical representation of the Test-Driven Development cycle

The project lasted eight weeks. The participants got familiar with the methodology of the project and TDD in the first week. It was also time to install the software and master skills in LabVIEW and TDD tools. Next six weeks were used for writing proper code and last one - for bug fixing. Each stage of the project can be represented by sub processes (Fig. 3). The project did not require using all possible ones (e.g. any critical situation took place so none of elements from Critical Processes was used).

Both teams completed their task successfully. The first team presented the system which quality was lower than the one from other group - not all design requirements were met and some features could be done better. There were problems with communication between notes, information about the measurements should be displayed on the website but they were not, database should enable more filtering options. The system written by the second group was deprived of such defects and better met the expectations.

The use of tools for TDD did not affect the quality of the final product. Participants were "losing" time studying tools instead of writing the program. They also had to improve programming skills in LabVIEW as well got used to the new approach of programming. Ultimately, the team with a worse, more limited tools quicker reached the end of its possibilities, and therefore had more time to create applications.

VI. ASSESMENT OF THE METHODOLOGY

Methodology fulfilled its task and both teams completed the project within time limits. One of the success factors was good communication and clear division of competences. Participants were able to accept their roles and tasks assigned to them. Encountered problems were dealt with by the appropriate people. President of ST contact only with the PM and CA. PM was contacted by both TLs to clarify issues, provide weekly reports and in organizational matters. TL was responsible for communication in his team. Each member had contact with TL and CA, when opinion or advice was



Figure 3. Processes and sub processes of project management methodology

needed. Presented processes did not complicate work or introduce too much formalities to the project. They are invisible to the teams of programmers, let by the PM and the President of ST control the progress of the project. Actual project course fits to the used processes, which demonstrates their consistency and fairness.

The introduction of equal time intervals proved to be very accurate idea - the participants accustomed to regular work. The problem of many projects is the fostering of work before the upcoming deadline. In every project there are problems that occur and even though they cannot be solved very quickly, because there is no enough time to handle all of the them. Methodology improved the management of the project by delivering proper sub processes that simplified such organization of the enterprise.

In addition, the teams reached the secondary goal which was checking how TDD can contribute to the measurement and control systems. TDD is unusual in its way of software development. Developers test the system continuously which results in lower number of bugs found in test stage. This is the reason why tests were shortened to one week. In presented case, such period was long enough to perform all necessary tests and correct the existing code.

Use of TDD proves versatility and usefulness of the methodology of projects. Any other software engineering techniques like FDD (Feature-Driven Development) can be successfully used together with presented methodology. The methodology enables also to manage project in more traditional way.

Methodology refers to several types of standard documents for inside project communication. Schedule, a

list of milestones, weekly report and the final report were written and used during the experiment. The number of documents and frequency of delivery was appropriate - they enabled to control the project and TL was not overload by writing them. The problem with the traditional methodology is formality. Documents are created in very large quantities and after all they are often not used. Proposed methodology is devoid of this problem - only the necessary documents are created and they are expected to be reused.

The success of the experiment is one of the factor of methodology assessment. In our opinion, good methodology supports project participants and makes them satisfied with created working conditions. This is the reason why we made a survey and asked participants about their opinions. Participants were of the opinion, that such approach allows to concentrate on their instead of checking deadlines or losing time on searching solution to occurred situation. They knew at which stage project is and there was no chaos within the teams in their opinion.

However, they admitted that methodology makes a project more difficult by its processes and sub processes and slow down general performance. More sophisticated approach requires some time and effort to learn how to function in new reality. Paradoxically, the way how participants find methodology is similar to ours. Methodology always requires additional work, reports, documents, meetings, but this is the price that is paid for having project organized.

VII. CONCLUSION

The original methodology for projects management in measure and control environment was described in this article. Its main objectives - the team management, time management, processes, sub processes and documents were presented in previous sections. Methodology was proved to be right by being used in real projects that finished successfully. It was also checked that methodology is compatible with newest software development techniques like TDD. The combination of presented project management methodology and TDD is the solution that can result in proper organization of project and high quality of final product.

The methodology's strong point is balance between formality and agility. The limited number of sub processes and documents (in comparison to traditional project management methodologies) make it more acceptable by

project participants. Emphasis on documents re usability is great feature and accelerates the process of creating the documents and, in effect, whole project performance.

TDD was found as a methodology that requires change in approach to the software development. It requires continuously testing of the software and result in careful tested product what is demanded in measurement and control systems. Its disadvantage is time that has to be spent on learning the approach, however, the outcome may be very satisfying.

It is not right to say that the methodology ensures success, because it does not. The success is made by many factors. Team members are required to have relevant knowledge in respect to their duties. The project results show clearly that it is difficult to patch up the gaps in knowledge and experience in such a short period of time. Both groups have succeeded, because they were organized, appropriately motivated and committed to the project. Important was teamwork, which is the key to success. Project management is not an end in itself, it allows to regulate the flow of information and division of responsibilities, and without these and many other factors, the project is doomed for failure. Project methodology does not make a project successful. However, in some cases it saves it from failure.

Further researches will be concentrated on analyzing and improving the innovatory methodology with particular emphasis on software engineering. Measurement and control systems require the highest quality of code. Techniques like TDD, division of tasks or proper team organization are some ways to reach it.

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