

1503008_v10

by Emyr Dyer

FILE	7311_EMYR_DYER_1503008_V10_174990_971162919.PDF (1,021.16K)		
TIME SUBMITTED	13-DEC-2019 07:26PM (UTC+0000)	WORD COUNT	6046
SUBMISSION ID	116359083	CHARACTER COUNT	36742



Course: BSc (Hons) Electrical and Electronic Engineering
Module: SGEE6003 – Major Project
Assignment: 1. Project Definition, Research and Quality Planning
Name: Emyr Wyn Dyer
Student No. 1503008
Date: 13/12/2019
Word Count: 3756

CONTENTS

1	Executive Summary	1
2	Introduction	2
3	Project Background, Problem Definition and Constraints	3
3.1	The CIM System	3
3.2	Intellectual Property	4
3.3	Health & Safety	5
3.3.1	Work	5
3.3.2	Product Safety	5
3.4	Development Risk	6
3.5	Ethical Engineering	7
3.6	Security	8
3.7	Environmental Considerations	8
4	Functional Design Specification and Test Plan	9
4.1	Functional Design Specification	9
4.2	Test Plan	11
5	Literature Review	12
5.1	All Solutions	12
5.2	Solution 1 – WinCC SCADA	12
5.2.1	ISO Model of Data Flow	13
5.2.2	Advantages	13
5.2.3	Disadvantages	13
5.3	Solution 2 – HTML Webpages	14
5.3.1	ISO Model of Data Flow	14
5.3.2	Advantages	14
5.3.3	Disadvantages	14

5.4	Solution 3 – Android Studio Application.....	15
5.4.1	ISO Model of Data Flow.....	15
5.4.2	Advantages.....	15
5.4.3	Disadvantages	15
5.5	Comparison Table	16
6	Project Planning, Work breakdown and Management Techniques	17
6.1	Work Based Structure	17
6.2	Gantt Chart	18
6.3	Risk Management.....	19
7	Conclusions and Recommendations	20
8	Citation List	21
9	Appendix	24

FIGURES

Figure 3-1:	Schematic of the Conveyor and Stations of the CIM System	3
Figure 5-1:	Hardware Configuration for All Solutions.....	12
Figure 5-2:	ISO Model for WinCC Application	13
Figure 5-3:	ISO Model for HTML Webpage Application	14
Figure 5-4:	ISO Model for an Android Application	15
Figure 6-1:	Work Based Structure Document	17
Figure 6-2:	Gantt Chart	18
Figure 6-3:	Risk Matrix	19
Figure 6-4:	Risk Severity	19

1 EXECUTIVE SUMMARY

The project is to produce an alternative to the SIMATIC Touchscreen HMIs currently used to operate Siemens S7-1200 PLCs which control the CIM system (engineering demonstrator), using webserver technology built into the Siemens S7-1200 PLCs. The alternative is required to permit the same level of control as the SIMATIC HMIs, from a networked device such as a PC or Touchscreen Tablet using appropriate networking infrastructure (LAN, Wi-Fi, etc.).

Through literary review of published works, and reading of UK Parliamentary legislation relating to Engineering environments and Software Development, an understanding of how to ensure a safe development environment is gleaned to protect those that may be affected by operations carried out to produce a working solution to the Project Proposal. Techniques in Risk Management are also researched to ensure timely delivery of the working solution.

Also addressed are the solutions to achieving the requirement for an alternative control method to the SIMATIC Touchscreen HMI and Pre-Industry 4.0 SCADA solutions. The three potential solutions addressed were a Siemens WinCC SCADA application, an HTML Webpage application, and an Android application programmed in C++.

An HTML webpage solution was selected, as it is the more cost-effective and reliable method of delivering an HMI/SCADA alternative, referred to as an ABA (Automation Browser Application) as producing an ABA utilises neglected features of hardware (webserver) already acquired by businesses. Through analysis of risk, the most significant threat to the successful implementation of an ABA is time lost through development, over other risks such as complications from adapting to new technologies.

In conclusion, the HTML based ABA will achieve the most value for money by fully utilising all features of the Siemens S7-1200 PLC, with minimal changes to networking infrastructure.

It is highly recommended that time used is closely monitored, and wisely invested by fully utilising access to hardware to develop the solution through trialling prototypes, while time away from hardware is spent on further research and documentation of the development process.

A limitation of this report is that much of the legislative documentation is always liable to change, placing new restrictions on the development process to protect the environment, thereby removing access to resources that may be required.

2 INTRODUCTION

The CIM (Computer Integrated Manufacturing) System is an engineering demonstrator used to teach engineering students the skills to develop and implement automated systems as controlled by PLCs (Programmable Logic Controller), which in turn are operated by HMIs. As a feature, the Siemens S7-1200 PLCs have webserver functionalities, which are an underused potential for developing 'Smart-factories' using networked computer systems.

