IT PROJECTS-BASE CONTINUOUS LEARNING AT THE CHERNOBYL NPP

Maxim Saveliev, Vitalii Lytvynov

***Abstract**: The best practices of Chernobyl NPP personnel training are presented in the framework of international projects implementation to improve safety and transform the Object "Shelter" into an ecologically safe condition based on the iterative methodology of creating automated systems and software proposed at Chernobyl NPP.*

***Keywords**: IT-project management, training in industry, knowledge transfer, automated system life circle models.*

***ACM Classification Keywords**: K.6.1 Management of Computing and Information Systems - Project and People Management*

Introduction

As a rule, education and training are considered in the context of training in specialized learning institutions. For a variety of "classical" specialties such approach may be justified. Indeed, the basic principles of physics or the theory of materials strength do not change during the "life span" of a typical industrial engineer. It is only needed to maintain proficiency from time to time, which also takes place in educational institutions. However, such approach does not work now for engineering and technical personnel found at the edge of scientific and technological progress, namely, nuclear energy, aerospace, chemical and biological industry and of course information technology. These days, implementation of complex projects requires continuous improvement of education level for personnel of all key stakeholders, including both a direct executor of certain activities and a final consumer. This issue is embodied in project management guides, quality manuals, and for the industry associated with increased risk in governmental rules and regulations. For example, in the nuclear industry sphere educational standards, frequency of additional training and knowledge tests of various categories of personnel, a need to arrange specialized training centers and the requirements for their fitting out are legislated. The largest commercial companies are doing the same by arranging or financing specific departments or affiliates not only for R&D, but also to train their employees. As a rule, the basis for this is a lack of flexibility of the state educational institutions, as well as the nature of business of such companies. In other words, one might talk of a gap between a need of advanced industry for the continuous training of its employees and traditional education system.

Chernobyl NPP and surrounding 30 km Exclusion zone is such a territory where these problems emerged in the most keenly way both in Ukraine and in the work at large. The accident at Chernobyl NPP is the largest man-made catastrophe of the twentieth century which required considerable efforts of the world community to overcome its consequences. Before April 26, 1986 the world has never faced such a challenging problem. About 600 thousand people participated in elimination of consequences of the largest accident in the history of nuclear power, 160 thousand people were evacuated and 220 thousand relocated, 5 million people were living on contaminated area that not require relocation. [WHO, 2006]

Most ChNPP projects are characterized by acquiring new knowledge and creation of systems which are unique in the industry which means that classical approaches for projects implementation and, in particular, personnel training are ineffective. Besides since there are representatives of various countries and cultures at the site, interaction and communication issues have appeared which were caused not only by a need to interwork with the help of an interpreter and/or “international English” but also by a variety of engineering schools, methods, technical norms, management methods, and quality assurance. The above leads to negative consequences like missed deadlines and budget overruns.

The above problems called for developing of a special project management methodology for the ChNPP site, which has successfully been implemented by the Chernobyl NPP management, international "Shelter Implementation Plan" Project Management Unit (SIP-PMU), and strongly supported by the Ukrainian Management Association by the Ukrnet projects (hereinafter UPMA). More than 100 specialists of the ChNPP received second higher education to implement this methodology - the master degree in the field of project and program management, and more than 30 Chernobyl NPP experts were certified per International Project Management Association IPMA system, two experts were certified by Japanese Project Management Association PMAJ. [Bushuyev, Medintsov, 2013].

At the same time developed methods embraced large capital-intensive projects, primarily in the field of construction, dismantling, installation of new equipment, but did not take into account the specifics of the IT-projects implementation, their iterative nature, liability to changes and special requirements for personnel. In addition, the unique conditions at the ChNPP and object "Shelter" have created such specific requirements, that performers could assess their complexity only in the course of the project. For example, existing limitations on safety requirements, personnel health may not provide for immediate access to the ChNPP site or required equipment by a specific expert, and consequently would require taking a decision remotely, based on incomplete data.

