Real-Time Bridge Monitoring
Final Project Report

Version 2.0

Revision History

Date	Version	Description	Author
2014-01-06	1.0	Initial version Chapter 1, 2, 3 and 4	Andrea Bottoli
2014-01-13	2.0	Finalization	Andrea Bottoli Lorenzo Pagliari

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1. Introduction

1.1 Purpose of this document

The purpose of this document is to provide an overview of the Real-Time Bridge Monitoring project results and team member performance during the Distributed Software Development (DSD) course of 2013/2014.

This course is a joint course between Politecnico di Milano (PoliMi) in Italy, University of Zagreb (FER) in Croatia and Mälardalen University (MDH) in Sweden.

The Real-Time Bridge Monitoring members are from PoliMi and MDH.

This document is defined at the final phase of the project work.

1.2 Intended Audience

This document is intended to all the stakeholders in the Real-Time Bridge Monitoring project including:

- Project group members
- Project Supervisors (Raffaela Mirandola and Elisabetta Di Nitto)
- Project Customers (Francesco Ballio and Gianluca Crotti)
- DSD course staff

1.3 Scope

This document covers the results of the Real-Time Bridge Monitoring project via metrics, tables and snapshots from other documents; it will also cover some of the differences between the initially planned and finally delivered metrics and milestones.

1.4 Definitions and acronyms

1.4.1 Definitions

Keyword	Definitions
Real-Time Bridge Monitoring	The project name

1.4.2 Acronyms and abbreviations

Acronym or abbreviation	Definitions
POLIMI	Politecnico di Milano
MDH	Mälardalen University
FER	University of Zagreb
DSD	Distributed Software Development

1.5 References

Project homepage: http://www.fer.unizg.hr/rasip/dsd/projects/real-time_bridge_monitoring

Project application: http://161.53.67.134/BridgeMonitoring/

Project documents: http://www.fer.unizg.hr/rasip/dsd/projects/real-time_bridge_monitoring/documents

2. Background and Objectives

2.1 Project Goal

The Goal of this project is to develop a system that can help the monitoring process of bridges and to improve the speed of reaction at dangerous events. The system has to indicate the level of alarm in which the bridge is, so eventual security measures can be performed by the users; also make these information available on the web.

2.2 Project Requirements

2.2.1 Data sources

The system gathers data from various sensors that are:

- Anemometer
- Hydrometer
- Echo sonar
- Cameras

2.2.2 Data calculations

The system has to calculate the various characteristics of the bridge:

- The bridge stresses
- The forces acting on the bridge
- The wind speed
- The impact of the amount of traffic and its direction

2.2.3 User interface

The system has a user interface on which all the information will be displayed; it will also be displayed a temporal graph showing the temporal trend of values in the current day. The interface let to the users the possibilities to change some bounds or other variables.

There will be also the possibility to display historical data of the bridge on graph to allow the users to make comparison from the current state and the historical one; the users have to insert the period of time that they will want to see.

2.2.4 Web Application

The system can be reached on web to allow the uses to see all the information on their own devices.

2.3 Project Milestone

The main milestones are:

- Project Vision
- Project Plan
- Requirements definitions
- Design description
- Alpha prototype
- Beta prototype
- Acceptance test
- Final product

2.4 Project Deliverables

The deliverable are:

- Project Plan & Vision (with presentation)
- Project Plan Document
- Project Requirements and Architecture (with presentation)
- Design Description
- Alpha Prototype (with presentation)
- Beta Prototype (with presentation)
- Testing Report
- Final Project (with presentation)

2.5 Project testing

The testing phase expect to test the system reaction at some unexpected situations as the loss of network connection, loss of data, incorrect data, data missing and some other cases.

2.6 Project delivery

The final project/product will be delivered at 13-01-2014 on the web page with all the source codes.

3. Organization

3.1 Project group

The project group consists of seven members all together.

There are three members from the Italian side, that are coming from the Politecnico di Milano University: Andrea Bottoli, Lorenzo Pagliari and Marko Brčić.

The other four members are from the Mälardalens University: Dzana Kujan, Miraldi Fifo, Jörn Tillmanns and Nikola Radisavljevic.

Their roles in the group are defined and represented in the table below.

