INTERNATIONAL SYMPOSIUM ON PROJECT APPROACHES IN ENGINEERING EDUCATION

Project Management Guide for Student Project Teams

Natália Almeida[*], Camila Carrer[+], José Dinis-Carvalho[#], Rui M. Lima[#]

[*]Industrial and Management Engineering Master Programme, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal
*Production Engineering Course, Universidade Estadual Paulista, Campus of Bauru, 17033-360, Bauru/SP, Brazil
[#]Production and Systems Department, School of Engineering, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal

Email: nc.almeida88@gmail.com, camilacarrer@hotmail.com, dinis@dps.uminho.pt, rml@dps.uminho.pt

Abstract

Project based learning is a methodology based on students' teams developing interdisciplinary work to deliver an outcome as a result of a project. The engineering students' teams when performing project work have to adopt project management methodologies. Assuming that the quality of the results on project work is also dependent on the project management methodology applied and that project management is one of the competencies to be developed during engineering degrees, this paper presents a project management guide to be followed by students' teams involved in large projects. This project management methodology is the result of the experience of students and teachers involved in project based learning practices in the last 6 years in the engineering school at the University of Minho.

Keywords: Project based learning (PBL); Project management methodology; Team work; Engineering Education.

1 Introduction

The Portuguese Ministry of Science, Technology and Higher Education (MCTES) refers as essential the adoption of an educational system favoring the development of experimental work and project work competencies (MCTES, 2008). They are also in favor of adopting active learning methodologies in cooperative and participative environments and focused on problem solving. The learning outcomes expected in engineering education go beyond the technical competencies listed in traditional engineering programs. Besides the specific technical competencies associated to a professional area, the transversal competencies related with communication, project management, team work, autonomy, etc., are also relevant competencies to be achieved by engineering students. Project Based Learning (PBL) is one of the learning methodologies more effective in creating this range of competencies (Helle, Tynjälä, & Olkinuora, 2006), (Lima, Carvalho, Flores, & Hattum-Janssen, 2007) and (Powell & Weenk, 2003). PBL is becoming a quite popular learning approach in many Engineering universities across Europe and in many other countries in the world because is an effective way of motivating students to work while promoting cooperative learning, critical thinking, communication competencies, project management competencies, learning by doing, autonomy research and engage students in investigating authentic problems. All these competencies are more than welcome in the organizations.

The quality of the deliverables in project work and the learning effectiveness associated depends on a great deal on the project management methodology adopted by the students' team as well as on the team member project management competencies. The size of the projects that we are considering in this article is large enough to be highly dependent on the project management effectiveness.

When a project is assigned to a team of students without appropriate project management training, which is normally the case in many engineering education institutions, students' teams tend to assume intuitive approaches resulting normally in poor results. The students' teams from the department of Production Engineering and Systems at the University of Minho normally perform typically quite well in the first 2 or 3 weeks and then they tend to lose part of the control of some tasks and of what every member is doing. Some of the problems that we recognise as common among student teams undergoing large projects are:

- The motivation, although starting with high levels in the beginning of the project, gradually decreases along the semester. Sometimes the motivation increases again at the end of the semester.
- Very frequently the objectives are not clearly understood by every member.
- Very little effort is given to planning.
- Very little effort is given to monitoring.
- The work load is not levelled along the semester.
- The work load is not assigned equally to every team member.
- The initial plan is not followed nor adapted along the semester.

- The focus on the original objectives is frequently lost.
- The tasks descriptions and assignments are frequently fuzzy.
- …

Assuming that all these difficulties that are typically connected to project work carried out by student teams and also assuming that it negatively influences the results and team performance a project management methodology was developed aiming to lead students' teams to achieve better project results.

The objective of this paper is to present a project management guide proposal specially oriented to teams of engineering students involved in relatively large interdisciplinary project following the Project Led Education principles (Powell and Weenk 2003). As a relatively large project we consider a team of 6 to 8 students involved in a project corresponding to half of the semester total work. In the context of the Bologna process a new credit system was defined based on total learning work, including the work developed in direct contact with teachers and work developed in autonomously way: European Credit Transfer System – ECTS (European Commission, 2009). Considering that in our Engineering Scholl 1 ECTS is equivalent to 28 hours of work, a half semester project has 15 ECTS and corresponds to a minimum of 2520 hours*man. This methodology will allow the teams of students to be more effective in project work as well as developing solid project management and team management competencies.

2 Project Management Guide Proposal

For MIEGI's students have contact with practices and develop competencies in project management, it is intended to present a project management guide designed for supporting teams with a set of forms. This guide will allow students to apply project management techniques, guiding them in this process. In the creation of this guide, there was the concern to provide a tool, easy to understand, little bureaucratic and easier to use by students teams.

The proposed guide is supported by forms, guidelines and procedures in order to help students in the project management process as well as in the inherent records during the project life cycle as can be seen in Figure 1. In this work a project life cycle for students was developed that is based on three fundamental phases: initial, intermediate and final.