The Aim and Objective of the Project is to use the webserver feature to produce an alternative means of operating the PLCs, without relying on HMIs and increasing the scope of accessibility of data held on the PLCs by outputting data to textboxes and graphics on screen and receive input via on-screen controls. The screens may also be 'mirrored' to wall-mounted monitors or mobile devices, to provide easy access to system data that students can utilize, during academic investigations. These objectives will be reflected in a Functional Design Specification which will help set the direction of the Project.

Solutions will then be approached by researching available technologies compatible with the PLC webserver feature, and how they can affect both society and the environment, through how the technology is interacted with and how it is produced.

Feasibility of the project will be examined by investigating risks involved in development and in Health and Safety terms. Security will also be considered as failures in network security could bring financial losses to an unwitting organisation with weaknesses in protective systems.

A key factor of Industry 4.0, is the networking of all industrial systems to enhance the control of plant systems, through means such as cloud computing. Upgrading a plant to Industry 4.0 standard can be a financially costly prospect due to purchasing of additional hardware, so the other goal of this project is to provide a cost-effective means of enhancing the controllability of a plant without adding significant cost, and if possible, improve efficiency in terms of energy used.

3 PROJECT BACKGROUND, PROBLEM DEFINITION AND CONSTRAINTS

3.1 THE CIM SYSTEM

The CIM System comprises of a looped conveyor with five core 'Stations' situated around it, which are as follows:

- The Process Station – A gripper is used to move components between process tanks where fluid is pumped into and heated to 'treat' the components.
- The Pneumatic Station – Hosts pneumatic manipulators which are used to interact with components.
- The Vision Inspection Station – An automated Quality Assurance station, that uses image processing to evaluate the quality of the assembled product.
- The Hydraulic Station – A Pick and Place system used to assemble the components into a finished product.
- The Finishing Station – The endpoint where the product is deposited.

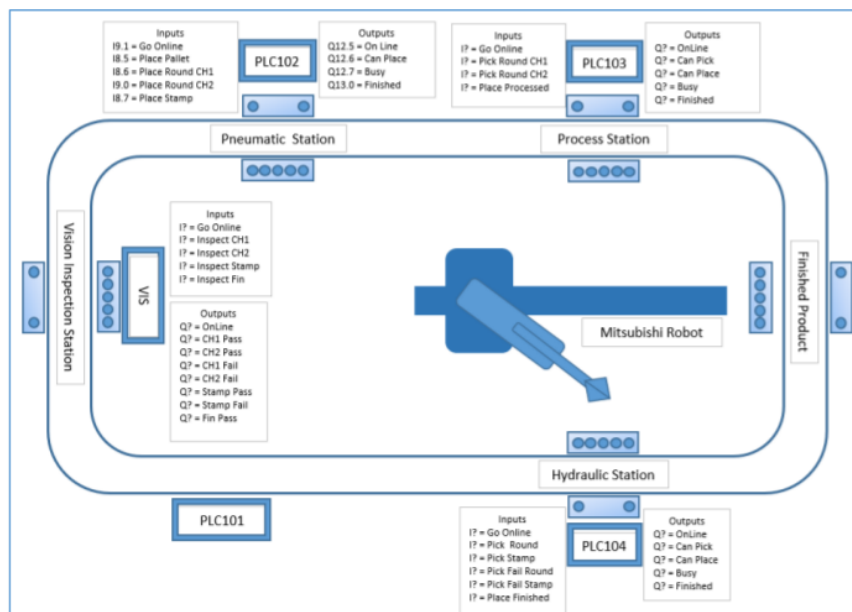


Figure 3-1: Schematic of the Conveyor and Stations of the CIM System

In all, there are four Siemens S7-1200 PLCs used in the operation of the CIM System with one main PLC with I/O Expansion modules, and one each at the Process Station, the Pneumatic

Station, and the Hydraulic Station. There are also several SIMATIC Touchscreen HMIs used to observe and directly control the processes executed by the PLCs, with the largest screen being a 12-inch display. The S7-1200 PLCs are programmed and configured using Siemens' SIMATIC STEP7 Software, which is part of the TIA (Totally Integrated Automation) Portal, Siemens' suite of automated system design software.

3.2 INTELLECTUAL PROPERTY

The CIM System itself, is the Intellectual Property of Coleg Sir Gâr as its design and construction were largely led by employees of the College. In regards to the ABA which is being developed for the CIM System, the issue is problematic under UK Law. In the UK software code can be protected by copyright, which is used to protect original work that requires skill and effort to create. Usually, copyright is used to defend artistic works, so in theory, code could be considered a 'literary' work, and graphical imagery as 'film'. For infringement of copyright to truly apply, the code would need to be replicated entirely without alterations, however, if segments of code were used, with variables and functions renamed, claiming copyright would be difficult as you cannot claim copyright for coding 'technique' (Stokes, 2019).

