KUNGLIGA TEKNISKA HÖGSKOLAN

Project Plan
Noise and echo cancellation in a teleconference
Project in Wireless Communication

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Thomas Gaudy
Xavier Bush

Advisor:
Per Zetterberg

Spring 2015

Contents

1   Introduction

This is the Project Plan of the Project in Wireless Communication *Noise and echo cancellation in a teleconference.* As a project plan, this is also the contract between the team members and the supervisor of the Project, Per Zetterberg, that contains the goals, the organisation, the resource plan, the risk analysis, the documents rules and the project model that the project follows.

2   Background

This project intends to be the first real project where to apply the theoretical knowledge acquired in the KTH's Master performed by the team members. Moreover, all the experience to gain during the project such as team work, project management, code programming and application of theory into practice were taken into account to choose the project, and all of these competences will be used when performing our Master Thesis next year.

In the following sections, the Project Plan will be developed in detail with the aim to follow it as good as possible and to show it to the project supervisor (sponsor).

3   Specification of the project

The aim of the project, as the title of itself says, is to program a noise and echo cancellation algorithm in a teleconference in real time. The very first scenario (Figure 1) considers that only one of the users is speaking in an echo and noisy environment. Further in the project, if the first scenario is successfully solved, a second scenario will be approached: both users might be in a echo and noisy environment.
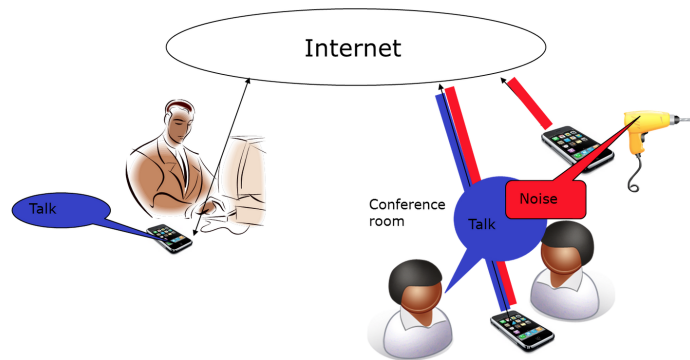
Figure 1: Illustration of teleconference with noise (interference) cancellation

4   Sketch of solution

With a needed background in adaptive signal processing and programming, mostly in MATLAB and Android, the goal is to cancel the noise and the echo generated in the user's environment during a teleconference (Figure 1). To do so, the group will use mostly the content of the course *Adaptive Signal Processing (EQ2400)* and therefore mode and test

the system in a theoretical way. The test of the algorithms will be done by MATLAB and the implementation in real time will be coded with Android in the Eclipse environment. As there are 5 members in the team and different areas where to work, everyone has been allocated in these areas with certain responsabilities (see *Organisation*) and will report properly the progress of the project.

The first approach to solve the problem will be by using Adaptive Signal Processing techniques. In order to work the project, the team has been provided 5 cellphones to work with:

- 2 phones for the users (1 phone per user)

- 1 phone as a server

- 1 phone to record the noise

With the information of the recorded noise, adaptive filtering techniques such as LMS will be used as noise cancellation tools. In terms of echo cancellation, the team still have to look deeper into it but the first approach will be LMS as well. Anyway, there are different possibilities to analyze before starting the MATLAB program because the model can be slightly modified:

- Order of the cancellation: first echo cancellation and second the noise cancellation or vice versa

- The cancellation should be done in the server or in the receiver. Seems more reasonable the receiver option but all possibilities will be taken into account

Finally the first model that will be used to treat the noise is show in the Figure 2. On the other hand, the echo cancellation will follow a similar model but the CIOs need to study deeper the final model.
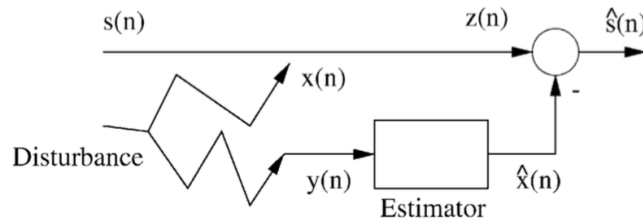
Figure 2: Model of noise cancellation

5 Goals

The goals of the team can be divided in two academic goals (business goals) and project goals. The academic goal is to achieve the best result within the time constrain given by the course (8 weeks). Consequently, the minimum score required will be a **B** being **A** the desired mark. In terms of project goals, as engineers the project should fulfill the expectation of noise and echo cancellation with the minimum possible delay, in order to have a real time application.