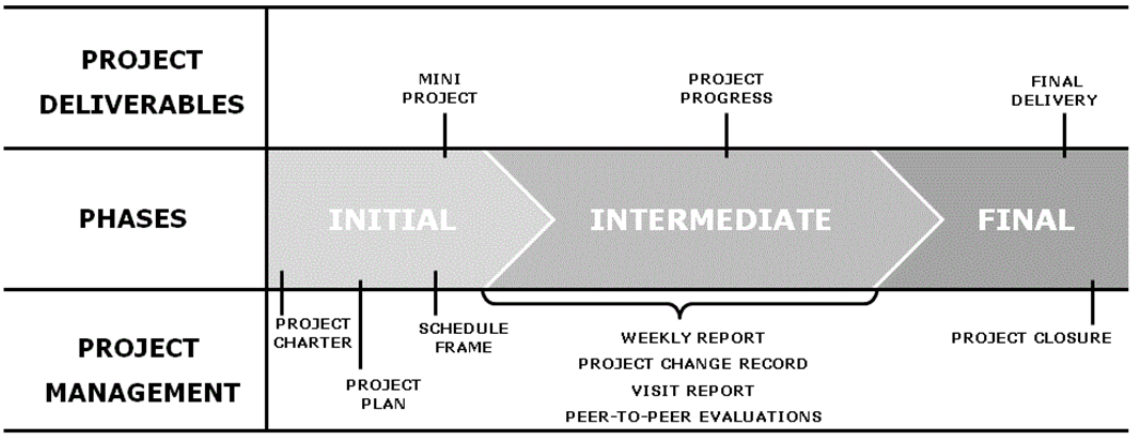


Figure 1: Students' Project Management Framework – based on PMI (2004).

The forms are categorized as follows: General Information, Project Charter, Project Plan, Schedule Frame; Weekly Report; Visit Report, Project Change Record, Peer-to-Peer Evaluation and Project Closure. In parallel with the forms, students have access to detailed explanations, including examples, of how to fill them and when they are required. Thus, students can apply project management techniques designed specifically for these kinds of projects.

2.1 Initial Phase

Project Initiation phase is characterized by the project approval and by project planning. For this purpose, it is necessary that students understand how important it is to spend time and effort in project planning, mainly to define activities and refine the project objectives.

The coordination team starts the semester presenting objectives and general guidelines of an open project. After this presentation, the teams should meet to share ideas and experiences, to choose the team Leader, if necessary, and look for support from teachers and tutors in order to fill the GENERAL INFORMATIONS form. This form contains general information about the project, such as the project theme, the team members, the team leader and the team tutor, the courses involved in the project and the coordination team, as well as the identification of the company when applicable.

Throughout the first week, team members should meet several times to discuss and reflect about the project and related issues in order to complete the PROJECT CHARTER form. Thus, teams should identify the project stakeholders, the general and specific objectives, the project scope and its milestones. Figure 2 shows an example of the specification of general objectives and scope contained on PROJECT CHARTER form. The PROJECT CHARTER is a document intended to formalize the beginning of the project and it must be filled in a meeting and approved by the team leader and team tutor.