The above conditions of projects implementation at the Chernobyl NPP pose the problem of effective knowledge transfer between IT-project stakeholders, primarily from ChNPP experts who have knowledge of the object and the specific conditions of the site and Contractor specialists, as well as

from project performers (as a rule from international companies) to the ChNPP's experts as the end user of new systems and technologies. And if the second task is usually finds a solution through formal training cycles for the Client's personnel during the transmission of a new system or object, than the need to address the first problem is usually being considered only when the project begins to experience challenges.

IT-Projects Implementation Methods at the Chernobyl NPP Site

Since the majority of IT-projects at the ChNPP are financed by international institutions such as the EBRD, US DOE, the European Commission, they are implemented via an approach typical for such organizations: the tendering process for the "turnkey" work within the framework of a Contract with a fixed value, for example a FIDIC contract type. Particularity of this type of contract is that in their standard form they do not intend any other project life cycle model other than a waterfall model. In addition, if it is not specifically defined in the special conditions of the contract, arrangement of "turnkey" work implies a shift of all project risks related to errors committed at the time of the system installation, or, worse yet when it is handed over to the Client. And in this case, all project participants are at a disadvantage, the Contractors suffer financial and image losses; the Client does not get the system of proper quality, and the funding agency spends money inefficiently. In other matters, shortcomings of the waterfall model when implementing the IT-projects for which such model does not fit, are well known and description thereof is not the purpose of this article. It is worth noting here that these shortcomings have proved themselves to the full within the ChNPP site.

Iterative methodology for creating automated systems and software, based on a synthesis of GOST-34 (government standard for automated systems creation effective within the post-Soviet space) and recommendations of the RAD and Agile methodologies [Saveliev, 2013] was developed to overcome the negative experience of the ChNPP projects implementation. RAD and Agile methodologies contribution included extensive involvement of the Client at early stages, i.e. domain screening, development of requirements to the system and its design decisions. And GOST-34 gave a set of mandatory formal documents and requirements for its content. The proposed methodology links the release of two system prototypes by the Contractor together with a Draft Design and Technical Specification – formal documents with a standard structure. The purpose of the prototype release is to demonstrate to the Client the conceptual feasibility of concept design offered to the Contractor under the Clients specific conditions.

Then an alpha version and release candidate are issued at the stage of Technical Design and Working Documentation respectively. Final solution is aligned with successful completion of a trial operation. In a graphic form this methodology is given in Figure 1.

