PROJECT MANAGEMENT AS A BREAKTHROUGH AT CERN

P. Ninin ST Division – Monitoring and Communication Group (ST/MC)
M.Vanden Eynden SL Division – Controls Group (SL/CO)
CERN, Geneva, Switzerland

Abstract
Building and maintaining control systems for high-energy physics is becoming an increasingly complex and costly activity. The quickly evolving technology and the tight budget conditions require today a better management of our engineering activities. This situation led us to organize these activities as "projects" and to use modern project management practices already widely spread in industry. In this context, many aspects of the re-engineering of the controls infrastructure of the two CERN largest particle accelerators - SPS and LEP - as well as the supervision of the CERN wide technical services are fully conducted as projects with special control over the costs, resources, objectives, activities and maintenance aspects. This paper presents our experience in project-based management with special emphasis on its applicability in a research environment, the impact on the current working practices, and the potential benefits for the future. Some key concepts and techniques of project management are introduced and illustrated through practical examples.

1. INTRODUCTION

The fast technology evolution and shrinking budgets have major impacts on the engineering activities at CERN. New technology requires more expertise but also greater care before being deployed. A lack of strategy in this domain leads either to the wrong belief that jumping to new technology will solve all problems, or to deadlock situations where people embark in endless system modifications to satisfy unclear objectives.

Equally important, laboratories like CERN will have to contract out some of their computing activities to industry. This requires first that CERN engineers who build control systems for high-energy physics understand and practice themselves modern project management methods widely used in industry.

How to face these important challenges? How to consolidate our approach to new technology insertion? How to define clear requirements and strategic choices?

How to provide quality? How to create and animate teams towards important CERN objectives? The next sections illustrate how project-based management may provide an answer to these questions.

1.1 Why Do We Need a Project-based Approach?

Projects can be seen as a temporary endeavour undertaken to create a product or service. Projects are fundamentally different from ongoing activities because they cease when their declared objectives have been attained, while non-project undertakings adopt a new set of objectives and continue to work. As we see, projects require the definition of objectives and timetables. As the project must end at a fixed point in time, engineers will organize their activities and will define strategies instead of rushing prematurely in endless developments. Projects, by definition, encourage good engineering practices. We experienced that, in a challenging situation, the combination of a team, a common unique objective and a deadline was the catalyst which releases the energy.

1.2 Why Do We Need Project-based Management?

As we have seen, a project encourages engineers to better organize their activities. Encouragement is good but solutions are even better.

While many engineers claim to work in "projects", project-based management practices are rarely applied. This remark makes all the difference between what we propose for the future and the present situation: the term project management is sometimes used to describe an organizational approach to the management of ongoing operations. Controls Projects involve new and unknown tasks, lead to a change in people's daily work, and are subject to strict deadlines. Therefore, project management means organizing, planning and controlling the project.

2. PROJECT-BASED MANAGEMENT IN PRACTICE AT CERN

Since three years, several project-based management experiences in the field of controls have taken place in the CERN SL and ST Divisions: the CERN SL PowerPC Project [1], the CERN ST TDS Project [2], the CERN SL SSIS Project [3] and the CERN SL Apollo97 Project [4]. As shown in Table 1, these controls projects involved both CERN and external manpower and had direct impact on the operation and performance of the two largest accelerators at CERN – SPS and LEP. Some projects were re-engineering projects while others were aimed at inserting new technology. This diversity of objectives contributed to enrich our experience in the field of project management and led us today to manage controls projects as described in the following sections.

Table 1

Recent CERN SL and ST Controls Projects

Project	Description	Resources
CERN SL Apollo97	Migration and re-engineering of SPS machine software from Apollo towards HP-UX platform. CERN + IHEP Protvino Collaboration.	3 man/year
CERN SL PowerPC	Replacement of CERN SL front-end computers by VMEbus PowerPC systems. CERN + Industry Collaboration.	7 man/year
CERN SL SSIS	Re-engineering of SPS software interlock system. Project contracted out to Industry.	3 man/year
CERN ST TDS	Large scale supervision system for CERN technical services. CERN + Industry Collaboration.	6 man/year

2.1 What is Important?

A project requires the establishment of an organizational structure and the management of work within that structure with the assistance of specific methods and tools [5]. As shown in Figure 1, there are three important areas of project management: planning, organization and control.