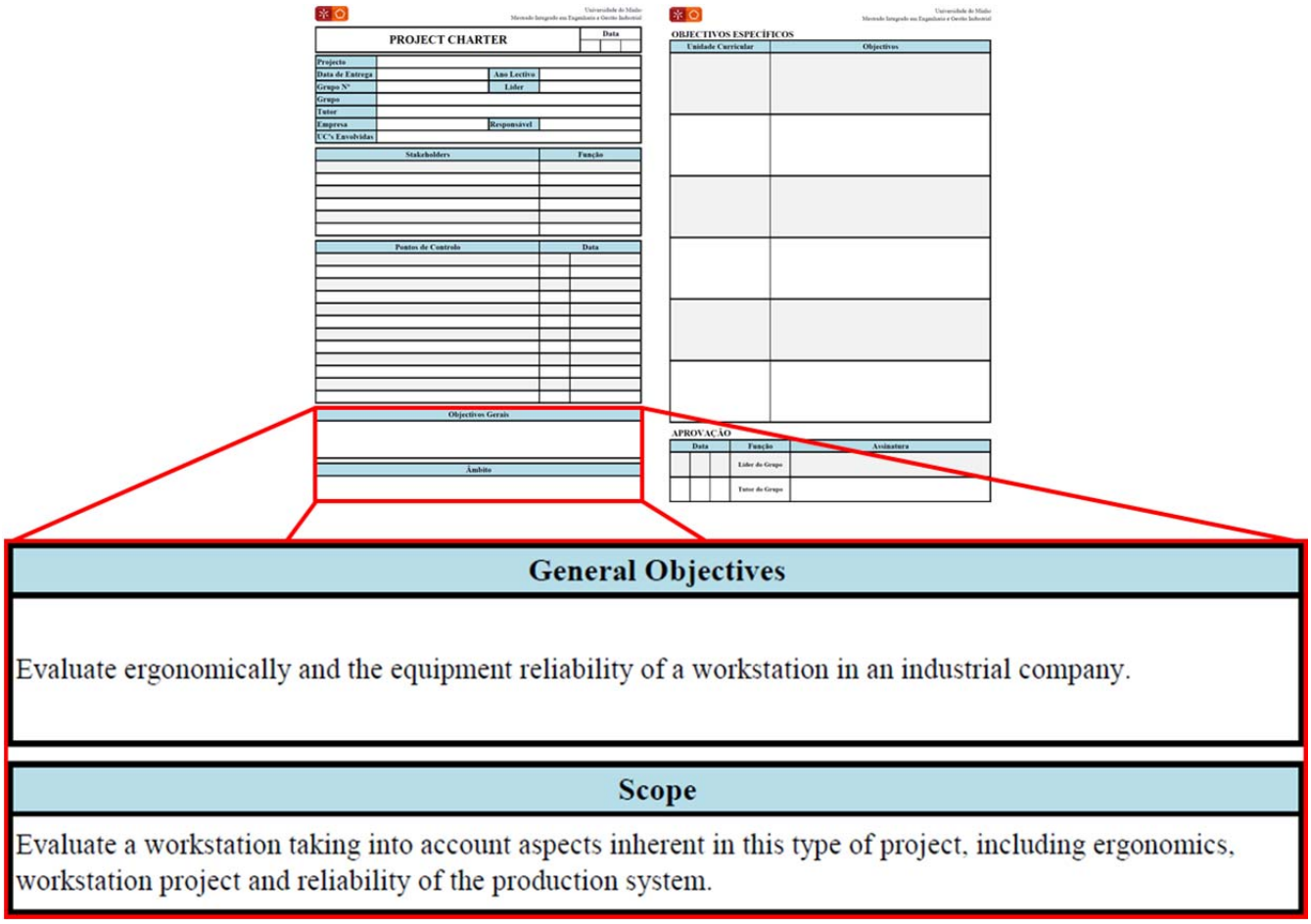
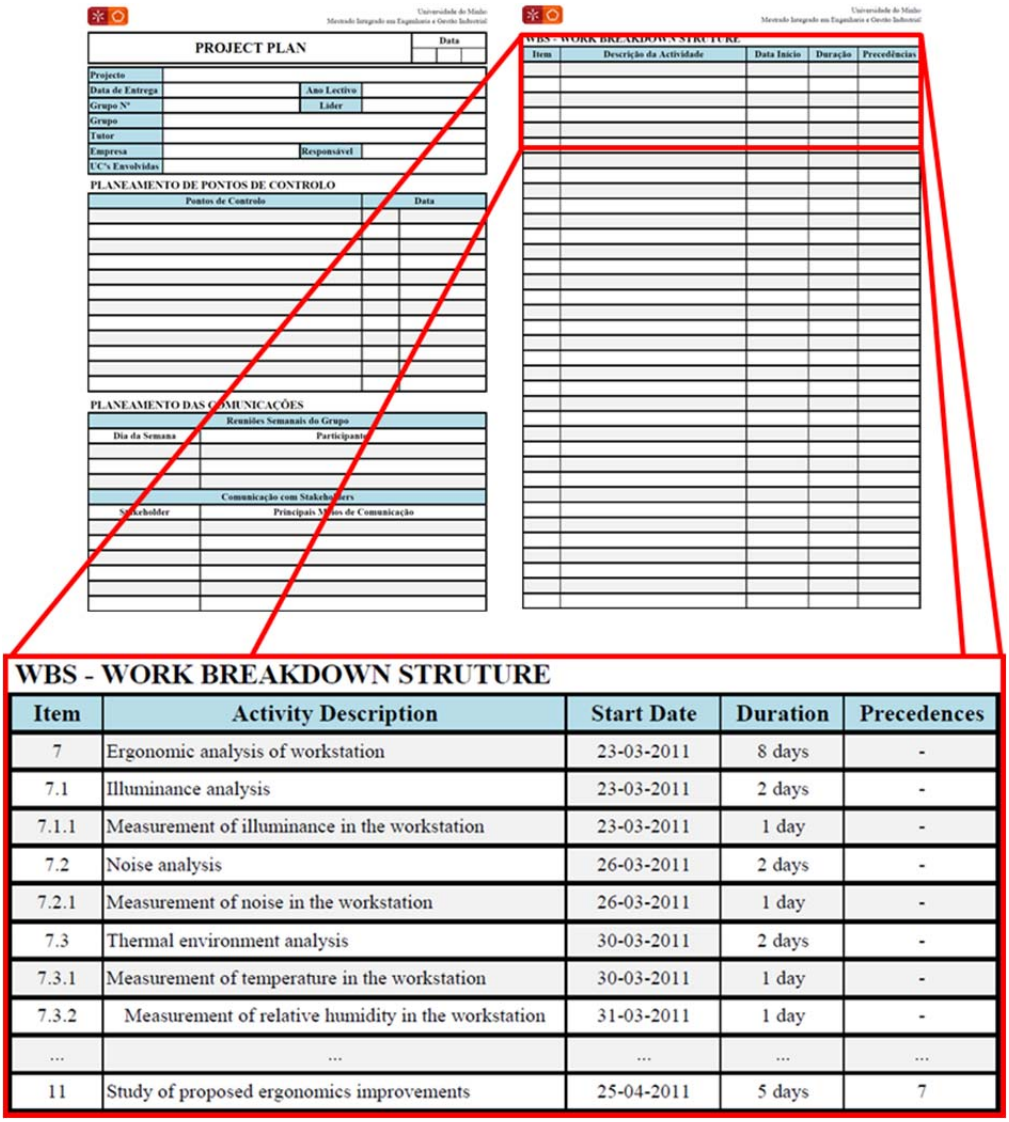


Figure 2: Extract from Project Charter form - example of Project General Objectives and Scope

In the same first week, teams must also dedicate time to make a plan for project and fill the PROJECT PLAN form. This form aims to support different planning aspects: milestones, communication between stakeholders, schedule meetings and create the WBS (Work Breakdown Structure). Figure 3 presents an extract of WBS included on PROJECT PLAN form. During the project, there are expected changes and updates of this form whenever is necessary.