Name	Initials	Responsibility (roles)
Andrea Bottoli	**AB**	**Project Manager**
Dzana Kujan	***DK***	***Team Leader***
Marko Brcic	MB	Documentation manager
Lorenzo Pagliari	LP	Design manager
Miraldi Fifo	MF	Testing manager
Jorn Tillmanns	JT	Database manager
Nikola Radisavljevic	NR	Integration manager

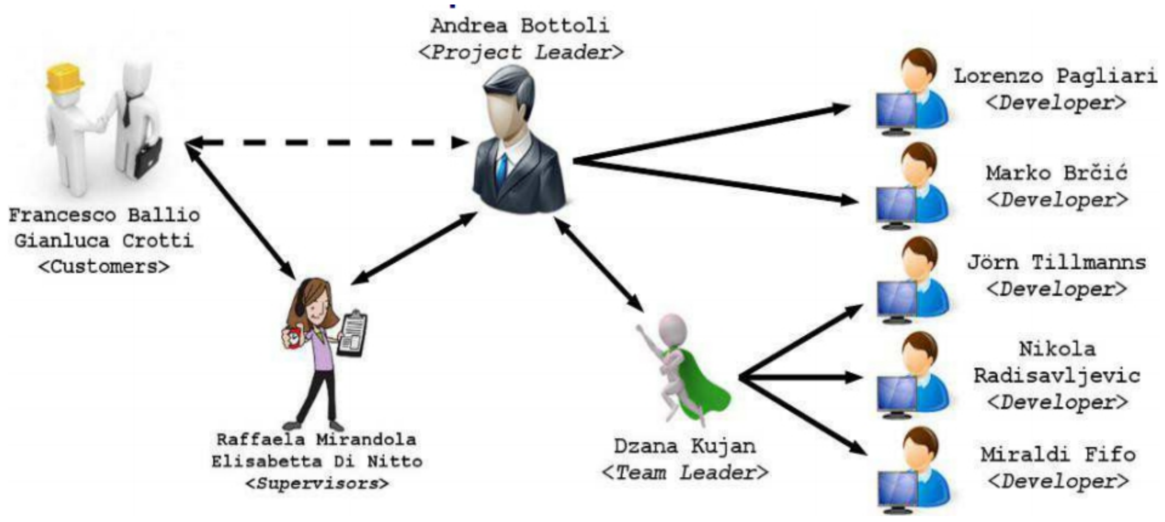
3.2 Customer

There are two customers in this project: they are Ballio Francesco and Crotti Gianluca.

3.3 Supervisor

There are two supervisors in this project: they are Mirandola Raffaela and Di Nitto Elisabetta.

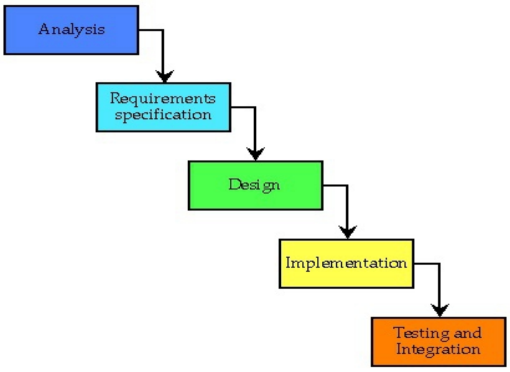
This organization structure is better depicted in the following picture.

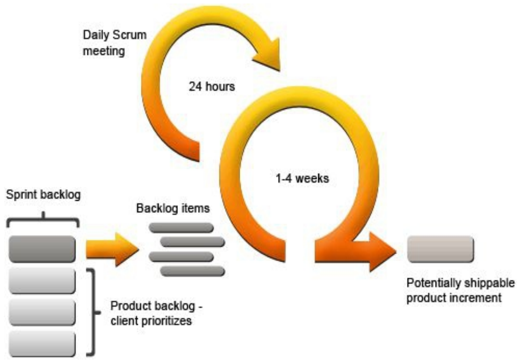


4. Development process

4.1 Introduction

On the overall project the team follow a Waterfall model, but in the Requirements phase, Design phase and Implementation phase the team will follow a SCRUM model.





4.2 Project Phases

4.2.1 Analysis

In this phase the team analyzed the project, thinking at high level at the possible users, at the possible scenarios in which the system will work. Also works to build a shared vision of the project, on which each members of the team is agree.

4.2.2 Requirements Specification

In this phase the team set up with the customers the requirements of the project, focusing on the behavior of the final product and also on the type and structure of data in input at the system.

During the Design phase and Implementation phase the team can make some changes at the requirements, adding or removing some features depending on the issues that will rise.

