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Development and implementation of project managers' training at the DLR Space Administration

Acting on a mandate from the Federal Government, the DLR Space Administration (DLR SA) is responsible for the establishment, the planning and the implementation of the German Space Program, which encompasses the activities on the national as well as the European level. A key activity thereby is the project management process, which includes the implementation of unique internal DLR SA procedures in the areas of project management, system engineering and product assurance. The DLR SA endeavors to make use of the best knowledge and practices in these areas, available in Germany and in Europe. For this purpose, DLR SA has adopted the ECSS space standards and uses them as a basis for all of its projects. Coupled with the well-designed and well-structured DLR SA internal management processes, the implementation of the ECSS standards provides for improving the quality of the project management. A very important prerequisite for success in this business is that the project managers have been trained on the correct usage of the DLR SA procedures and the ECSS standards to guarantee conformity and adequate handling. In November 2008, the DLR SA began the development of a dedicated training for the project managers. The training is directed at the fulfillment of the DLR project managers' tasks in areas of project management, system engineering and product assurance. In April 2011, the first session of the training was successfully conducted. In this paper, we share our approach to the training's objectives and curriculum, as well as key lessons from our experience in the project managers' training development and implementation.

1. Introduction

A project in the DLR SA is defined as a strong business endeavor undertaken to achieve a unique set of scientific, technical, technological and programmatic objectives under the constraints imposed by the pre-defined schedule, the costs and the other resources. The DLR SA plays the role of the customer in all of its projects, while the German industrial enterprises are normally the suppliers and are bound to produce the required products or to provide the required services by contract or by other cooperation conventions. The basis for the contract between the customer and the supplier is the Statement of Work, which defines the project objectives, the high level requirements and the constraints. These requirements are later transferred into the Technical Requirements Specification. In the project management process, the DLR SA sets a very high value on the correct implementation of the in-house management processes that involve the project management office, as well as the project support, the product assurance and the business

administration departments. The project support department is responsible for making sure that all product requirements, including functional, mission, design, operational, and other technical requirements are adequately allocated for each project. The product assurance department has the same function for the corresponding product assurance requirements. Besides, the project support and the product assurance departments are responsible for definition of the ECSS requirements for the projects, including tailoring of the management, the engineering and the product assurance standards. The project support department conducts the project reviews to assess the fulfillment of the project objectives dedicated to the correspondent project phase, to state on the project development maturity, and to release the project for the next phase in his life cycle.

The project management process in the DLR SA has revealed to be a complex process involving several stakeholders and requiring the accurate fulfillment of different tasks. To improve the quality of the project management

in the DLR SA, the strong project management support has been established that includes among other things the proper training of the project managers. This paper will provide an insight into the concepts of the DLR SA for establishing and conduct this training.

2. The areas of the project manager's competence

Considering the project management organization as a multi-level customer-supplier network with the DLR SA on the top, we cannot overestimate the role of the qualification and the competence of the DLR SA project manager, who is responsible for the overall success of the project. Apart from the adequate technical background, the project manager should be able to manage the team, to administer the organizational and the interpersonal interfaces, and should have a profound knowledge of the management procedures in areas of the project management, the system engineering and the product assurance.

Three main areas of the project manager's competence are described in [1]. In the preparation of our training concept, a distinction was made between the ability of the DLR SA project manager in the social area (social competence), in the methodological area (methods and tools/ cross-sectional disciplines) and in the specific project management area, which is called "professional competence" and is associated with the project management processes applied in the DLR SA (Figure 1).

Areas of project managers' competence		
Social competence	Methods and tools / cross-sectional disciplines	Professional competence
Communication techniques Management competence: Motivation, delegation, supervision, team building Negotiation techniques Conflict management	Project management General knowledge Project administration tasks and in-house procedures Decision making and problems solving (Kepner-Tregoe) Development of strategy and definition of goals Time management Presentation techniques	Project management Planning, Implementation, Risk management System Engineering Planning, Requirements, Specifications, Verification Product assurance Planning, Requirements, Correction measures

Figure 1. Three areas of the DLR SA project manager's competence

Since the project manager needs to be competent in all three areas, he needs a dedicated training in each area. The first two areas (the social competences and the methods) have been covered by the DLR generic training provided by the DLR personal development department. The third area (professional competences) represents the very specific processes that have to be applied at the DLR SA and had not been covered by any training. This specific training was the subject of our interest.