PROJECT PLAN

Data

Projecto			
Data de Entrega		Ano Lectivo	
Grupo Nº		Líder	
Grupo			
Tutor			
Empresa		Responsável	
UC's Envolvidas			

PLANEAMENTO DE PONTOS DE CONTROLO

Pontos de Controlo	Data

PLANEAMENTO DAS COMUNICAÇÕES

Reuniões Semanais do Grupo	
Dia da Semana	Participante

Comunicação com Stakeholders	
Stakeholder	Principais Meios de Comunicação

WBS - WORK BREAKDOWN STRUCTURE

Item	Descrição da Actividade	Data Início	Duração	Precedências

WBS - WORK BREAKDOWN STRUTURE

Item	Activity Description	Start Date	Duration	Precedences
7	Ergonomic analysis of workstation	23-03-2011	8 days	-
7.1	Illuminance analysis	23-03-2011	2 days	-
7.1.1	Measurement of illuminance in the workstation	23-03-2011	1 day	-
7.2	Noise analysis	26-03-2011	2 days	-
7.2.1	Measurement of noise in the workstation	26-03-2011	1 day	-
7.3	Thermal environment analysis	30-03-2011	2 days	-
7.3.1	Measurement of temperature in the workstation	30-03-2011	1 day	-
7.3.2	Measurement of relative humidity in the workstation	31-03-2011	1 day	-
...	...	...	...	...
11	Study of proposed ergonomics improvements	25-04-2011	5 days	7

Figure 3: Extract from Project Plan form - example of WBS (Work Breakdown Structure)

Alternatively, the WBS can be created with suitable software, for example, Microsoft Office Project. To create the WBS, the team should identify all the activities that should take place throughout the project, although the project progress may cause several changes in the WBS.

Within the context of the PROJECT PLAN it is suggested the filling of the SCHEDULE FRAME, which consists of a tabular board where information can be printed and where team members can stick small pieces of paper (post its) with relevant information such as the identification of activities, responsibilities and deadlines, as shown in the Figure 4. Being a visual tool presented on the team project area (where the team spends most of the working time) this board aims to keep a permanent overview of the progress of the project. This visual tool aims a more effective planning and control of all project activities.

In this framework, the milestones, vacations and holidays must previously be filled with highlighted colors. Alternatively, those who create the WBS and a Gantt chart using project management software application can print it and use it as the tabular board background with a similar effect as the board suggested above.