Patents can be used to protect software technology produced through code, as in the example of Amazon patenting the method of '1-click' purchasing in 1997 (Alef, 2010).

In the case of the ABA, open-source code and code-modules would be used to develop the interface, and the Webserver technology is a feature of the S7-1200 PLC itself would be used to run the code, so the author would not claim copyright as the code is written for the College, and hardware used is owned by the College through purchase.

3.3 HEALTH & SAFETY

3.3.1 Work

Whenever commercial work is undertaken, under the Health and Safety at Work Act (1974), the employer, the employee, the local governing authority and the HSE have roles to fulfil. Responsibilities for ensuring a safe working environment is usually expressed as a goal or target to meet under reasonable circumstances by taking appropriate measures to mitigate risk (Parliament of the United Kingdom, 2019).

Regarding the development and use of the ABA, Display Screen Equipment Regulations (1992) are applicable when users work at a fixed desk, on mobile devices, at home or between multiple workstations (hot-desking). Under these circumstances, an employer must assess the workspace, which comprises of electrical equipment (checked with a PAT test), furniture (desk and chair), work environment, tasks done and any employee disabilities. Included in the assessment, should be risks identified with steps undertaken to reduce them. Re-assessments should be carried out when there are new users, layout changes or a complaint about pain or discomfort is made (Parliament of the United Kingdom, 2019).

When working on the CIM System, the Electricity at Work Regulations 1989 takes effect, which dictates that when carrying out planned maintenance, sources of energy are appropriately released, and then isolated and secured to prevent unwitting reactivation of the system (Parliament of the United Kingdom, 2019).

All individuals involved should be competent in carrying out maintenance safely as verified through certification and regular re-assessment (Health and Safety Executive, 2019).

The CIM System itself must adhere to BS 7671:2001 standards for electrical installations, which can be tested using IEE Wiring Regulations 18th edition. By following these standards, the risk of injury resulting from interaction with the system is reduced (ABB Furze, 2018).

3.3.2 Product Safety

Software applications or apps are now largely considered goods and services. Essentially, should the user incur a physical injury while using an app, the developer may become liable unless suitable precautions were implemented (Papasidero, 2016), such as adequate safety warnings to users of the app against using the app while operating heavy machinery or in an unsafe environment. As the ABA application, in theory, could be operated by a mobile device in an industrial environment, it essential for suitable warnings to be put in place.

While there is no specific current legislation exclusively regarding product safety in software, existing legislation for product safety could be considered to prepare for a potential change in the law. The General Product Safety Regulations 2005 (Office for Product Safety and Standards [UK Gov], 2019) requires that all risks be minimised, technical documentation produced to be recorded, that the product is properly labelled along with instructions for safe use. Should the hardware system's safety measures fail, the manufacturer should remedy the risk, by correcting the fault and warning the customer of the hazard as well as potentially issuing a recall of the faulty product.

In the event a customer feels they have grounds to sue for compensation, it would be advantageous to have had in place product liability insurance to protect against significant financial loss.

As such, the ABA itself is not being sold as a product in this instance, so technically there is no relevant legislation related to the development of the ABA, however as good practice, the guidance should still be followed to ensure that the application is safe for use.

3.4 DEVELOPMENT RISK

At the start of development, the number of risks to the project are high, so it is vital to identify potential risks and find ways to mitigate them (Munier, 2014).

At this point in project development, internal risks include:

- Failing to identify the necessary technological requirements.
- Not identifying competing product advantages.
- Development costs.
- The learning curve of technology and disciplines.
- Illness and injury.

Internal risks are mitigated as follows:

- Using the Webserver feature of the PLC is the core objective of the project.
- Evaluation of the 3 solutions should reduce the threat of competition.
- At most a memory card expansion is required.
- Use of technology elements researched and compatibilities identified.
- Development time set aside in planning.

External Risks include:

- Market needs
- Competitor's technological development
- Client changing requirements

External Issues mitigated by:

- Carrying out market solution research (3 solutions) for needs and technology trends.
- Ensuring there is an agreement between developer and client.
- Looking at recent legal developments to predict legislation changes (application product safety).

A potential risk that a user of the ABA could have been subject to, might have been flicker induced epileptic seizures, however by using AJAX, the page refresh issue is effectively eliminated, and CRT monitors which were notorious for inducing seizures are seldom used as production has largely ceased as of 2010.