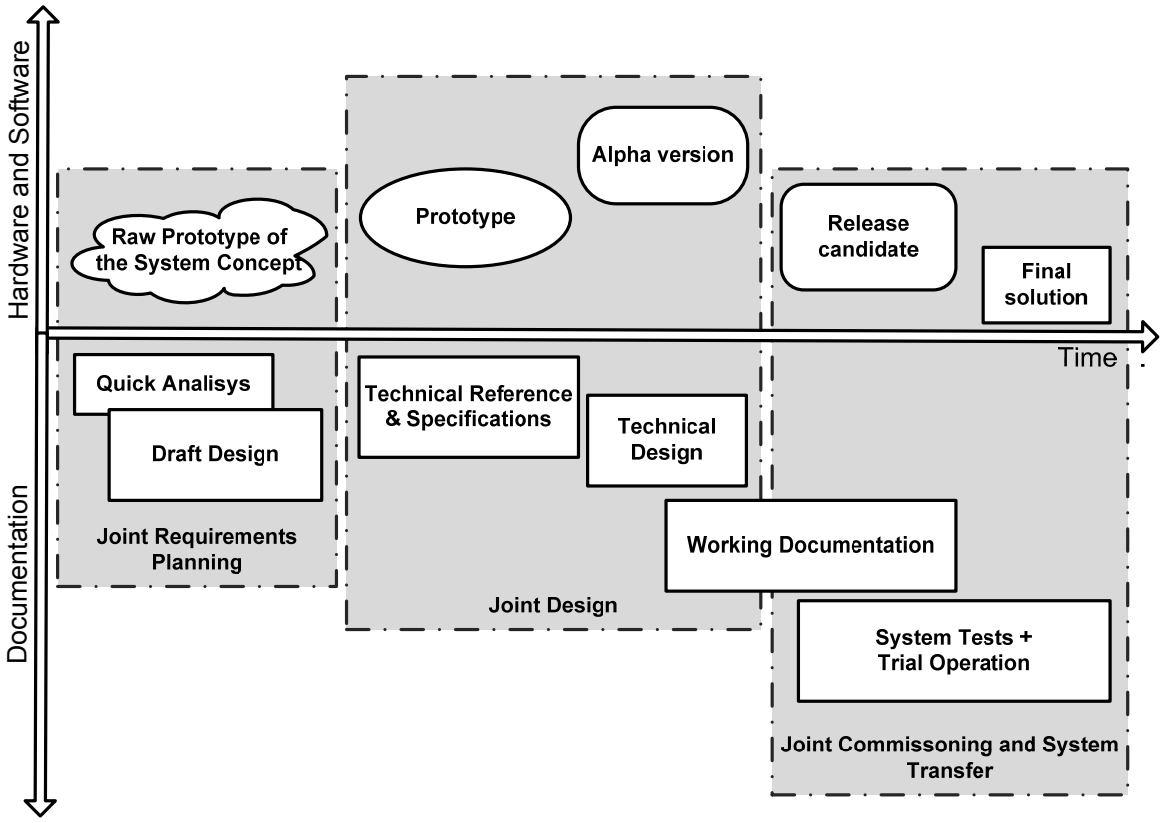

Fig 1. Methodology of IT-Projects implementation at the Chernobyl NPP

A key feature of this methodology is to refine requirements and design solutions by creating an analytical simulator of the future system, deployed in parallel both within the Contractor and the Client's site. The abovementioned analytical simulator is a controlled stimulator of domain (CSD) and actually a model of system being created (MSC). CSD generates input signals from the external environment to the newly designed system, as well as simulates the environment reaction to the output system signals. Immediately prototypes and versions of the system being developed appear for MSC which might be effectively achieved by applying modern virtualization technologies of computing systems. Interfaces between CSD and MSC are unified at the most to the real system and its environment, which is achieved by reusing design solutions.

Cycles of report documents review by the Client preceded by presentations in which the Contractor does not only tell about the content and structure of the submitted design decisions, but mostly trains the Client on how these solutions can be checked using analytical simulation.

The main benefit of this methodology is to minimize the impact of inevitable changes in the system requirements on the newly created system. The latter is achieved by the Client's early learning of the automated system, even before its actual creation. Thus, a need for change is shifted to early stages of the system creation. This can be illustrated by the following graph, see Fig. 2.

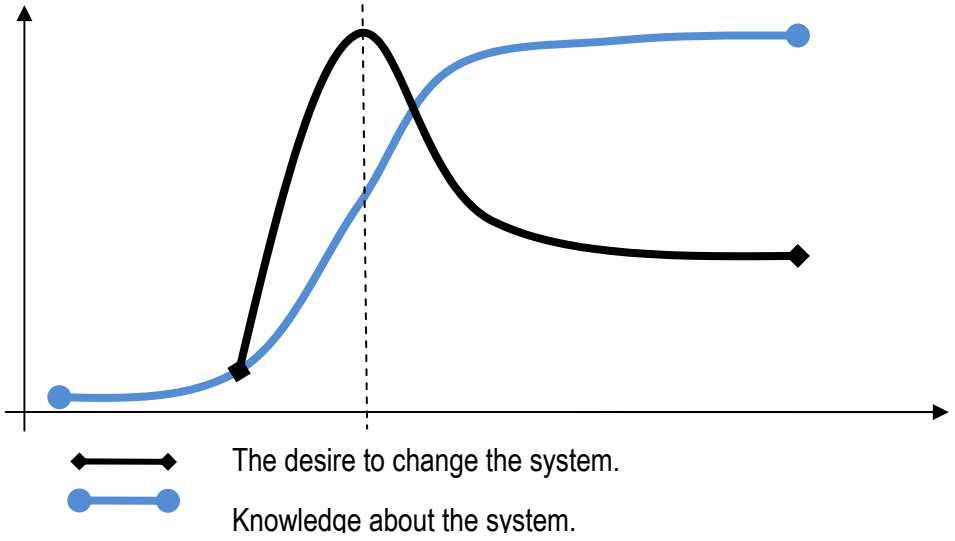

Fig.2. Connection between the knowledge of the system and the desire to change it.