4.2.3 Design

In this phase the team works on the design of the architecture of the system and on the behavior of the user interface to make it as user friendly, expressive and comprehensible as possible for the user.

4.2.4 Implementation

In this phase the team focus on the development of the various parts of the system.

4.2.5 Testing & Integration

In this phase the team will test the system's features in all the possible scenarios, to verify the correctness of the behavior of the system.

4.3 Roles

In the overall development process all the members of the team are developers. Adding this, threre are also other roles:

- Project leader
- Team leader
- Document manager
- Design manager
- Test manager
- Integration manager
- Database manager

4.4 Quality Assurance

During all the iterations of the Design phase and Implementation phase the Test manager will check that the system's features meet the customers desires.

Sometimes, the customers involvement guarantees that the product fits their needs.

5. Milestones

Id	Milestone Description	Responsible Dept./Initials	Finished week				Metr	Rem
			Plan	Forecast		Actual		
				Week	+/-			
M-001	Project Plan & Vision	All	42	42	0	43		
M-002	Requirements gathering	All	43	43	0	43		
M-003	Requirements document	All	43	44	1	43		
M-004	System Design	All	43	44	0	43		
M-005	Requirement Document	All	44	44	0	44		
M-006	Design Document	All	44	44	0	44		
M-007	Status Report	All	44	44	0	44		
M-008	Organize Repository	Marko Brcic	45	45	0	45		
M-009	Team Policies	Marko Brcic	45	45	0	45		
M-010	Share telephone number	All	45	45	0	45		
M-011	Modify Requirement Doc	Dzana Kujan	45	46	1	45		
M-012	Modify Design Doc	Lorenzo Pagliari	45	46	1	45		
M-013	Setup tools on PC	All	45	45	0	45		
M-014	Change DB	Jorn Tillmanns	45	45	0	45		
M-015	Implementation Parser	Jorn Tillmanns	45	45	0	45		
M-016	Implementation DAO	Jorn Tillmanns	45	45	0	45		
M-017	Start Implementation Math	Andrea Bottoli	45	46	1	45		
M-018	Test Parser	Miraldi Fifo	46	47	0	46		
M-019	Test Classes alpha prot.	Miraldi Fifo	46	47	0	46		
M-020	Alpha prototype	All	46	48	2	46		
M-021	Requirements Gathering	Andrea Bottoli	47	47	0	47		
M-022	Update Design Doc.	Andrea Bottoli	47	48	0	48		
M-023	Update Requirem. Doc.	Dzana Kujan	47	48	0	48		
M-024	Finalize Math Engine	Lorenzo Pagliari	48	49	1	48		
M-025	Web Design	Miraldi Fifo	48	49	1	48		
M-026	Status Report	All	49	49	0	48		
M-027	UserLoginSystem	Jorn Tillmanns	49	50	1	48		
M-028	Finalize Math Engine	Lorenzo Pagliari	49	50	0	49		
M-029	Junit tests v1	Miraldi Fifo	49	50	0	49		
M-030	Web Site Mockups	Nikola Radisavljevic	49	49	0	49		
M-031	Web Site Graphs	Dzana Kujan	49	50	0	49		
M-032	Beta Prototype	All	50	51	0	50		
M-033	Beta Prototype pres.	Lorenzo Pagliari	51	51	0	51		
M-034	Technical documentation	Andrea Bottoli	51	51	0	51		
M-035	Acceptance Test Plan	Miraldi Fifo	51	52	0	52		
M-036	Test Report	Miraldi Fifo	01	02	1	52		
M-037	Final Presentation	All	02	02	0	01		
M-038	Final Documentation	All	02	03	1	01		
M-039	Final Product	All	02	03	1	01		
M-040	Final Questionnaire	All	02	03	1	01		