3. The training development and implementation process

3.1. General concept

The training development and implementation process, which has been established and applied in the DLR SA, is shown in Figure 2.

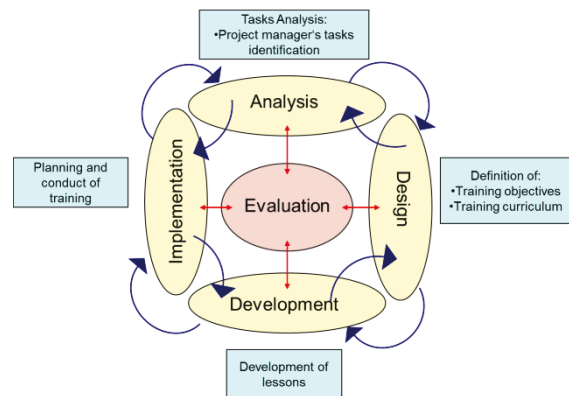


Figure 2. The training development and implementation process [2]

The process consists of four sequential steps [2]:

- **Analysis:** To identify the required training needs, the project managers' tasks and activities have to be analyzed. The outcome of the analysis is the list of knowledge and skills required to fulfill the identified tasks.
- **Design:** Based on the defined list of required knowledge and skills, the training objectives can be defined and the training curriculum, which covers all training objectives, can be established.

- Development: The training lessons have to be developed with the content that is established in the training curriculum.
- Implementation: The training session can be planned and conducted.

As we can see from Figure 2, the training development and implementation process is an iterative process. The center of the process is the evaluation, which is very important to improve the lessons' content, to keep the lessons up-to-date and to implement the "lessons learnt".

3.2. Tasks analysis

The approach was based on the practices from [3].

The basis for the tasks analysis was the set of internal project management processes established at the DLR SA that consists of four main processes: the project initiation, the project planning, the project implementation and the project reviews processes. Each process has been brought down into detailed tasks to be performed in sequential order. Thereby each task has been elaborated to the level of activities to fulfill the task.

To define the training needs, the internal processes have been analyzed and the activities have been elaborated to a degree which is sufficient to answer the question: What knowledge is necessary to perform this activity and what practical skills need to be developed? This first analysis' step was followed by a brainstorming session that was organized at the DLR SA as a workshop with participation of experts and experienced project managers in October 2008.

The result of this brainstorming session was a list of training needs in the form of knowledge and skills, which require either special training or just a particular type of support (for example samples of documents, examples of successful implementation, or other pieces of information).

3.3. Design and development phases

The results of the brainstorming session were carefully processed, as the identified training needs (knowledge and skills) were transformed into the training objectives. The training objectives were grouped logically to build the respective lessons. The content of each lesson was discussed in the team of trainers and harmonized subsequently. Once the first draft of the training curriculum had been created, it was shown to experienced project managers to obtain their feedback and further suggestions. There were several cycles of this process until the training curriculum was finalized and the development of training lessons could start.

During design and development phases, the trainee qualification and the level of teaching caused the most frequently arisen discussions. Following important and not obvious questions had to be answered:

- a) Who should address the training – the inexperienced only or also the experienced project managers?
- b) What strategy and teaching form should be used in the lessons?
- c) What level of training (i.e. knowledge) should be provided?
- d) What should be the duration of each lesson and subsequently of the entire training course?

To solve these questions, several factors were taken into consideration, such as trainers' and trainees' availability (personnel and time resources), training request from DLR departments, as well as the level of the training that was expected by the potential trainees. Eventually the following concept has been implemented:

- a) The trainee group should be a mixed group of some experienced and some inexperienced project team members. This concept has been seen as an asset for both categories.
- b) The presentations, the leading discussions and the practical exercises have been selected as the possible teaching forms. Thereby the leading discussions and the contribution from the experienced project managers should be especially promoted.
- c) The adequate level of the training has been defined as a good general knowledge level, with some details

provided up to a comprehensive level. The level of each lesson has to be easily adapted to the needs of the particular trainee group.

- d) The duration of the entire course was estimated to be maximal four full days.

The training curriculum contains lessons in the areas of the project management, the system engineering and the product assurance. The content of the course reflects the specific of the DLR SA as a space agency with the pure management tasks. That means for example, that the lessons dedicated to the system engineering do not describe the technical system's concepts themselves, but the system engineering management tasks and methods instead. The course provides the sufficient amount of information for the project managers how to manage the project efficiently.