In the classical waterfall model, with its misuse, the Client gains knowledge of the system at the final stages when the funding and timing have been exhausted and at this moment an urgent need for change appears. In these cases, project managers who are not experienced in IT-projects implementation start seeking the cause of problems in the insufficient quality of the source data in the best case, and in a "sabotage" of the Client at the worst.

On the other hand the methodology proposed at the ChNPP encourages the Client to obtain knowledge of the system at early stages, through joint work on the development and refinement of requirements, as well as the designing of software and hardware solutions.

Client's Personnel Training by Involving into Project Implementation

As part of the described above method of the IT-project implementation the Client creates a project management team for the project's life circle at the initial stage, which in addition to the project manager and supporting staff (project controls engineers, translator, contract and financial specialists) includes the Client's leading technical experts of information technology for complete or partial operational subordination to project manager. Technical experts engaged in the project management team shall undergo compulsory training of the project management basics, design regulations and standards effective at the Client's enterprise if they are involved for the first time.

Project implementation team is formed out of the Client's personnel comprising future operators and maintenance personnel which reports to the object's manager - usually the manager of the enterprise

structural unit in which the IT-project result will be deployed. The personnel are to be familiarized with goals and objectives of the project, their future roles both during the project and after its completion. It is important to clearly define a new work schedule of Client's personnel, set time for project activities, as well as time for self-study. If the current level of the personnel qualification does not correspond to the level required for the future system operation, corresponding training theoretical courses should be planned and held.

As a rule participation in such implementation group gives the Client's personnel a chance to switch from regular operating activity which can motivate and almost always initially accepted with enthusiasm. Another thing is that if this enthusiasm will not be supported by the creative activity under the project - it will quickly fade out. At the same time, the project is a new activity that will inevitably break the established position in the Client's organization, so some resistance from the Client's personnel can be expected both in active and passive forms. Managers need to understand that the maximum commitment of the personnel can be expected only when the personnel will feel "safe", i.e. he will understand that participation in this new activity will not jeopardize him.

Upon the formation of the project implementation team, the Contractor shall be informed about its structure, goals, and objectives.

In the initial phase of the project during the survey of the automation object, the Contractor makes mandatory acquaintance with members of both abovementioned the Client's project teams, interviews them to collect requests and requirements to the system. In parallel to this, the Contractor begins to create a prototype of the system and simulation of the controlled object - a model of system being created (MSC) and controlled stimulator of domain (CSD). The aim of this work is to convey the concept of the future system to the Client's personnel as soon as possible and to get a feedback.

After creating MSC and CSD they are deployed at the Client's site, and project implementation team starts their operation. As the project progresses the abovementioned models are to be updated, and the personnel are to be trained to use new features if there is a need. Information systems like bug-tracking performed well as a way of organizing of feedback from the Contractor.

Acquisition of new technologies always creates difficulties with aging of a person, and this should be considered carefully. In addition, new technologies often have a high cost; therefore people have a psychological fear of responsibility of "breaking an expensive thing," which is a powerful brake when mastering new knowledge. At the same time, experiments on the model of the system being created remove this psychological factor, which soon gives a way to satisfaction of learning new skills. The author recurrently has had to observe how first timid attempts to influence the user interface of the future system are gradually replaced by a wish to test their prowess and find new "bugs".

It should be noted that the efforts taken to create the MSC and CSD bring additional benefits for the project participants. During the pre-commissioning, certain modules and parts of the simulator can be used to customize the operation of the final product or to test for example an emergency condition which is impossible to do on the working object, and then at the operation stage to isolate a fault of equipment, for example by connecting the device simulator, instead of replacement of its modules.