6. Project Results

6.1 Requirements

6.1.1 Requirement Compliance Matrix

Id	Requirement Description	Completed
EXTERNAL USER REQUIREMENTS		
EU1	The external user should be able to see the stack image with each pylons, with also the flow direction.	YES
EU2	The external user should be able to see the latest pictures of the both sides of the bridge.	YES
EU3	The external user should be able to see the diagram showing the change of value of wind speed for the current day.	YES
EU4	The external user should be able to see the diagram showing the change of value of wind direction for the current day.	YES
EU5	The external user should be able to see the diagram showing the change of water level for the current day.	YES
EU6	The external user should be able to see the diagram showing the change of depth of river bed for the current day.	YES
EU7	The external user should be able to see the diagram showing the change of maximum wind speed for the current day.	YES
EU8	The external user should be able to see the diagram showing the change of maximum direction value for the current day.	YES
EU9	The external user should be able to see the current value of the flow rate.	YES
EU10	The external user should be able to see the current value of the wind speed.	YES
EU11	The external user should be able to see the current value of the water speed.	YES
EU12	The external user should be able to see the current value of the Wind Direction.	YES
EU13	The external user should be able to see the current value of the Water level.	YES
EU14	The external user should be able to see the current value of the River Bed level.	YES
EU15	The external user should be able to see a Google maps picture of the bridge with a wind rose picture.	YES

Id	Requirement Description	Completed
	HUMAN CONTROLLER REQUIREMENTS	
HC1	The human controller should be able to log into the system with user-name and password.	YES
HC2	The human controller should be able to see the stack image with each pylons, with also the flow direction.	YES
HC3	The human controller should be able to see the latest pictures of the both sides of the bridge.	YES
HC4	The human controller should be able to see the diagram showing the change of value of wind speed for the current day.	YES
HC5	The human controller should be able to see the diagram showing the change of value of wind direction for the current day.	YES
HC6	The human controller should be able to see the diagram showing the change of water level for the current day.	YES
HC7	The human controller should be able to see the diagram showing the change of depth of river bed for the current day.	YES
HC8	The human controller should be able to see the diagram showing the change of maximum wind speed for the current day.	YES
HC9	The human controller should be able to see the diagram showing the change of maximum direction value for the current day.	YES
HC10	The human controller should be able to see the current value of the flow rate.	YES
HC11	The human controller should be able to see the current value of the wind speed.	YES
HC12	The human controller should be able to see the current value of the water speed.	YES
HC13	The human controller should be able to see the current value of the Wind Direction.	YES
HC14	The human controller should be able to see the current value of the Water level.	YES
HC15	The human controller should be able to see the current value of the River Bed level.	YES
HC16	The human controller should be able to see a Google maps picture of the bridge with a wind rose picture.	YES
HC17	The human controller should be able to change the debris value. The debris value is a boolean.	YES
HC18	The human controller should be able to change the traffic value. The traffic value is a boolean.	YES
HC19	The human controller should be able to see the alarm button.	YES
HC20	The human controller should be able to send an alarm by clicking on the 'Send Alarm' button.	YES
HC21	The human controller should be able to see the M-N Domain graph with the location of each pylon in the domain.	YES
HC22	The human controller should see the table for CS values for each pylon, their combination label, and values N, M, Tx, Ty, Mx and My.	YES
HC23	The human controller should be able to see the history diagram showing wind speed during chosen period of time.	YES
HC24	The human controller should be able to see the history diagram showing wind direction during chosen period of time.	YES
HC25	The human controller should be able to see the history diagram showing maximum wind speed during chosen period of time.	YES
HC26	The human controller should be able to see the history diagram showing maximum wind direction during chosen period of time.	YES
HC27	The human controller should be able to view the history graph showing the water level during chosen period of time.	YES
HC28	The human controller should be able to view the history graph showing the river bed height during chosen period of time.	YES
HC29	The human controller should be able to view the history graph showing the safety trend during chosen period of time.	YES
HC30	The human controller can choose a start date and end date for the historical graphs.	YES
HC31	The human controller can choose a specific day for the historical graphs.	YES
HC32	The human controller can choose a specific month for the historical graphs.	YES
HC33	The human controller should be able to log out of the system.	YES