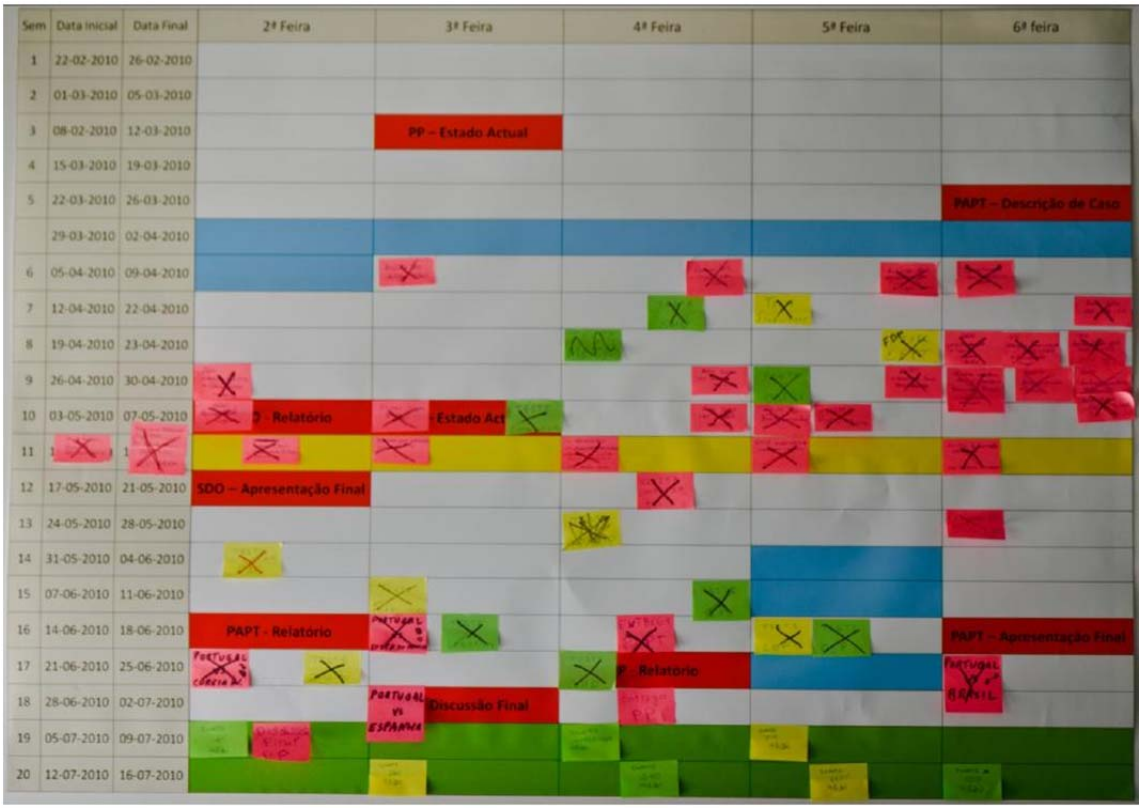


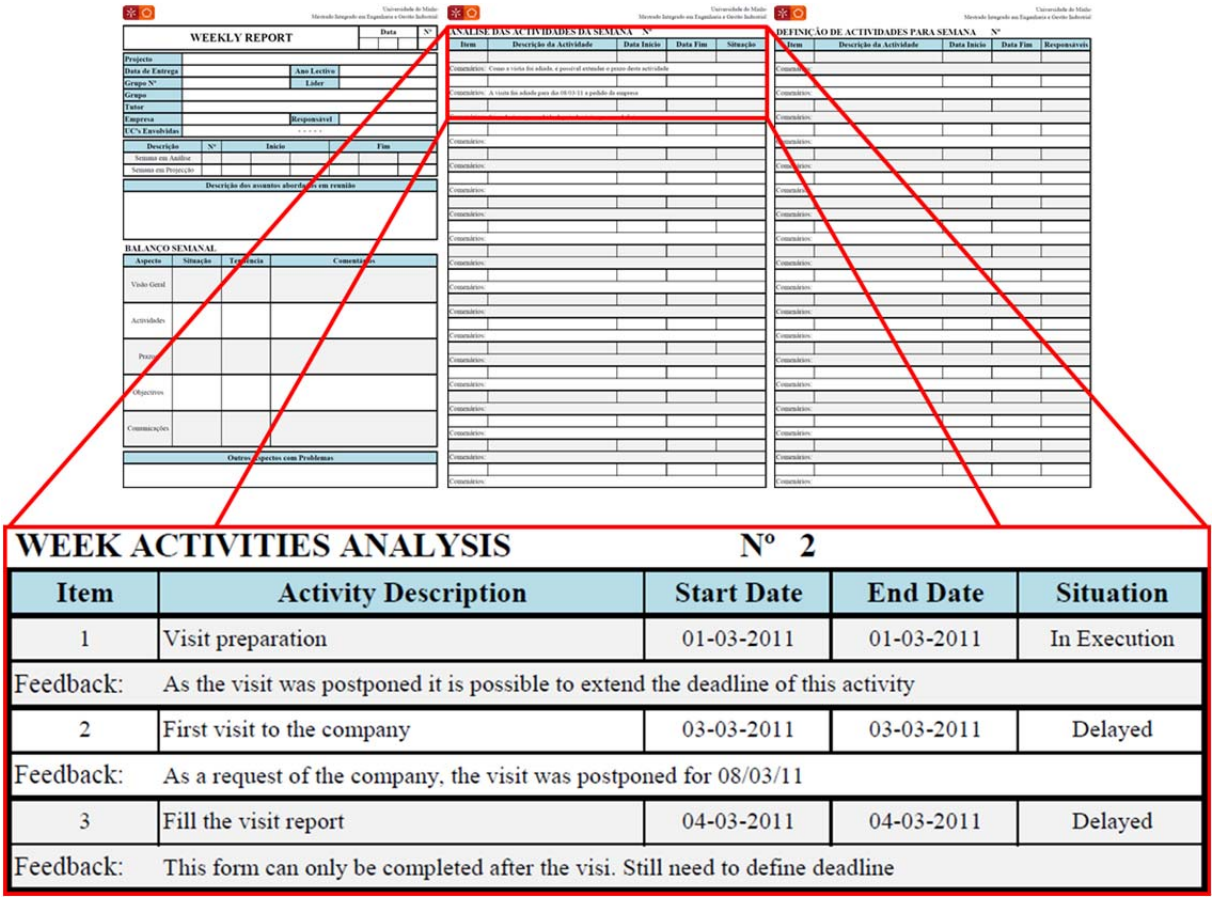
Figure 4: Example of Schedule Frame used by a team last year.

2.2 Intermediate Phase

The intermediate phase of the project life cycle is characterized by execution and continuous planning and control of the processes, so teams should monitor the progress of the project and introduce changes to ensure that the objectives will be reached. As shown on the framework of figure 1 we assume that the same management routine should be followed every week. In this way and in weekly terms, teams must fill in the WEEKLY REPORT form, which is designed mainly to focus and record relevant information from the previous week and plan activities for the following week, providing an overview of the project progress and performance.