Due to the complexity of the project, the budget (hours invested by the team members) will not be a constrain (in comparison with the time and the quality). Even though,

every member of the team has other courses or seminars to attend, which will turn into risk factors that may affect during the performance of the project (see *Risk Analysis*). According to the previous information, the Figure 3 shows the triple constraint of the project.
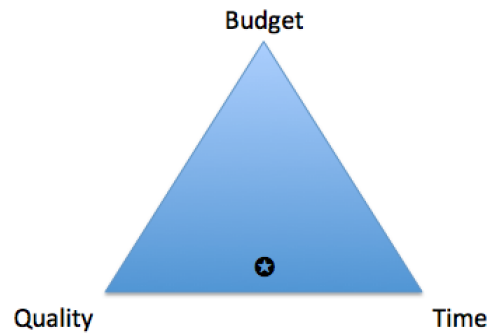
Figure 3: Triple constrain of the project

6 Organisation

The organisation is fully made up by electrical engineering students. Each of the team members perform a different role and most of the members work in two different areas. The reason of working in different areas make easier the knowledge transfer in this areas, fact that will make the project run faster. The members, their roles and contact information are specified below:

- Animesh Das

    - Role: Theory Group & Management Group
    - e-mail:animeshu1989@gmail.com (animeshd@kth.se)
    - Telephone: +46 737155575

- Jonas Sedin

    - Role: Theory Group & Android Group
    - e-mail: sedinjo@gmail.com (jonassed@kth.se)
    - Telephone: +46 704252951

- Mohammad Abdulla

    - Role: Android Group
    - e-mail: hamodiilatch@gmail.com (mabdulla@kth.se)
    - Telephone:

- Thomas Gaudy

    - Role: Android Group

- e-mail: gaudy.thomas@gmail.com (gaudy@kth.se)
- Telephone: +46 760936034

- Xavier Bush

  - Role: Theory Group & Management Group
  - e-mail: xavier.bush@gmail.com (xbush@kth.se)
  - Telephone: +46 764141834

The sponsor members as Project Examiner/Supervisor and Project Support are:

- Per Zetterberg

  - Role: Project Examiner
  - e-mail: perz@ee.kth.se
  - Telephone: +46 8 790 77 85

- Hadi Ghauch

  - Role: Group Assistant
  - e-mail: ghauch@kth.se

- Martin Ohlsson

  - Role: Android Guru
  - e-mail: martinoh@kth.se
  - Telephone: +46 87907818

7 Tasks & Time and Resource Allocation Plan

Tasks

As it has previously said, the tasks of the project have been distributed among the team members depending on the areas of work. All the tasks with its classification, type of task, date to be ready and responsible, have been distributed as shown in the *Annex 1*. Due to the *Mid-term evaluation* the Android tasks have been distributed among the team's programmers depending on the comlexity of the task and the ammount of phones involved. Eventually, tasks 1, 2, 3 and 4 will be done individually and tasks 5, 6 and 7 will be done by groups.

On behalf of the Theory team, there are three phases involved: noise cancellation, echo cancellation and the merge of these two procedures (with code optimizing and transfer from MATLAB to Android). All the details in the *Annex 1*.

Finally, the Management area will take care about the Project Plan, all the Status Reports of the project and the Final Report. All the detailes, again, in the *Annex 1*.

Time and Resource Allocation Plan (TRAP)

The measurable resources of the team is the amount of hours to dedicate to the project, and it has been planned as a *Time and Resource Allocation Plan.* Considering this, each of the members will work, a priori, 4 hours per day and 4 days per week, with some exceptions in the weeks with more work. After a first test in certain assignments it is a reasonable amount of hours with a total close to 190 hours in the 8 weeks of the course.

In order to plan the hours to dedicate and make a right follow up of them, it has been done a document named *TimeAndResourcePlan.xls* this document is attached in this Project Plan as the *Annex 2* As a clarification, the hours that stated in the Time and Resourse Allocation Plan are effective hours in the laboratory, the self study is not included. As it can be seen, the *Outcome* row is the follow-up of the hours a posteriori, when the *Plan* row is the planned hour. The goal in this section is to have the same amount of hours in both rows, meaning that that the plan has been succesfuly done.