3.5 ETHICAL ENGINEERING

In 2017, the Royal Academy of Engineering and the Engineering Council jointly released a statement of Ethical Engineering, which established four core principles that Engineers should adhere to (Royal Academy of Engineering, 2017). The principles were:

1. Honesty and integrity – Where Engineers should work diligently, be conscious of others' rights, be considerate of rights and confidentiality, be open about conflicts of interest, and reject all forms of corruption such as bribery and discrimination.
2. Respect for life, law, the environment and public good – By being mindful of the Health & Safety of others, ensure work adheres to the law of the land, maintain respect and security of property and information, defend the integrity of natural and man-made environments, reduce adverse effects for future generations, be aware of limited resources, and maintain the standing of Engineers and associated institutions.
3. Accuracy and rigour – Engineers should only conduct work in areas where they can perform task competently or at least with competent support to ensure a high standard, maintain up-to-date knowledge in their qualified field of profession, be unbiased in reviewing theory by objectively examining evidence, and evaluate and reduce risks without intentionally misleading others or allow others to be led astray.

4. Leadership and communication – By being aware of concerns on the impact of technology in society, advocate equality and diversity, develop awareness of the effect of engineering developments, maintain professionalism when making statements, and confront policies that raise professional concern.

3.6 SECURITY

When networking the PLCs of an automated system to a larger networked system, the automated system is subject to the same vulnerabilities as the rest of the computer network. Vulnerabilities can best be described as threats from malware picked up from the Internet or unauthorised access to the network infrastructure, drops in network connectivity due to faults or poorly executed maintenance, or faulty software updates. To mitigate these threats, a well-written network security policy detailing user group access permission, enforcement methods, and password complexities and encryption (Health and Safety Executive, 2019).

3.7 ENVIRONMENTAL CONSIDERATIONS

When considering the recycling of equipment used for development or implementation, most pieces of hardware can be repurposed in developing other new projects, but where repurposing of hardware is impossible due to damage some various laws and directives that come into play. One law called The Waste Electrical and Electronic Equipment Directive established as European Law in 2003 (later revised in 2012) states that 20kg per capita per annum of recovered electrical equipment must be re-used or recycled (European Commission, 2019). It is not known with certainty of the fate of the WEEE Directive in UK law (Practical Law, 2019), as at the time of writing the Withdrawal of the United Kingdom from the European Union has not yet taken effect, however as many countries have set more ambitious targets for recycling, it is likely the UK Government will set standards that are comparable to the WEEE Directive (letsrecycle.com, 2019).

4 FUNCTIONAL DESIGN SPECIFICATION AND TEST PLAN

4.1 FUNCTIONAL DESIGN SPECIFICATION

The ABA must satisfy the following requirements:

- Be hosted on the Siemens S7 PLC with Webpage data stored on Memory Card with future Expansion capability, to prevent hindrance to further PLC performance.
- At a minimum, Google Chrome is to be fully supported as the operating browser.
- Display updating data with as little perceivable flicker as possible to maintain the visual accuracy of data rendered both graphically and as values.
- Allow the equal level of controllability and response as the existing 12-inch SIMATIC HMI.
- Operate on a separate Virtual LAN from existing network infrastructure to maintain security.
- Have password protection to prevent malicious or negligent tampering with the system, implemented through Access Control.

The measurable elements that can be tested to ensure success include the following:

- Response time of 1 second or less and absence of visual flicker (refresh of page contents).
- Security integrity (access to controls) protected by ramping temporary lockout after 5 failed attempts.
- Critical faults indicated by failures to start, stop or proceed.
- Accuracy of on-page readings within 1% when compared to PLC.
- Reliability of Network operation i.e. any perceived dropouts in connection.
- A minimum of 1 page per Station, with 12 tags per page.

Overall development of the project will be monitored through regular recording of progress in weekly logbooks which can be compared to the Project Gantt Chart.

While the system is being developed for an Engineering Classroom environment, this system can be deployed in an industrial environment as the physical equipment and software used is developed for that type of environment. It should be stated that the CIM System, which the ABA is designed to control, comprises of a water-based automation system with heated tanks, pumping system, conveyor and robotic arms to demonstrate an industrial process.

A maximum budget of £200 has been set for procurement of additional hardware, as the objective is to re-configure existing hardware. Delivery of the proposed ABA will be no later than 24th April 2020, with a Presentation delivered on 15th May 2020.

Regarding the usability of the ABA, it needs to be straightforward for an individual with an engineering background to be able to operate and understand the interface for the ABA. However, the goal is to make it possible for someone to replicate the process of developing their own ABA to operate another system controlled by a Siemens S7 PLC through the documentation produced for this project and will, therefore, be usable by students for development and training.

To maintain a safe working environment already in place, the ABA must not in any way compromise and safety measures already implemented, as well as adhere to any Health & Safety regulations that may be added with the introduction of new equipment installations.

During development, there will be some increases in energy usage due to additional networking hardware being implemented for the design and testing of the ABA. However, in an industrial application of the ABA, as existing equipment is being used and reconfigured, it is not expected that more energy than is already being used will be expended in the final implementation of the ABA. As the objective of the Project is to re-configure existing equipment,

To adhere to the WEEE Directive, any additional development hardware will be used for future development of new systems, once the development of the ABA has been completed.