Id	Requirement Description	Completed
	ENGINEER REQUIREMENTS	
E1	The engineer should be able to log into the system with user-name and password.	YES
E2	The engineer should be able to see the stack image with each pylons, with also the flow direction.	YES
E3	The engineer should be able to see the latest pictures of the both sides of the bridge.	YES
E4	The engineer should be able to see the diagram showing the change of value of wind speed for the current day.	YES
E5	The engineer should be able to see the diagram showing the change of value of wind direction for the current day.	YES
E6	The engineer should be able to see the diagram showing the change of water level for the current day.	YES
E7	The engineer should be able to see the diagram showing the change of depth of river bed for the current day.	YES
E8	The engineer should be able to see the diagram showing the change of maximum wind speed for the current day.	YES
E9	The engineer should be able to see the diagram showing the change of maximum direction value for the current day.	YES
E10	The engineer should be able to see the current value of the flow rate.	YES
E11	The engineer should be able to see the current value of the wind speed.	YES
E12	The engineer should be able to see the current value of the water speed.	YES
E13	The engineer should be able to see the current value of the Wind Direction.	YES
E14	The engineer should be able to see the current value of the Water level.	YES
E15	The engineer should be able to see the current value of the River Bed level.	YES
E16	The engineer should be able to see a Google maps picture of the bridge with a wind rose picture.	YES
E17	The engineer should be able to change the debris value. The debris value is a boolean.	YES
E18	The engineer should be able to change the traffic value. The traffic value is a boolean.	YES
E19	The engineer should be able to see the alarm button.	YES
E20	The engineer should be able to send an alarm by clicking on the 'Send Alarm' button.	YES
E21	The engineer should be able to see the M-N Domain graph with the location of each pylon in the domain.	YES
E22	The engineer should see the table for CS values for each pylon, their combination label, and values N, M, Tx, Ty, Mx and My.	YES
E23	The engineer should be able to see the history diagram showing wind speed during chosen period of time.	YES
E24	The engineer should be able to see the history diagram showing wind direction during chosen period of time.	YES
E25	The engineer should be able to see the history diagram showing maximum wind speed during chosen period of time.	YES
E26	The engineer should be able to see the history diagram showing maximum wind direction during chosen period of time.	YES
E27	The engineer should be able to view the history graph showing the water level during chosen period of time.	YES
E28	The engineer should be able to view the history graph showing the river bed height during chosen period of time.	YES
E29	The engineer should be able to view the history graph showing the safety trend during chosen period of time.	YES
E30	The engineer can choose a start date and end date for the historical graphs.	YES
E31	The engineer can choose a specific day for the historical graphs.	YES
E32	The engineer can choose a specific month for the historical graphs.	YES
E33	The engineer can view all the parameters that are stored in the database and used for calculations.	YES
E34	The engineer can change any parameter that is stored in the database and used for calculations.	YES
E35	The engineer controller should be able to log out of the system.	YES

Id	Requirement Description	Completed
	ADMINISTRATOR REQUIREMENTS	
A1	The administrator should be able to log into the system with user-name and password.	YES
A2	The administrator should be able to register a new user by entering information about the user: first name, last name, user-name, email and permission level (Engineer or Human Controller).	YES
A3	The administrator should be able to edit any information about any user (except password).	YES
A4	The administrator should be able to delete a registered user from the system.	YES
A5	The administrator should be able to log out of the system.	YES

Id	Requirement Description	Completed
	PARSER REQUIREMENTS	
P1	Each received package should be parsed into the database in the following way. Every hour the system receives a packet in which there are an analog file, a sonar file both with 3600 lines of values and two images, one for each camera. All these values are to be converted from the parser into the db.	YES
P2	For the analog and sonar sensors, the name of the files should be parsed in the following way. In the file names, analog*********.txt and sonar**********.txt, the ID (**...) represents the number of seconds that have elapsed since 1st January 1904 (using Labview encode), on the Greenwich meridian.	YES
P3	For the picture files, the ID of the name Modean[Mantova]********.jpg should represent the exact time and date when the picture was taken.	YES
P4	The first column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the wind speed (measured in mA). It should be converted to [m / s] by using the following formula: V [m / s] = (((V [mA] ∗ 1000) − 4) ∗ 3,75).	YES
P5	The second column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the distance between the hydrometer and the level of water (measured in mA). The actual distance [m] should be parsed by using the following formula: h [m] = 20 + (((h [mA] ∗ 1000) − 4) ∗ (−1,25)). The water height should be parsed by using the following formula: h_{water}[m] = 29,86 − h [m].	YES
P6	The third column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the wind direction (measured in mA). It should be converted to [°] by using the following formula: dir [°] = (((dir [mA] ∗ 1000) − 4) ∗ 22,5).	YES
P7	The fourth column of the analog*********.txt file should be parsed in the following way. Each row in the timestamp of the detection of the sample (Labview encode). The decimals for the timestamp are allowed to be dropped.	YES
P8	The first column from the sonar**********.txt file should be parsed in the following way. The first column is the distance between sonar and the bottom of the river (measured in meters). The height of the bottom [m] should be parsed by using the following formula: hBottom[m] = 12,3 − xx.xx [m].	YES
P9	The second column from the sonar**********.txt file is the timestamp of the detection of the sample and should be parsed by using the Labview encode: the number represents the number of seconds that have elapsed since 1st January 1904, on the Greenwich meridian.	YES