The teams should reflect on the week under review and conduct an evaluation on the following aspects: Overview, Activities, Deadlines, Objectives and Communications. For each aspect the teams should refer its situation (Without Problems; Under Risk to have problems; with problems) and its trend (Stable; Improving; Getting Worse), in order to characterize each one of the aspects in evaluation. Moreover, teams should analyze in detail the activities undertaken in the previous week as shown in the Figure 5 and refer the situation of each of these activities (Done; In Execution; Delayed; To Begin).

Concerning to the next week, the teams should reflect on the activities to be undertaken in the same week, indicating who is responsible for each activity and its deadline.



WEEK ACTIVITIES ANALYSIS Nº 2

Item	Activity Description	Start Date	End Date	Situation
1	Visit preparation	01-03-2011	01-03-2011	In Execution
Feedback:	As the visit was postponed it is possible to extend the deadline of this activity			
2	First visit to the company	03-03-2011	03-03-2011	Delayed
Feedback:	As a request of the company, the visit was postponed for 08/03/11			
3	Fill the visit report	04-03-2011	04-03-2011	Delayed
Feedback:	This form can only be completed after the visi. Still need to define deadline			

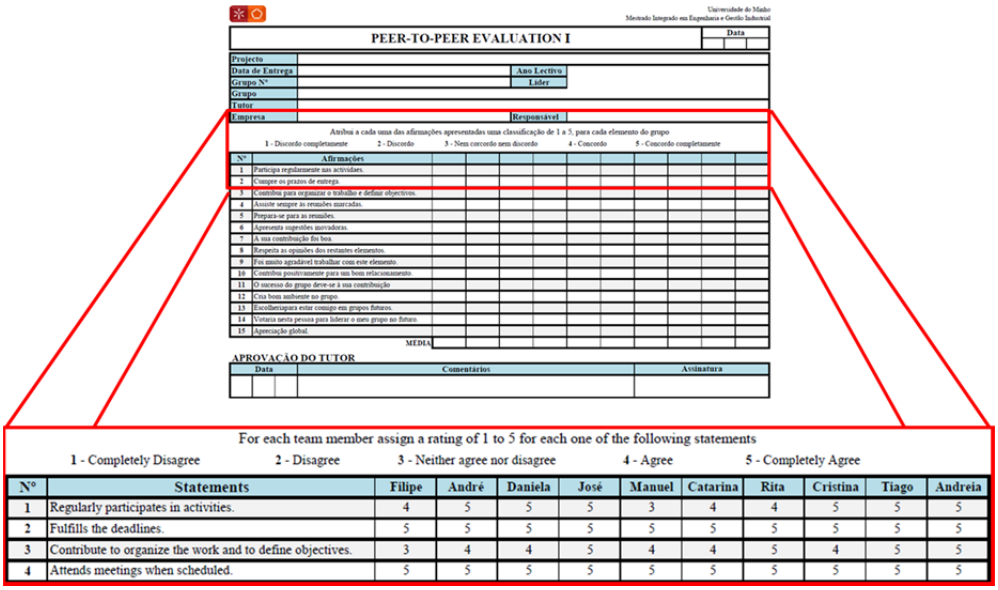
Figure 5: Extract from Weekly Report form - example of activities analysis from week under review.

There is also the PROJECT CHANGE RECORD form to be used whenever the project scope changes. Besides the change description, in this form, the teams should consider if such change will cause some impact on the project activities, deadlines, resources, objectives and communications. The teams should also describe the necessary actions to implement this change. It is important that the teams properly update the PROJECT PLAN, the SCHEDULE FRAME and other documents that may suffer changes.

The VISIT REPORT is another form that aims to control the activities of the project. This form should only be filled if applicable to the project in question and whenever the teams conduct a company visit. In this form it is possible to record important general observations, for example, visited departments, meetings with officials, a factor that prevented the completion of planned actions, planned actions and their evaluation according to their status: Done, to repeat or not taken place, major issues discussed in the company and schedule future visits.

Still regarding the project control, teams must accomplish peer-to-peer evaluations, for such, there are presented two possible forms, each team should choose one, even if it is different from those presented. These evaluations should be performed periodically and according to the official dates and milestones or anytime the teams considers it is necessary. This process must be performed in the presence of all team members and, if possible, the Team tutor as well.

In one suggested form for peer-to-peer evaluation, each team member is evaluated by the remaining members and by him/herself, assigning a rating of 1 to 5 for each one of the fifteen statements presented in the form, as can be seen in Figure 6. In this rating, 1 corresponds to *Completely Disagree* and 5 to *completely agree*.