4.2 TEST PLAN

Test No.: _____ Date of Test: ____/____/____				
Test Step	Test Description	Target	Actual	Pass/Fail and Comment
1	Does the ABA start? Tested by opening Address/Shortcut to ABA.	ABA Opens		
2	Measure response time between the PLC and User Input and Feedback to ABA	= or < 1 second		
3	There should be at least 1 page per CIM System Station. Are all Stations represented in the ABA?	1 Page minimum per Station		
4	Readings displayed are accurate to values read and stored in the PLC. Achieved by comparing ABA to online connection to PLC through Step7.	Values are within 1%		
5	Do the Security Measures perform as expected? Security measure rejects login attempts after failure.	Login rejected		
6	Does the ABA at any point lose connection to the CIM System? Measured by desynchronization of values between PLC and ABA.	Continuous Connection		
7	When Operating are there any failures to proceed. (CIM System stops without warning)	No unexpected stoppages		
8	When ABA is running, are there any failures to Start or Stop the CIM System?	Starts and Stops on command		

5 LITERATURE REVIEW

5.1 ALL SOLUTIONS

For all three solutions identified, the network hardware setup is largely the same, with the Application either stored locally on each device, or hosted on the Siemens S7-1200's built-in webserver (Figure 5-1). To better show the differences between solutions, the OSI 7-layer model (Gibson, 2011) is used to describe the protocols and communication methods used in each solution (5.2.1, 5.3.1, and 5.4.1).

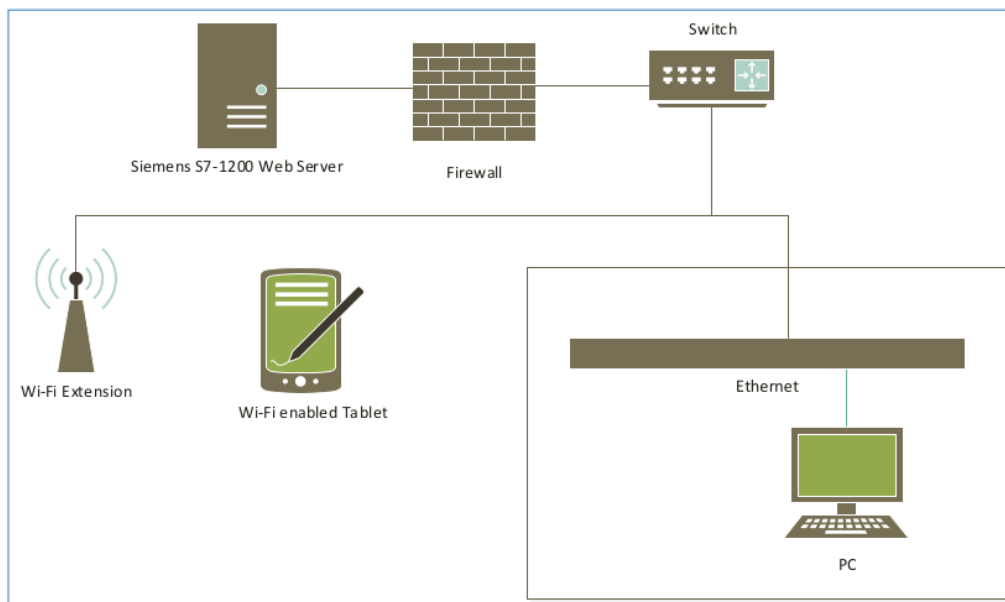


Figure 5-1: Hardware Configuration for All Solutions

5.2 SOLUTION 1 – WINCC SCADA

WinCC is the solution offered by Siemens for the development of SCADA systems, enabling remote monitoring and control of plant systems. WinCC is designed with the Siemens S7 series of PLCs in mind, fully utilising the PROFINET connection to the local network infrastructure (Berger, 2013).

5.2.1 ISO Model of Data Flow

1. The Physical Layer	Cisco Switch, Wireless Extension via Extender/Access Point or Wireless Router
2. The Data Link Layer	LAN (Local Area Network)
3. The Network Layer	IPv4 (Internet Protocol Version 4)
4. The Transport Layer	TCP (Transmission Control Protocol, Open Communication Block)
5. The Session Layer	PAP (Password Authentication Protocol)
6. The Presentation Layer	Transport Layer Security (Data Encryption)
7. The Application Layer	WinCC (Code Structure), DHCP (IP Addressing for Network Devices)

Figure 5-2: ISO Model for WinCC Application

Note: PROFINET is described as working across all layers, and certain protocols are ignored, such as PAP.