Gantt Chart

At the end of this document, and follow a similar structure of the *Annex 1* this project's Gantt Chart can be found. Te total amount of weeks of the Gantt Chart is 11 where all the tasks have been allocated on behalf of the group where does everyone of them belong to. The *3rd* level classification has not been allocated to a responsable or to a certain time frame because all the *3rd* level tasks feedback each other and will not follow a certain order between them.

8   Risk Analysis

In terms of risks that may affect the project we have analyzed two types of them:

- Technical risks: involving all the technical risks or lack of knowledge that the team may find during the project. This risks are unmeasurable and uncertain since Android programming and real time application are new areas for the team members and problems of different nature may occur.

- Managerial risks: all external risks that might put in difficulty the right follow up of the Project Plan. This section contains other courses, seminars, projects and language courses that the team members follow simultaneously.

In this Risk Analysis have not been taken into account personal activities or situations of the course members understanding that each member of the team should handle them so not to affect the performance of the project. For this reason, Table **??** shows the risk table done following the *Mini-Risk Method* ("Handbook for Small Project"), where **P**=Probability that the risk happens (from 1 to 4), **C**=consequence if the risk happens (from 1 to 4) and **R**=Risk Value (from 1 to 16).

Nr	Risk	P	C	R	Action
1	Do not find a good theoretical model	1	4	4	Read more literature
2	Do not pass the mid-term evaluation	1	4	4	Re-schedule the TRP
3	Problems with real time	2	4	8	Help and re-schedule TRP

9 Documents and Rules

This section contains the rules to follow in terms of documentation during the project, some of them will be handled by the team's Managament Group and some of them will be handled individually. The projects to be done during the project will be next:

- Project Plan: will be done by Xavier at the beginning of the project. The hand in it in will be done by posting it in the project's KTH social group.

- Reflective diary: this document will be done individually. Will be handled by e-mail to Per Zetterberg in pdf or .doc file before the deadline indicated by the schedule. Should include all what each team member has done in a schematic way with all the documentation needed to suport the lyrics.

- Progress Report: will be done by the Animesh and handed in before the deadline of the schedule. As the Project Plan, it will be posted in the porject's KTH social group. All the information will be provided by the team members to Xavier so to elaborate this document.

- Final Report: will be done by the Xavier with all the information provided by the Theory Group and Android Group before the deadline of the course.

The backup of the information will be don daily using next sources:

- Github: the group has a shared github server. All the progress will be uploaded at the end of the day

- Hard Disk: Every member of the team will have a daily backup in his own machine

With this backup procedure there will be at least 3 copies a day of the project.

10 Project Model

The project model will follow the general Project Flow (Ref. Handbook for Small Projects, Joakim Lilliesköld). In the Annex 1 can be found a Schedule with all the deadlines and important dates during the project and to which phase it refers to and so who is responsible of each task. The project is divided into next phases:

- Pre-study: already done before taking the course

- Start: Will finish when the Project Plan will be finished and approved

- Execution: Will last from the 1st of April until the 31st of May

- Closing: Will finish with the last *Reflective Diary*

Milestones and Tollgates will be used to organise the project. On the one hand, Milestones will be considered as checkpoints defined by the team members to check the status of the project before a deadline. On the other hand, Tollgates will be the checkpoints of approval from the sponsor (course examiner) after a certain deadline. So as the project is short (8 weeks) and the amount of taks is considerably high it has been assigned only 1 Milestone before every deadline plus a weekly meeting to check the status of the project. Due to the small size of the team, the meeting will not be always scheduled at the same day, but preferably at the end of the week.

11 Bibliography

- Eriksson, M & Lilliesköld, J. (2010) *"Handbook for Small Projects"*. Stockholm: Liber.

- Slides of Lectures from the course Adaptive Signal Processing (EQ2400)

- Slides of Lectures of the course Project in Wireless Communication (EQ2440)