<table>
<tr><th>Id</th><th>Requirement Description</th><th>Completed</th></tr>
<tr><th colspan="3">CALCULATIONS REQUIREMENTS</th></tr>
<tr><td>C1</td><td>All calculations should be preformed after each parse of the data.</td><td>YES</td></tr>
<tr><td>C2</td><td>The push of the wind on the planking should be calculated by the formula:
$S_{Vplank}=\frac{1}{2}*C_{Dwi}*\rho_{air}*A_{traf}*V^2_{EFFwind}$</td><td>YES</td></tr>
<tr><td>C3</td><td>The push of the wind on the traffic for traffic combination A1 should be calculated by the formula: $S_{V(A1\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_1*A_{traf})*V^2_{EFFwind}$</td><td>YES</td></tr>
<tr><td>C4</td><td>The push of the wind on the traffic for traffic combination A2 should be calculated by the formula: $S_{V(A2\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_1*A_{traf})*V^2_{EFFwind}$</td><td>YES</td></tr>
<tr><td>C5</td><td>The push of the wind on the traffic for traffic combination A3 should be calculated by the formula: $S_{V(A3\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_2*A_{traf})*V^2_{EFFwind}$</td><td>YES</td></tr>
<tr><td>C6</td><td>The parameters a_i , b_i , c_i should be calculated using the table below.
<table>
<tr><th colspan="5">Scale of estimate flow rates with fixed section</th></tr>
<tr><th>Parameters</th><th>h_{water}<17m</th><th>17m<h_{water}<22m</th><th>22m < h_{water} < $h_{MAXwater}$</th><th>$H_{MAXwater}$=25,3m</th></tr>
<tr><td>a_i</td><td>46</td><td>60</td><td>96</td><td>96</td></tr>
<tr><td>b_i</td><td>-902</td><td>-1350</td><td>-2800</td><td>-2800</td></tr>
<tr><td>c_i</td><td>4658</td><td>8000</td><td>22500</td><td>22500</td></tr>
</table></td><td>YES</td></tr>
<tr><td>C7</td><td>The flow rate should be calculated using the formula: $Q = a_i * h^2_{water} + b_i * h_{water} + c_i$</td><td>YES</td></tr>
<tr><td>C8</td><td>The speed of water should be calculated using the formulas:
<table>
<tr><th colspan="3">2D analysis – fixed bottom</th></tr>
<tr><th>h_{water} [m]</th><th>Q [m^3/s]</th><th>V_{water} [m/s]</th></tr>
<tr><td>3</td><td>510</td><td>0,24</td></tr>
<tr><td>10,5</td><td>5400</td><td>2,73</td></tr>
<tr><td>14</td><td>10000</td><td>3,54</td></tr>
</table>
$V_{water} = a * h^3_{water} + b * h^2_{water} + c * h_{water}$</td><td>YES</td></tr>
<tr><td>C9</td><td>The area of stack should be calculated using the formula: $A_s = B_s * h_s$
with: a. if [SONAR1] < bottom_ref → h_s = [IDRO2] – bottom_ref
b. if [SONAR1] > bottom_ref → h_s = [IDRO2] – [SONAR1]
and: a. if D = 0 → $B_s = B_{s0} = c$
b. if D = 1 → $B_s = B_{s1} = 2*D_{pylon}$</td><td>YES</td></tr>
<tr><td>C10</td><td>The Area Stack and Swater should be calculated using the formulas:
<table>
<tr><th>(D = 0)</th></tr>
<tr><td>$A_s = B_{s0} * h_s$
$S_{water} = \frac{1}{2} * C_{D0} * \rho_{water} * A_s * V^2_{water}$</td></tr>
<tr><th>(D = 1)</th></tr>
<tr><td>$A_s = B_{s1} * h_s$</td></tr>
<tr><td>$S_{water} = \frac{1}{2} * C_{D1} * \rho_{water} * (A_s * \beta_A) * V^2_{water}$</td></tr>
</table></td><td>YES</td></tr>
<tr><td>C11</td><td>The portion of palking should be calculated with the formula:
$PP_{structure} = P_s + [(2 * P_{pu} + 6*P_{tp} + 2*P_b) + 6*(P_p*(h_{beam} - [SONAR1]))]$</td><td>YES</td></tr>
</table>