PEER-TO-PEER EVALUATION I

Data

Projecto	
Data de Entrega	Ano Lectivo
Grupo Nº	Líder
Grupo	
Tutor	
Empresa	Responsável

Atribua a cada uma das afirmações apresentadas uma classificação de 1 a 5, para cada elemento do grupo

1 - Discordo completamente 2 - Discordo 3 - Nem concordo nem discordo 4 - Concordo 5 - Concordo completamente

Nº	Afirmações									
1	Participa regularmente nas actividades.									
2	Cumpre os prazos de entrega.									
3	Contribui para organizar o trabalho e definir objectivos.									
4	Assiste sempre às reuniões marcadas.									
5	Prepara-se para as reuniões.									
6	Apresenta sugestões inovadoras.									
7	A sua contribuição foi boa.									
8	Respeita as opiniões dos restantes elementos.									
9	Foi muito agradável trabalhar com este elemento.									
10	Contribui positivamente para um bom relacionamento.									
11	O sucesso do grupo deve-se à sua contribuição									
12	Cria bom ambiente no grupo.									
13	Escolheria para estar comigo em grupos futuros.									
14	Votaria nesta pessoa para liderar o meu grupo no futuro.									
15	Apreciação global.									
	MEDIA									

APROVAÇÃO DO TUTOR

Data	Comentários	Assinatura

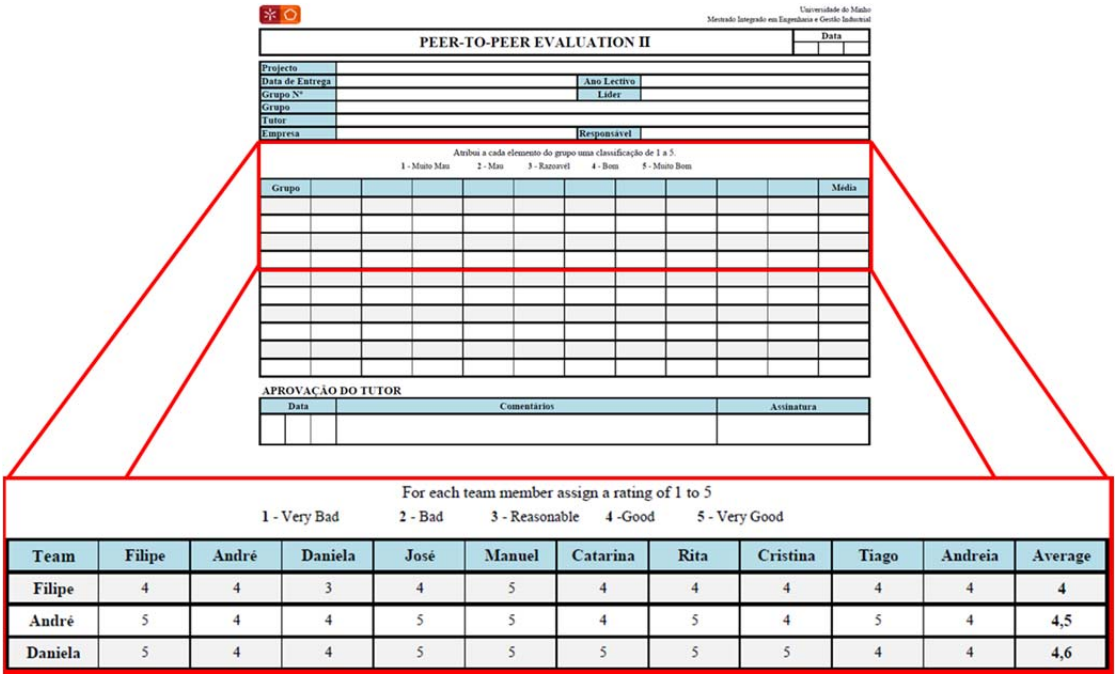
For each team member assign a rating of 1 to 5 for each one of the following statements

1 - Completely Disagree 2 - Disagree 3 - Neither agree nor disagree 4 - Agree 5 - Completely Agree

Nº	Statements	Filipe	André	Daniela	José	Manuel	Catarina	Rita	Cristina	Tiago	Andreia
1	Regularly participates in activities.	4	5	5	5	3	4	4	5	5	5
2	Fulfills the deadlines.	5	5	5	5	5	5	5	5	5	5
3	Contribute to organize the work and to define objectives.	3	4	4	5	4	4	5	4	5	5
4	Attends meetings when scheduled.	5	5	5	5	5	5	5	5	5	5

Figure 6: Extract from Peer-to-Peer Evaluation I form- example of statements included in form and its respective evaluation.

The other suggested form is more simple and direct. Each team member evaluates his own performance and the others performances by assigning a rating from 1 to 5, as shows Figure 7. In this form, 1 corresponds to Very Bad and 5 to Very Good.



PEER-TO-PEER EVALUATION II

Data

Projecto	
Data de Entrega	Ano Lectivo
Grupo Nº	Líder
Grupo	
Tutor	
Empresa	Responsável

Atribua a cada elemento do grupo uma classificação de 1 a 5.

1 - Muito Mau 2 - Mau 3 - Razoavel 4 - Bom 5 - Muito Bom

Grupo										Média

APROVAÇÃO DO TUTOR

Data	Comentários	Assinatura

For each team member assign a rating of 1 to 5

1 - Very Bad 2 - Bad 3 - Reasonable 4 -Good 5 - Very Good

Team	Filipe	André	Daniela	José	Manuel	Catarina	Rita	Cristina	Tiago	Andreia	Average
Filipe	4	4	3	4	5	4	4	4	4	4	4
André	5	4	4	5	5	4	5	4	5	4	4,5
Daniela	5	4	4	5	5	5	5	5	4	4	4,6

Figure 7: Extract from Peer-to-Peer Evaluation II form- Example of evaluation.