Task / Level	Project Planning	Project Organization	Project Control
Global	Objectives Mandate Milestone plan	Responsibility *Who will do what ?*	Milestone Reports
Detail	Activities *How will it be done ?*		Activity Reports

Figure 1. Overview of Project Management

2.2 Project Planning

As shown in Figure 2, project planning at launch time is aimed at achieving a common understanding of the task to be resolved and to lay the foundation for allocating and committing resources [6]. Planning is also aimed at obtaining an overview of the work to be carried out and at defining how control and monitoring take place. We have experienced that planning must be a group activity. If all the project members are involved, they acquire a common insight into the project and a common understanding of future requirements. Planning should be an opportunity to think anew, from a different perspective, and to test ideas in a stimulating environment. It is also the best way to obtain commitment.

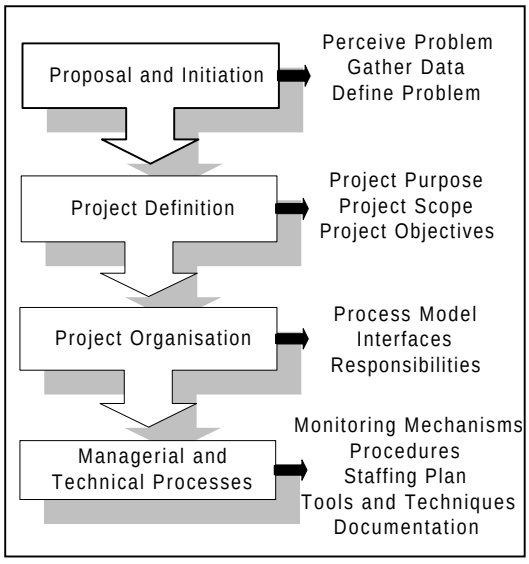

Figure 2. Launching a Project

Launching projects this way is quite innovative: it brings high transparency in the organizational activities and allows managers to better control their resources. As shown in Figure 3, an important aspect of project planning is the “Milestone planning” [5]. Milestone planning is important because it shows the logical sequence of the conditions or states a project must pass through to achieve the final objectives, describing what is to be achieved at each state, not how the state is to be achieved.

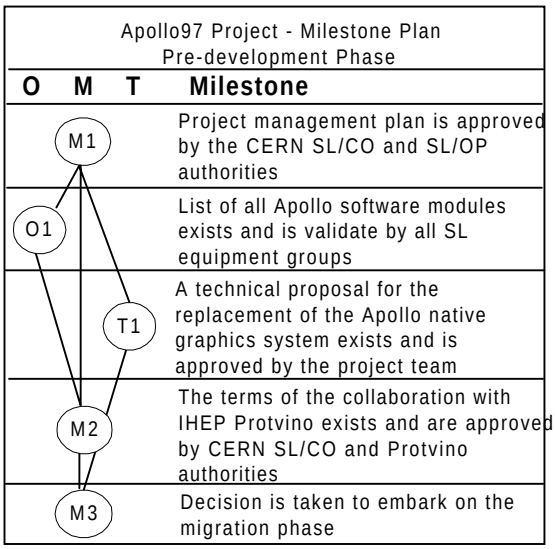

Figure 3. Milestone Planning.

The circles represent the milestones and the lines joining them the logical dependencies between them. The milestone plan can be seen as a logical network for the project. Milestones are grouped into vertical columns representing the areas of work. For example, the CERN Apollo97 project involved important milestones in different areas of work: some management decisions (M) had to be taken before embarking in technical activities (T). Some organizational activities (O) were required in order to take management decisions.

2.3 Project Organization

Projects are rarely isolated from the rest of an organization. Project activities involve people from and outside the project. For example, line managers will have to be consulted before taking important project decisions or external organizations entities may provide some services used by the project. Project organization is aimed at clarifying all roles and responsibilities. Because each project is unique, organization should be as suitable as possible with regard to the task to be performed. As shown in Figure 1, organization occurs at two levels: a project responsibility chart explains the roles of the different parties in important project matters. Project responsibility charts are directly derived from the project milestone plan: responsibilities should be established for each project milestone. At a later stage, the activity responsibility charts explain and describe the roles of specific people in concrete project activities (i.e. writing a software module).

2.4 Project Control

What is project control? Project control is different from project monitoring. While project monitoring is describing what has occurred and what the situation is, project control is doing something about what the project reports show. Control is management, not paper work, it must happen through discussion, analysis, and results in measures which improve the situation of the project. As shown in Figure 1, reporting can be done at the global project level (milestone plan report) or at the project activity level (activity plan report). At the project level, reporting must give an account of which milestones have been reached. It should also state whether anything in particular has occurred in the work toward reaching the milestone which is of interest for the management of the organization. At the project activity level, reporting must state if a resource estimate shows itself to be wrong or if particular human or technical problems have been encountered. Even more important, project control is not only aimed at looking at problems, it should also motivate people on objectives by providing encouragement.