5.2.2 Advantages

Due to the use of PROFINET as part of the Network Connection to the PLC, the response time is typically quicker as PROFINET disregards certain networking protocols to facilitate faster delivery of data to the linked control system, which is typically a SIMATIC HMI (Berger, 2013).

5.2.3 Disadvantages

The Package cost for a WinCC based SCADA system is significantly high as the Runtime software with 200 tags and documentation costs £2,511 (Parmley Graham, 2019).

In addition to the costs of acquiring a WinCC SCADA system, there would be additional costs resulting from the implementation and running of suitable Server hardware.

5.3 SOLUTION 2 – HTML WEBPAGES

This solution utilises the Webserver functionality built-in to all Siemens S7-1200/1500 PLCs. Development of this solution will require the use of some form of Web Development software, to build the interface and write code to work with the PLC programming. As HTML and jQuery are used as the basis for building the Web Application, AJAX will be used to call variable data from the PLC with JSON being used to store the data during operation (Berger, 2013).

5.3.1 ISO Model of Data Flow

1. The Physical Layer	Cisco Switch, Wireless Extension via Extender/Access Point or Wireless Router
2. The Data Link Layer	LAN (Local Area Network)
3. The Network Layer	IPv4 (Internet Protocol Version 4)
4. The Transport Layer	TCP (Transmission Control Protocol,
5. The Session Layer	Open Communication Block)
6. The Presentation Layer	PAP (Password Authentication Protocol)
7. The Application Layer	JSON (Handle PLC Variable data), Transport Layer Security (Data Encryption), HTML and JavaScript/jQuery(Code Structure), AJAX (Data Requests), DHCP (IP Addressing for Network

Figure 5-3: ISO Model for HTML Webpage Application

5.3.2 Advantages

All web technologies used in this option are open-sourced, meaning there should be no licence-fees to account for in terms of cost. While it is true that some add-ons built-in jQuery by developers require a licence fee to use, there are some jQuery modules available that should work well in the development of an ABA (Ruvalcaba & Delamater, 2017).

In terms of hardware costs, theoretically, the only expenditure would be an additional memory card for an S7 PLC, for storage of image data. Otherwise, there are no additional hardware requirements other than what is usually already in place, namely networked computer systems, this also avoiding and additional usage of electrical energy.

5.3.3 Disadvantages

PLC performance can be affected if large amounts of Webserver data is uploaded to the PLC, namely image data, which if improperly compressed or a bitmap format, can take up significant space.

5.4 SOLUTION 3 – ANDROID STUDIO APPLICATION

This potential avenue for the development of an Automation Application would create an app that would run on Android devices such as Phones or Tablets.

This solution would be developed in the Android Studio (IDE), which supports the two popular programming languages, Java and C++. Communication between the S7-1200 and the Android application should be possible as both AJAX and JSON are compatible with at least the C++ language (Clifton Craig, 2015).

5.4.1 ISO Model of Data Flow

1. The Physical Layer	Cisco Switch, Wireless Extension via Extender/Access Point or Wireless Router
2. The Data Link Layer	LAN (Local Area Network)
3. The Network Layer	IPv4 (Internet Protocol Version 4)
4. The Transport Layer	TCP (Transmission Control Protocol, Open Communication Block)
5. The Session Layer	PAP (Password Authentication Protocol)
6. The Presentation Layer	JSON (Handle PLC Variable data), Transport Layer Security (Data Encryption)
7. The Application Layer	C++ (Code Structure), AJAX (Data Requests), DHCP (IP Addressing for Network Devices)

Figure 5-4: ISO Model for an Android Application

5.4.2 Advantages

One aspect of developing an Automation Application using this IDE is the Layout Editor, which has a drag-and-drop approach to building a User Interface.

By developing Automation Application as an Android Application, the typical features of Android Devices also come into play such as Bluetooth, Wi-Fi and NFC for connecting to enabled sensors and Network Infrastructure (Smyth, 2019). There is also the consideration of other hardware that has become standard on modern Android Devices such as Facial Recognition and Fingerprint identification (Smyth, 2019) which enhances plant security by ensuring only authorised individuals have access to the ABA.

5.4.3 Disadvantages

The IDE has support for Cloud Computing, which is key to Industry 4.0 (Gilchrist, 2016) in enhancing the flow of information around a plant. However, this level of Cloud Computing is dependent on an outside organisation managing the flow of information, which itself could be considered a potential breach of security.

As Android is typically used in battery-operated devices, the operating system automatically manages app performance to keep power usage to a minimum. While it is true that this could be considered an advantage in terms of device life, the performance of the application itself could be affected (Smyth, 2019).

5.5 COMPARISON TABLE

By referring to the Functional Design Specification, and the Solution research, the three Solutions, are examined in terms of Cost, Compatibility and Theoretical Performance. 5, 3 and 1 Points are allocated for the 3 aspects of each solution.