It should be mentioned that the regulatory framework of the USSR, and then of modern Ukraine requires for systems important for safety of nuclear plant, to train operating personnel one year prior to operation. In the same way GOST-34, which regulates the types of automated systems tests, intends that the Client's personnel will have theoretical knowledge by a preliminary test, and will acquire practical knowledge and skills of the system work during the trial operation [GOST-34, 1992].

These requirements have not lost their relevance in view of information technology development and they should be considered when planning the IT-project schedule. And here again the early training of the Client through involving him into the project implementation enables to optimize terms of relevant works and project schedule.

The Clients and the Contractor's Personnel Roles when Implementing a IT-Project

Without going into details of differences of various types of Clients and Contractors organizational structures, it should be noted that in general classification of Contractor and Client personnel per their roles in a project can be illustrated by the following diagram.

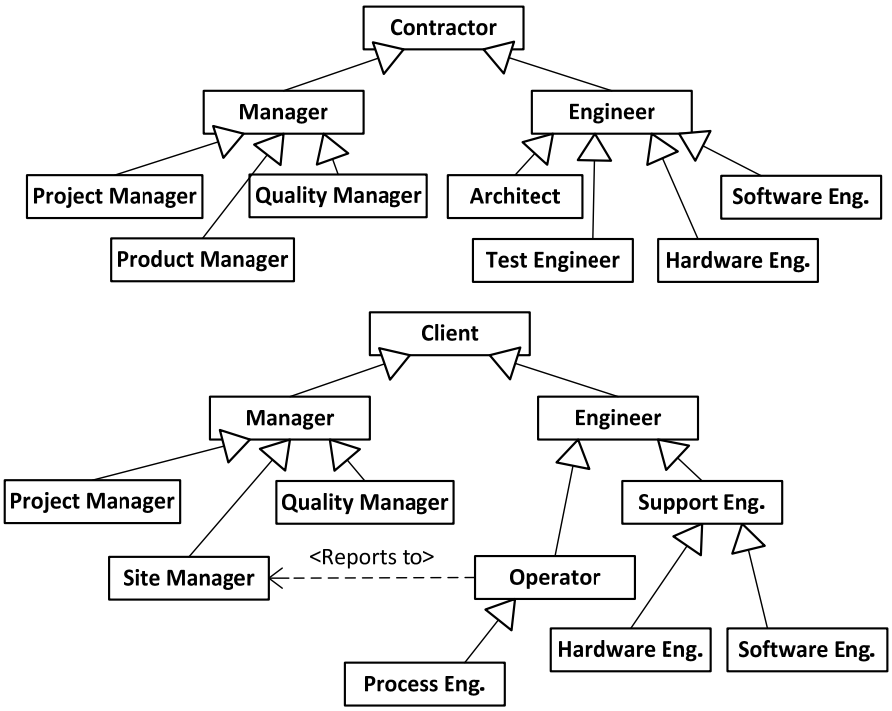

Fig.3. Hierarchy of the Clients and Contractors' personnel roles

The principal feature shall be noted here the influence of which on the project success is often underestimated. Both hierarchies of the personnel roles are very similar to each other. Besides, relations between the similar roles arise naturally when forming communication between the Client and Contractor, for example between Client and Contractor's programmers. And one might overlook the fact that the end user of the IT-project outcome is operating personnel – an Operator, but not supporting (maintenance) personnel, such as electronics and programmers engineers. Such roles as a Site Manager, Process Engineer, and Operator are the source of information about an object being automated, while the Software and Hardware Engineers are the source of information about potential features of designed automated system.

Specialization of roles means specialization of knowledge, but for successful management of IT-project reviews and meetings involving all participants in the project should be carried out on a regular basis during which the system at large shall be discussed to support the understanding of the general system concept from the personnel side, to inform the participants of the current steps of the project implementation, and items of concern. The interest of the project participants to related knowledge should also be encouraged.

Practice of the Chernobyl NPP has shown that the meetings between the project teams of the Client and the Contractor should be held 1 time per week. Technical reviews at least 1 time per month. Major meetings and project review should be planned for each milestone of the project schedule.