3. PROJECT-BASED MANAGEMENT IN A RESEARCH ENVIRONMENT

As we have explained, project-based management in the domain of controls has many potential benefits for engineers and managers of organizations like CERN. Of course, stepping into this new approach affects the organizational culture and requires great care to be taken. An organization needs to adapt considerably to accept the different culture of projects. This can occur in one of two ways: in a composite environment, in which controls projects and operations sit alongside each other; or in a project environment, in which all the organization's work is managed through projects. When introducing the composite environment, the organization undertakes a few, isolated projects to introduce specific changes into the operations environment. Many people in an organization (managers and engineers) are uncomfortable with the impact this structure has on the working environment, creating resistance to change. The following sections explain how to overcome this resistance.

3.1 Deciding about the Organization

The structure of organizations often constrains the availability of, or the terms under which resources become available to projects. Organizational structures can be characterized as spanning a spectrum from functional to "projectised" [7], with a variety of composite structures in-between. It is mandatory for the organization of controls projects to decide which model should be used. Figure 4 shows the composite organisation. This kind of organization is good because the old structure is still in place, allowing local controls projects to take place in a given section while larger controls projects can take place in a project-based perspective. In this scheme, groups and individuals are arranged in various constellations of responsibilities and authority, depending on the matter involved. It is also true that nowadays problems are complex and are rarely of such nature that they can be resolved at one specific place in the base organization. Many sections of the organization must be involved.

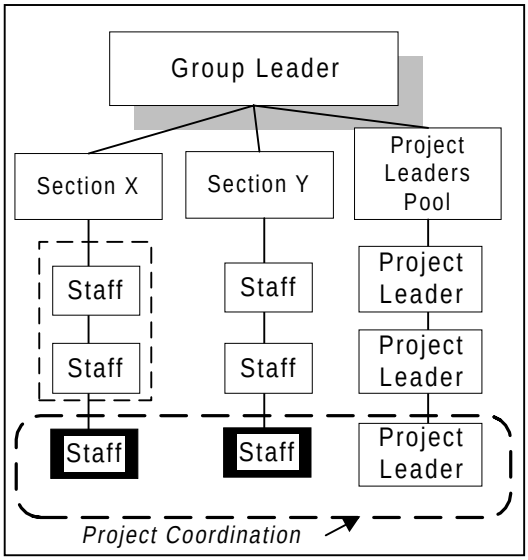

Figure 4. Composite Organization.

3.2 Participation

Implicit within the notion of organization development is the need for people to participate fully in the change process. It is often said that people resist to change. In reality, people resist having change imposed on them [5,8]. Managers should ensure that the need for change is explained and that the objectives and benefits of the project-based approach to specific groups are fully understood. If people understand the objectives and see that those objectives may be of benefit, they are more likely to contribute positively to the change.

3.3 Training and Development

Our recent experience has shown that training and development of new skills are mandatory.

"*Project management is not a matter of reading methods and applying them on top of our working practices. It is new culture"*.

Training should be as close as possible to the practical reality of projects. Good and bad examples run in the organization should be analysed and discussed during training. Modern project management techniques like *Goal Directed Project Management* [5] *and ESA PSS-05* [9] should be explained. A culture of project should be developed.

3.4 Commitment from the Management

Project managers must have the backing and commitment of the management. This is because the use of this new approach requires long-term planning and dedication at all levels of the organization, and because the project manager must have, and must be seen to have, the authority and autonomy to run his project. Management should demonstrate that it wants to manage its projects and is concerned with the progress of its projects. Finally, the organization must take use of its own experience and constantly develop project expertise in order to cope with the evolution of the technical, scientific and economical context.

4. BENEFITS AND CONCLUSION

In this paper, we have explained that the growing complexity and cost of High-Energy Physics engineering activities require the best possible management and commitment through organizations like CERN. Future engineering activities will involve even more collaborations between different sections of research institutes, but also contractual relationships with high-technology industries. This is matter of concern for everybody at CERN. Project-based management has been experienced recently for several controls projects and has proven its success from the human, organizational and managerial points of view. A recent inquiry showed that *100%* of the CERN staff members involved in the CERN controls projects referenced in this document want this approach to be developed at CERN [10] and would prefer to work in a project-based approach if they had the choice in the future. Time has now arrived to develop a wider culture of controls projects by explaining, encouraging and motivating the CERN engineers towards a new approach of engineering which improves the communication in the organization, commits people to clear objectives, brings transparency of information, resources and cost usage and, last but not least, encourages creativity. This will not be possible without the commitment of the management.

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