6.1.2 Requirements Compliance Summary

Total number of requirements	108
Number of requirements implemented	108
Requirements partially fulfilled	0
Requirements not fulfilled	0
Requirements dropped	0

6.2 Deliverables

To	Output	Planned week	Promised week	Late +/-	Delivered week	Rem
Supervisors/ DSD staff	Project Plan Document	43	44	+1	44	
Supervisors/ DSD staff	Requirements Definition Document	44	45	-	-	
Supervisors/ DSD staff	Design Description Document	45	45	-	-	
Supervisors/ DSD staff	Alpha Prototype	48	48	-	-	1
Supervisors/ DSD staff	Status Report	49	49	-	-	
Supervisors/ DSD staff	Beta Prototype	51	51	-	-	2
Supervisors/ DSD staff	Acceptance Test Plan	1	1	-	-	
Supervisors/ DSD staff	Test Report	2	2	-	-	
Supervisors/ DSD staff/ Customers	Final Project Presentation	2	2	-	-	
Supervisors/ DSD staff/ Customers	Final Project Report	3	3	-	-	
Supervisors/ DSD staff/ Customers	Final Product	3	3	-	-	3

6.2.1 Remarks

Remark Id	Description
1	The alpha prototype will have the basic features required, so the data parser and the DB integration
2	The beta prototype will have the main features of the product, like a math engine, graphs, statistics.
3	The final product will have all the features settled with the customers, like historical statistics, graphs, access control, system authentication.

7. Risks

Possibility	Risk	Preventive action
H	Poor communication with the customer	Try to insist on more frequent meetings with the customers.
H	Undefined date for receiving input data	Try to insist on receiving it as soon as possible.
H	Unclear requirements	Try to have as much contact with customer, and ask them for feedback. Get acceptance of requirements from the customer early in the project.
M	Communication within the team	Define precise roles of the team members (team manager, team leader) and define communication flow between all the sides of the team. Also, define fixed dates for group meetings.
L	Communication within the distributed groups	This will be solved by planning to have daily meetings and try to have sprints together.
L	Lack of technical background	We deal with this by choosing technologies that are widely used and well known to the team members
L	Cultural differences	Be patient and open-minded
L	Language misunderstandings	Be patient and ask a lot of questions, in order to not get a wrong understanding of what a person meant
M	Information flow – risk of now receiving all information or of receiving correct one	Work on frequent communication especially between customer-project manager, project manager-team leader
M	Losing data	Always have a back-up of all the files that have been created during the project
M	Integration problems	Good interface definitions
L	Missing Inputs	Create fake .txt files and images with fake plausible data, to simulate the situation of the bridge

8. Project Experiences

8.1 Positive Experiences

Write down what went well during the project work, be very specific – what, how, why!

8.2 Improvement Possibilities

Write down what did not go well during the project work, be very specific – what, how, why, how to improve in the future!

9. Metrics

9.1 Work per Member

List all project team members, all weeks the project was going on, hours invested per week, total hours a person invested during the project.

Member	Wxy	Wxz	W..	Total
X Y	6	2	0	
	5	1	0	
	2	3	0	
	2	3	0	
	2,5	1,5	0	
	2	2,5	2	
	2	3	0	
	2	3	0	
	0	2	0	
Total	23,5	21	2	1425

Comment the results, compare them with the forecasted amount of hours needed to finish the project, compare possible differences between project members (average number of hours invested, standard deviation, why there are persons – name them - with significantly less or more hours invested compared to average).

9.2 Milestone Metrics

From Milestone section of this document compile the summary data for milestones, enter the number of milestones completed on time or earlier, total number of milestones defined in the project and calculate the percentage of milestones on time or earlier and enter it in the Timeliness cell.

Completed as planned or earlier	Total	Timeliness

9.3 Effort Metrics

List all the activities in the project (project phases like requirement definition, design, implementation of certain artifacts, testing etc.), enter the actual number of days (total number of days invested by the project team) for each effort, planned number of days for that activity (see project plan document), and calculate deviation from the plan (+- percentage).

ID	Activity	Actual Effort	Planned Effort	Deviation (%)

Explain reasons behind significant deviations (if any)!

Effort estimation accuracy (%) *(100*(1 - abs(Actual – Planned)/Actual))*	84%