Both forms must be signed and commented by the Team Tutor as a sign of approval.

2.3 Final Phase

The last phase of the project life cycle is characterized by formalizing that the project reached the end. Thus the form PROJECT CLOSURE must be filled when the project objectives are achieved, or when the project ends for other reasons. This form is intended to formalize the ending of the project and leads the teams to accomplish a final reflection about the project success or failure. Therefore, the teams should accomplish a closing meeting to discuss, through a self-evaluation: if the general and specific objectives of the project had been reached, compile lessons learned, analyze the problems that occurred during the project, for example, communication failures, deviations on deadlines, if the scope was respected, and other problems/issues that may be discussed. Figure 8 exemplify a record of self-evaluation, last appreciation and lessons learned, contained in the PROJECT CLOSURE form.

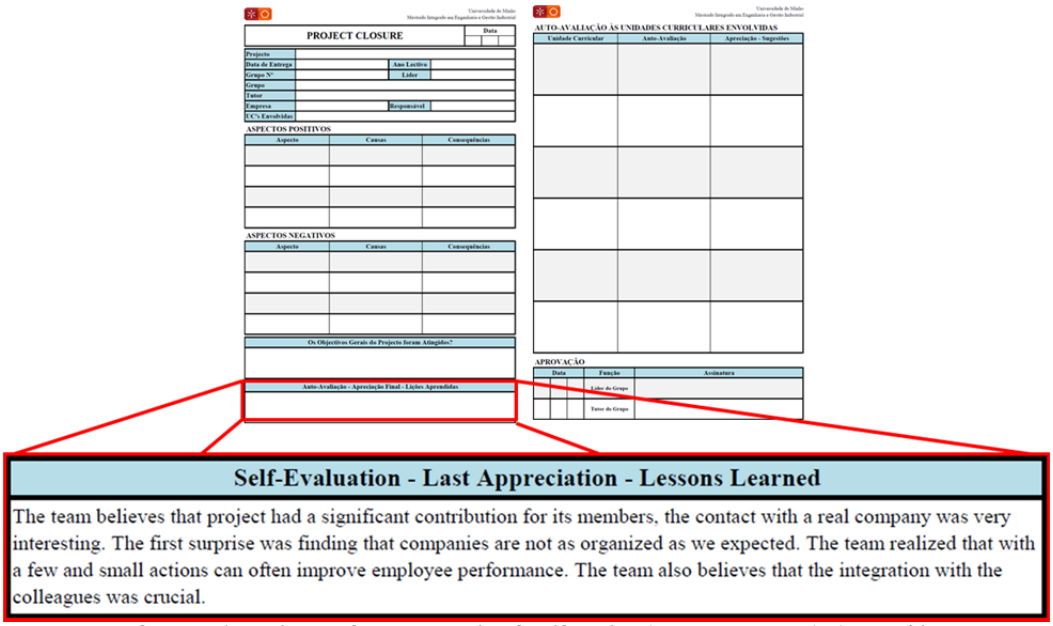


Figure 8: Extract from Project Closure form- Example of Self-Evaluation, Last Appreciation and lessons Learned

3 Conclusion

This paper addresses the problem of project management practices adopted by engineering students when doing project work. Since student teams tend to assume very relaxed project management methodologies with relatively bad performance, a project management methodology is proposed to be followed by student teams when involved with relatively large projects. This methodology assumes three project phases: initial phase, intermediate phase and final phase. The initial phase is focused on formalization of the project as well as on the initial planning. The intermediate phase is the most crucial phase for student teams since it is on this phase that there exist a higher risk to fall on relaxation losing objectives scope and control. This methodology proposes a week routine to be followed in terms of auto-monitoring and auto-control with forms to be filled in about week activity analysis as well as peer-to-peer evaluation. The final phase includes the final delivery followed by a team reflection on lessons learned. This methodology is based on the experiences gained along the last 6 year by students and teachers involved on project based learning activities taking place in the engineering school at the University of Minho.

Acknowledgment

This work was financed by National Funds of the Portuguese Foundation for Science and Technology, under Project PEST-OE/EME/UI0252/2011.

References

European Commission. (2009). ECTS Users' Guide. Luxembourg: Office for Official Publications of the European Communities.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education - theory, practice and rubber sling shots. Higher Education, 51(2), 287-314.

Lima, R. M., Carvalho, D., Flores, M. A., & Hattum-Janssen, N. v. (2007). A case study on project led education in engineering: Students' and teachers' perceptions. European Journal of Engineering Education, 32(3), 337-347.

MCTES. (2008). Aprofundar o Processo de Bolonha. Obtido em 21 de 08 de 2008, de Ministério da Ciência, Tecnologia e Ensino Superior: http://www.portugal.gov.pt/Portal/PT/Governos/Governos_Constitucionais/GC17/Ministerios/MCTES/Comunicacao/Notas_de_Imprensa/20080430_MCTES_Com_Bolonha.htm

Powell, P. C., & Weenk, W. (2003). Project-led engineering education. Utrecht: Lemma.

PMI (2004) A Guide to the Project Management Body of Knowledge (PMBOK® Guide) Third Edition ed. PA: Project Management Institute (PMI).