Aspect	Solution 1	Solution 2	Solution 3
Cost	£2,511 minimum (1 Point)	£169 (12 MB Memory Card) (3 Points)	Use own Smartphone and Tablet for testing (5 Points)
Compatibility	Total Siemens Compatibility (5 Points)	Built-in and manufacturer recommended technology used (5 Points)	Built-in technology used but with unconventional development software (3 Points)
Theoretical Performance	Development Software (WinCC) made for Siemens PLCs (5 Points)	Using AJAX and JSON (5 Points)	Temperamental Android hardware characteristics (1 Point)
Total Points	11 Points	13 Points	8 Points

As the highest-scoring option, the HTML Webpage option is the most suitable path for the ABA.

6 PROJECT PLANNING, WORK BREAKDOWN AND MANAGEMENT TECHNIQUES

6.1 WORK BASED STRUCTURE

The identified elements of project development found in the FDS, were broken up into subtasks as shown in Figure 6-1.

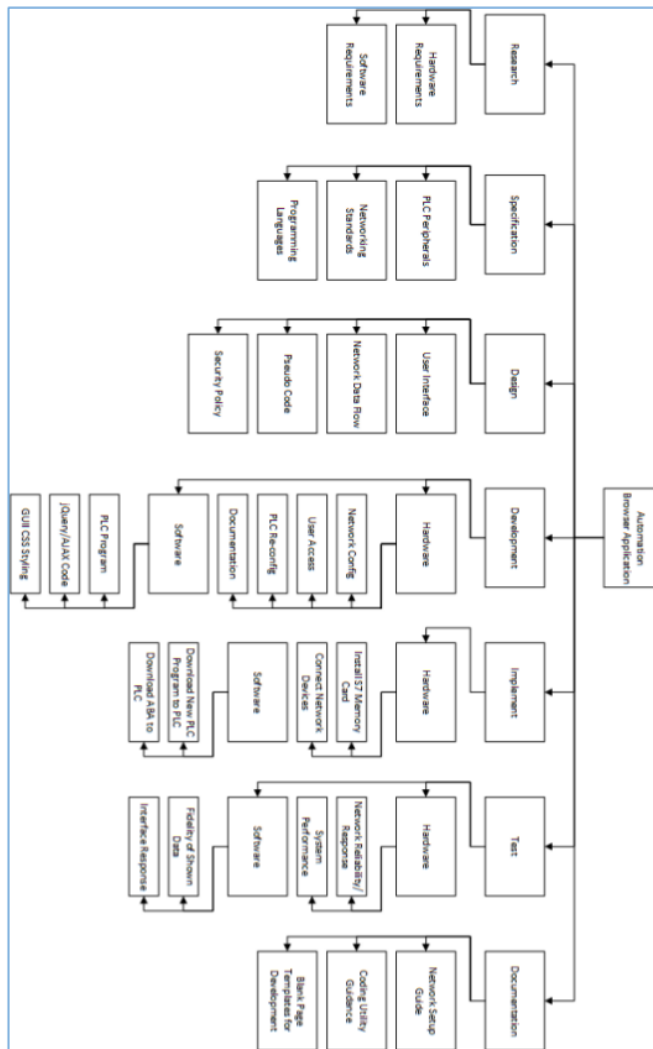


Figure 6-1: Work Based Structure Document

6.2 GANTT CHART

By taking deliverable deadlines, and objectives identified in the WBS, the following Gantt Chart was produced. Going forward, as the Logbooks are completed, the Chart will be updated with opposing cross-hatching to indicate progress.