3.4. Overview of the training content

As it has been already mentioned, the entire training course contains lessons in the project management, the system engineering and the product assurance domains. Below, the high level overview of the training content is done:

1. *Introduction to the project management in the DLR SA:* The frame conditions of the project management in DLR SA; the DLR SA project management processes/regulations; documentation.
2. *Project management according to ECSS:* Key elements of the project planning and implementation on the basis of the ECSS standards.
3. *Introduction to the ECSS system:* The overview of the ECSS structure and architecture and the applicability of the ECSS E- and M-standards in DLR SA.
4. *System engineering process and tasks:* The SE planning and organizational principles, the SE process and tasks over the entire project life cycle, the requirements engineering principles, the verification process.
5. *Technical requirements engineering:* Definition of user and customer needs and the technical requirements for the project, SE documentation.

6. *Product assurance and safety:* Principles of quality assurance, prevention of quality deficit, the frame conditions of the PA management in the DLR SA, the applicability of the ECSS Q-standards in the DLR SA, the support provided by the PA department for the projects in subjects of safety, reliability, software as well as in EEE-parts qualification, and the PA documentation.
7. *Risk management in the projects of the DLR SA:* Risk management policy, the internal DLR SA regulations and support, the risk management process and the risk management tool, which has been developed in the DLR SA to support the risk management analysis in the projects.
8. *Two special topics on request of the project managers:* Frequency management and debris avoidance regulations and procedures.

4. Training implementation

To provide for better training conditions, the number of trainees was limited to 8-12. The training room was equipped with two pin walls, one clip board and the beamer. Most of the lessons made use of Power Point presentations. Several explanations and exercises were performed on the pin walls. The well-conducted leading discussions were a success. The possibility to discuss the matters "ad hoc" was appreciated very much. This technique was recommended as indispensable part of the course in the future. Moreover, the trainees expressed their eagerness to continue these discussions beyond the training course, at dedicated meetings, which could be organized regularly to exchange experience between different projects and to share the "lessons learnt".

So far, three training sessions have been organized and conducted: The first one was in April 2011 and the subsequent sessions in March 2012 and in March 2013. Each session lasted four full days. The number of trainees was 13, 9 and 10 respectively. There was a mixed group of participants in both cases (both, the experienced and the inexperienced project managers). The both groups gave a positive feedback to the course.

5. Trainee satisfaction survey

After each training session, a de-briefing was conducted, where the results of the training and the recommendations were discussed. Additionally, in order to capture the key critical points and to obtain the desirable profile of the future training, the "Trainee satisfaction survey sheet" was developed, which had to be filled in by the trainees after each training session. The trainees had to assess each lesson with respect to each lesson objective through their personal comments and by answering the dedicated questions.

The results of the surveys, which were conducted after each training session, proved the adequacy of the overall training concept. The overall assessment was very positive. It was recommended to offer this course not only to the project managers but also to all employees who are involved in the project work. The comments and the recommendations of the trainees have been recorded and will be considered in the future training.

6. Conclusions

Modern project management requires sound knowledge of the project management principles and techniques applied to three domains that are constantly expanding in their complexity: the project management itself, the system engineering and the product assurance. The growing complexity and costs of space projects require a more efficient approach to the project management. The necessity of well-structured training has become obvious.

Through the tasks analysis performed in the DLR SA, the training objectives and the content were defined in an efficient way, i.e. avoiding the unnecessary information and satisfying the trainees' needs.

We can say, the DLR SA training has been "tailored" to the DLR SA projects with respect to the DLR SA frame conditions, responsibilities and specific regulations.

According to the feedback given by trainees, the level and the duration of the training were adequate. More detailed training is not possible

within four days. Training lasting longer than four days is not desirable due to time constraints. The amount of information received during the training was sufficient, so that the information could be applied in the projects straight away.

Following the recommendation from the trainees, the quarterly "lessons learnt" exchange has been organized for the project managers by the project support department.

7. References

- [1] Harry Zingel "Grundzüge des Projektmanagements", Version 3.3, 2000-2005
- [2] Instructor training course (ITC), NASA in cooperation with ESA/EAC, Cologne, Germany, November 2002
- [3] DACUM (Design a curriculum) common practices of NASA in cooperation with ESA/EAC

8. Abbreviations

DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
EAC	European Astronaut Centre
ECSS	European Cooperation for Space Standardization
ESA	European Space Agency
NASA	National Aeronautics and Space Administration
PA	Product assurance
SA	Space Administration
SE	System engineering
SW	Software