		ANNEX 1			
PROJECT PHASE	**MILESTONE**	**DEADLINE**	**TOLLGATE**	**DATE**	**RESPONSIBLE**
Phase I	Project plan Draft			29/03/15	Animesh & Xavi
	Start working on Android Assignments			26/03/15	Jonas, Mohammad & Thomas
	Start working on Theory/Matlab			26/03/15	Animesh, Jonas & Xavi
	Project plan Final Version			30/03/15	Animesh & Xavi
		Final project plan submission		01/04/15	Animesh & Xavi
		Reflective Diary 0		01/04/15	Everyone Individually
	Android Task 1			06/04/15	Jonas
	Android Task 2			06/04/15	Mohammad
	Android Task 3			06/04/15	Mohammad
	Android Task 4			06/04/15	Thomas
	Theory model & first tests in MATLAB			08/04/15	Animesh, Jonas & Xavi
		Reflective Diary 1		15/04/15	Everyone Individually
		Progress Report 1		15/04/15	Animesh & Xavi
	Android Assignment Completion (All tasks)			20/04/15	Jonas, Mohammad & Thomas
	Theory/Matlab work check and sync			21/04/15	Jonas, Xavi, Animesh
		Midterm Evaluation		22/04/15	Everyone
			Midterm Evaluation	-	Per
		Reflective Diary 2		22/04/15	Everyone
		Progress Report 2		22/04/15	Animesh & Xavi
		Midterm Evaluation Follow-up 1		29/04/15	Everyone
			Midterm Evaluation Follow-up 1	-	Per
		Reflective Diary 3		29/04/15	Everyone
		Progress Report 3		29/04/15	Animesh & Xavi
	End of Phase I, Discussion and way forward			30/04/15	Everyone

Phase					
Phase II	Start working on Project Report & Prototype			01/05/15	As Discussed, mainly by Animesh & Xavi
		Midterm Evaluation Follow-up 2		06/05/15	Everyone
			Midterm Evaluation Follow-up 2	-	Per
		Draft Project Report Integration & Protype advancement check		07/05/15	Animesh & Xavi
		Reflective Diary 4		06/05/15	Everyone
		Progress Report 4		06/05/15	Animesh & Xavi
		Reflective Diary 5		13/05/15	Everyone
		Progress Report 5		13/05/15	Animesh & Xavi
		Draft Project Report Integration & Protype advancement check		14/05/15	Animesh & Xavi
		Reflective Diary 6		20/05/15	Everyone
		Progress Report 6		20/05/15	Animesh & Xavi
		Progress Report 7		27/05/15	Animesh & Xavi
		Review of Final Report & Prototype		27/05/15	Everyone
		Final Report & Prototype Submission		28/05/15	Everyone
			Final Report & Prototype Submission	-	Per
		Grand Final		29/05/15	Everyone
		Reflective Diary 7		01/06/15	Animesh & Xavi

Annex 2	Cost/hour (SEK)	Day	30/3	31/3/2015	1/4/2015	2/4/2015	3/4/2015
		Outcome (h)	0	0	0	4	2
Animesh Das	400	Plan (h)	0	0	4	4	4
		Outcome (h)	4	5	5	4	2
Jonas Sedin	400	Plan (h)	3	5	4	4	3
		Outcome (h)	6	5			
Mohammad Abdulla	400	Plan (h)	4	4	2	6	2
		Outcome (h)	5	6	5		3
Thomas Gaudy	400	Plan (h)	4	4	4		4
		Outcome (h)	6	3	5	0	2
Xavier Bush	400	Plan (h)	4	4	5	4	2
		Outcome (h)					
		Plan (h)					

4/4/2015	5/4/2015	6/4/2015	7/4/2015	8/4/2015	9/4/2015	10/4/2015	11/4/2015	12/4/2015
2	2	4	6	6	5	5	2	2
2	2	2	5	5	5	5	2	2
		5	4	4	5	4		
	5	4	5	5	5	5		4
2	0	9	3	8	3	5	0	0
1	1	4	4	4		4	1	1
		4	0	5	5	1		
		3	5	5	5			

13/4	14/4	15/4	16/4	17/4	18/4	19/4	20/4	21/4
6	6	6	6	6			4	6
5	5	5	5	6			5	6
5	5	5	5	4		4	5	5
6	6	6		6	1	1	6	6
5								
6	6	6	6	6			6	6

22/4	23/4	24/4	25/4	26/4	27/4	28/4	29/4	30/4
6	6	6			6	6	6	6
6	6	6			5	5	5	5
5	5	2		5	5	5	5	5
6		6			6	6	6	
6	6	6			4	4	4	5

1/5/2015	2/5/2015	3/5/2015	4/5/2015	5/5/2015	6/5/2015	7/5/2015	8/5/2015	9/5/2015
			4	4	4	4		
4			4	4	4	4	4	
2		5	5	5	5	5	2	
6	1	1	6	6	6		6	1
			4	6	4	4		