As mentioned above, in the course of communication between the Client and Contractor's specialists there is tendency to form pairs between matching the Client - Contractor roles, namely Client's Project Manager - Contractor's Project Manager, Client's Software Engineer - Contractor's Software Engineer, etc. As a rule, Contractor's Architect - Client's PMU IT Expert and Contractor's Test Engineer - Client's Operator pairs would also be combined. A bilateral transfer of knowledge is observed between such pairs, just as it does when pair programming in Extreme Programming (XP) methodology which is now becoming more popular. And experience shows that this is happening in the same effective way. Another thing is that the contract or budget limitations of the projects do not always allow maintaining the truly work is pairs between the Client and the Contractor for a long time.

Knowledge Check within the Continuous Learning

Classical training involves the following chain: planning of training - theoretical learning - practical training - examination (test) - updating the curriculum. At first glance, the proposed method of continuous learning through involvement into the project implementation relies on intuitive self-education. This is not quite true. Indeed self-education and self-development through participation in community activities plays a key role. But it should be mentioned that the reporting documentation

(terms of reference, technical and working designs, maintenance and operating manuals) developed by the Contractor plays the role of theoretical material with which the Client should get familiar, analyze and give its comments. Such work on documents plays a role of practical lessons to master theoretical material. Experiments on the simulator play a role of training to get into practical skills. In addition, the Contractor is acting as an examiner, by forming responses to the Clients comments. This allows identifying gaps in knowledge and taking them into account when preparing programs and system testing procedures. Finally, the test of the system itself, including trial operation, is a sort of examination for both the Contractor and the Client.

Conclusion

The existing practice proves that the above approach ensures a real involvement of the Client's staff to the project and elimination communication barriers in the project. An effective knowledge transfer takes place about peculiarities of the domain as part of particular application on the subject is effectively transferred from the Client's staff to the Contractor. And knowledge transfer from the Contractor personnel to the Client about key aspects of the future system and the technologies used is equally effective. The Client immediately identifies design errors and system defects. And the Contractor controls the quality of the Client’s knowledge mastering about the system and process.

Analytical simulator designed to create a system carries on as a trainer to maintain proficiency and to train new operating personnel, since it simulates emergency modes of system operation, impossible to be simulated at the real operating equipment.

The given approach implements the principle of "Tell me and I forget, teach me and I may remember, involve me and I learn" by Benjamin Franklin. Such project-based learning takes place through creating a joint "Contractor-Client" model of the future system and testing it. Models testing together with review of reporting design and technical documents contribute to the knowledge acquisition as well as allow identifying the quality of gained knowledge. Operational feedback allows effective personnel shifting engaging engineers and trainers with needed skills.

Practices for personnel training given here proved to be effective not only during implementation of several projects at Chernobyl NPP, but also found successful use for training students of Slavutych branch of National Technical University of Ukraine "KPI".

Bibliography

[Saveliev, 2013] M.V.Saveliev. Selection of the life cycle model in projects in the field of information technology. Proceedings of the X International Conference PMKiev13. , Kiev, 2013.

[WHO, 2006] Health Effects of the Chernobyl Accident and Special Health Care Programs. World Health Organization. 2006.

[Bushuyev, Medintsov, 2013] Bushuyev S., Medintsov V.Diversification of Chernobyl's Power Plant Function Through Prism of Project Management, PM World Journal Volume 2, Issue 10 October 2013

[GOST-34, 1992] ГОСТ 34.603-92 Information technology. Types of automated systems tests.

Authors' Information

Maxim Saveliev *– IMMSP NAS, SSE Chernobyl NPP, Ukraine;*
e-mail: saveliev.maxim@gmail.com

Major Fields of Scientific Research: Software Engineering, Automated System Life Circle Models, Requirements Evolution, System Analysis, System-of-Systems

Vitalii Lytvynov – Dr. Sc. Prof. Chernihiv National University of Technology, 95, Shevchenko street, Chernihiv-27, Ukraine, 14027; vlitvin@ukrsoft.ua

Major Fields of Scientific Research: modeling of complicated systems, computer-aided management systems, decision support systems