10/5/2015	11/5/2015	12/5/2015	13/5	14/5	15/5	16/5	17/5	18/5
	6	6	6	6				5
	6	6	6	6	6			6
5	5	5	5	5	2		5	4
1	6	6	6	6	6	1	1	5
	6	6	6	6	6			5

19/5	20/5	21/5	22/5	23/5	24/5	25/5	26/5	27/5
5	5	5	5	5	5	8	8	8
6	6	6	6			8	8	8
4	4	5	4		5	8	8	8
5	5	5	5	4	4	8	8	8
6	6	5	5	4	4	8	8	8

28/5	29/5	30/5	31/5	1/6/2015	Total
					40
8	8		6		245
					20
8	8		6		246
					6
8	8		6		259
					49
8	8		6		249
					36
8	8		6	2	245

Project in Wireless Communication - Project Schedule
EQ2400

	Project Lead:	Xavier Bush
	Project Start Date:	3/25/2015 (Wednesday)
	Display Week:	1

WBS	Task	Lead	Predecessor	Start	End	Cal. Days	% Done	Work Days
1	**Android Group (AG)**							
1.1	Task 1	Jonas		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.2	Task 2	Mohammad		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.3	Task 3	Mohammad		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.4	Task 4	Thomas		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.5	Task 5	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	2
1.6	Task 6	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	2
1.7	Task 7	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	6
1.8	Full Implementation	ALL AG		Sun 4/26/15	Mon 6/01/15	37	15%	26
1.8.1	Transfer from MATLAB to Android							
1.8.2	Optimizing code							
1.8.3	Error handling solutions							
1.8.4	Placement of cancellation (Tx or Rx)							
1.8.5	Real time tests							
1.8.6	Real time optimizing							
2	**Theory Group (TG)**	All AG						
2.1	Theory Model	All AG		Wed 4/01/15	Sun 4/05/15	5	100%	3
2.1.1	Noise Cancellation Model							
2.1.2	Echo Cancellation Model							
2.1.3	LMS Implementation							
2.1.4	LMS Implementation							
2.1.5	Other Algorithms research							
2.2	First Tests	All AG		Mon 4/06/15	Wed 4/08/15	3	100%	3
2.2.1	LMS tests							
2.2.2	RLS tests							
2.2.3	Other Algorithms tests							
2.3	Alg. Optimization & solutions			Thu 4/09/15	Wed 4/22/15	14	25%	10
2.3.1	LMS Optimization							
2.3.2	RLS Optimization							
2.4	Transfer to Android & Optimization	All AG		Thu 4/23/15	Mon 6/01/15	1	15%	28
3	**Management Group (MG)**							
3.1	Project Paln	Xavier		Wed 3/25/15	Wed 4/01/15	8	100%	6
3.2	Progress Report 1	Animesh		Thu 4/02/15	Wed 4/15/15	14	100%	10
3.3	Progress Report 2	Animesh		Thu 4/16/15	Wed 4/22/15	7	0%	1
3.4	Progress Report 3	Animesh		Thu 4/23/15	Wed 4/29/15	7	0%	5
3.5	Progress Report 4	Animesh		Thu 4/30/15	Wed 5/06/15	7	0%	5
3.6	Progress Report 5	Animesh		Thu 5/07/15	Wed 5/13/15	7	0%	5
3.7	Progress Report 6	Animesh		Thu 5/14/15	Wed 5/20/15	7	0%	5
3.8	Progress Report 7	Animesh		Thu 5/21/15	Wed 5/27/15	7	0%	5
3.9	Final Report	Xavier		Thu 4/23/15	Tue 5/26/15	34	0%	24
4	**Individual Assignments**							
4.1	Reflective Diary 0	All members		Wed 3/25/15	Wed 4/01/15	8	100%	1
4.2	Reflective Diary 1	All members		Thu 4/02/15	Wed 4/15/15	14	100%	1
4.3	Reflective Diary 2	All members		Thu 4/16/15	Wed 4/22/15	7	0%	1
4.4	Reflective Diary 3	All members		Thu 4/23/15	Wed 4/29/15	7	0%	1
4.5	Reflective Diary 4	All members		Thu 4/30/15	Wed 5/06/15	7	0%	1
4.6	Reflective Diary 5	All members		Thu 5/07/15	Wed 5/13/15	7	0%	1
4.7	Reflective Diary 6	All members		Thu 5/14/15	Wed 5/20/15	7	0%	1

Week 1 — 3 / 23 / 15
Week 2 — 3 / 30 / 15
Week 3 — 4 / 6 / 15
Week 4 — 4 / 13 / 15
Week 5 — 4 / 20 / 15
Week 6 — 4 / 27 / 15
Week 7 — 5 / 4 / 15
Week 8 — 5 / 11 / 15

Project in Wireless Communication - Project Schedule

EQ2400

	Project Lead:	Xavier Bush
	Project Start Date:	3/25/2015 (Wednesday)
	Display Week:	4

Week 4: 4 / 13 / 15
Week 5: 4 / 20 / 15
Week 6: 4 / 27 / 15
Week 7: 5 / 4 / 15
Week 8: 5 / 11 / 15
Week 9: 5 / 18 / 15
Week 10: 5 / 25 / 15
Week 11: 6 / 1 / 15

WBS	Task	Lead	Predecessor	Start	End	Cal. Days	% Done	Work Days
1	**Android Group (AG)**							
1.1	Task 1	Jonas		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.2	Task 2	Mohammad		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.3	Task 3	Mohammad		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.4	Task 4	Thomas		Wed 4/01/15	Mon 4/06/15	6	100%	8
1.5	Task 5	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	2
1.6	Task 6	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	2
1.7	Task 7	All AG		Tue 4/07/15	Sat 4/25/15	19	100%	6
1.8	Full Implementation	ALL AG		Sun 4/26/15	Mon 6/01/15	37	15%	26
1.8.1	Transfer from MATLAB to Android							
1.8.2	Optimizing code							
1.8.3	Error handling solutions							
1.8.4	Placement of cancellation (Tx or Rx)							
1.8.5	Real time tests							
1.8.6	Real time optimizing							
2	**Theory Group (TG)**	All AG						
2.1	Theory Model	All AG		Wed 4/01/15	Sun 4/05/15	5	100%	3
2.1.1	Noise Cancellation Model							
2.1.2	Echo Cancellation Model							
2.1.3	LMS Implementation							
2.1.4	LMS Implementation							
2.1.5	Other Algorithms research							
2.2	First Tests	All AG		Mon 4/06/15	Wed 4/08/15	3	100%	3
2.2.1	LMS tests							
2.2.2	RLS tests							
2.2.3	Other Algorithms tests							
2.3	Alg. Optimization & solutions			Thu 4/09/15	Wed 4/22/15	14	25%	10
2.3.1	LMS Optimization							
2.3.2	RLS Optimization							
2.4	Transfer to Android & Optimization	All AG		Thu 4/23/15	Mon 6/01/15	1	15%	28
3	**Management Group (MG)**							
3.1	Project Paln	Xavier		Wed 3/25/15	Wed 4/01/15	8	100%	6
3.2	Progress Report 1	Animesh		Thu 4/02/15	Wed 4/15/15	14	100%	10
3.3	Progress Report 2	Animesh		Thu 4/16/15	Wed 4/22/15	7	0%	1
3.4	Progress Report 3	Animesh		Thu 4/23/15	Wed 4/29/15	7	0%	5
3.5	Progress Report 4	Animesh		Thu 4/30/15	Wed 5/06/15	7	0%	5
3.6	Progress Report 5	Animesh		Thu 5/07/15	Wed 5/13/15	7	0%	5
3.7	Progress Report 6	Animesh		Thu 5/14/15	Wed 5/20/15	7	0%	5
3.8	Progress Report 7	Animesh		Thu 5/21/15	Wed 5/27/15	7	0%	5
3.9	Final Report	Xavier		Thu 4/23/15	Tue 5/26/15	34	0%	24
4	**Individual Assignments**							
4.1	Reflective Diary 0	All members		Wed 3/25/15	Wed 4/01/15	8	100%	1
4.2	Reflective Diary 1	All members		Thu 4/02/15	Wed 4/15/15	14	100%	1
4.3	Reflective Diary 2	All members		Thu 4/16/15	Wed 4/22/15	7	0%	1
4.4	Reflective Diary 3	All members		Thu 4/23/15	Wed 4/29/15	7	0%	1
4.5	Reflective Diary 4	All members		Thu 4/30/15	Wed 5/06/15	7	0%	1
4.6	Reflective Diary 5	All members		Thu 5/07/15	Wed 5/13/15	7	0%	1
4.7	Reflective Diary 6	All members		Thu 5/14/15	Wed 5/20/15	7	0%	1