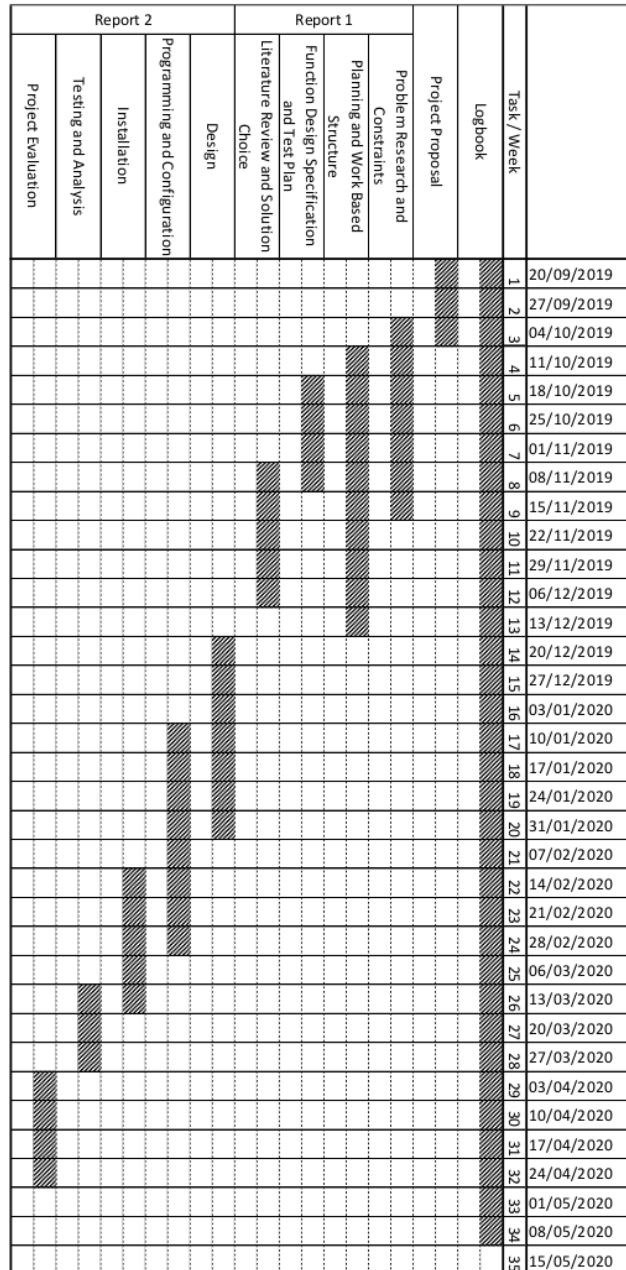


Figure 6-2: Gantt Chart

6.3 RISK MANAGEMENT

Taking the possible risks identified in section 3.4, and adding them to the grid (Barkley, 2004) in Figure 6-3, the severity of the risks were identified. Depending on the level of impact and the probability of the risk occurring, a score is applied to signify severity of risk.

		Probability			
		1 = high (between 80% and 100%)	2 = medium high (between 60% and 80%)	3 = medium low (between 30% and 60%)	4 = low (between 0% and 30%)
Impact	A = high (100)	100	80	60	30
	B = medium (50)	50	40	30 - delays during coding process due to long illness	15
	C = low (10)	10	8 - Learning Curve of technology	6 - delays during coding process due to short illness	3 - inability to acquire additional hardware and software

Figure 6-3: Risk Matrix

Risk Score Severity	Colour Code
very high - between 100 and 80	
high - between 80 and 60	
moderate - between 40 and 30	
low - between 15 and 3	

Figure 6-4: Risk Severity

By looking at the matrix, the biggest risk to the development is a long illness, that prevents access to the CIM System. To mitigate that risk, work will need to be identified that can be carried out during that potential period of illness. To mitigate the low risks, additional time is set aside, with Gantt Chart adjusted.

7 CONCLUSIONS AND RECOMMENDATIONS

With initial research carried out, and development objectives identified along with risks to manage, the prospects of completing the project on time are good.

The HTML Webpage Solution is shown to be the most promising avenue for the development of the ABA by using a scoring method, weighing characteristics and allocating points to each of the three solutions. With solution selected, the acquisition of the Memory Card required to develop the ABA has progressed to the ordering phase at the cost of £169.

All other elements required for the project are readily available including Siemens S7-1200 PLCs, Original CIM System Program, LAN hardware and Computers with necessary development software (SIMATIC STEP7 and Adobe Dreamweaver) installed on available computer systems.

An awareness about the importance of sustainability in engineering project developments, was reinforced through research into ethical engineering standards and UK Parliamentary legislation in respects to materials used and recycled and use of energy. The environmental advantage of the selected solution, is that existing hardware required to implement the ABA is generally already in use by industrial businesses (network switches/routers, cabling etc.), and with modifications made to network configuration policies, the material costs are negligible. Additionally, an external webserver with its own power requirements is not required to implement an ABA as there is webserver is running from the PLC itself, thus saving on energy usage and reducing the carbon footprint.

With the greatest risk to ABA development being an unexpectedly long illness, it is recommended that all access to the development hardware should be fully utilised, so that should illness strike, there is other less strenuous work that can be carried out to ensure completion of the project, such as detailed record keeping of development via logbooks, to facilitate production of comprehensive guidance literature in building other ABAs.

8 CITATION LIST

ABB Furse, 2018. *IET Wiring regulations BS 7671 18th edition*. [Online]

Available at:

https://library.e.abb.com/public/6963f062a6ff4b22aaa8a1c874a65943/ABB_FURSE_IET_WIRING_REGS_9AKK107046A3767_V2_LR.pdf

[Accessed 5 December 2019].

Alef, D., 2010. *Jeff Bezos: Amazon and the EBook Revolution*. Santa Barbara: Titans of Fortune Publishing.

Barkley, B., 2004. *Project Risk Management*. 1st ed. New York City: McGraw Hill Professional.

Berger, H., 2013. *Automating with SIMATIC S7-1200*. 2nd ed. Erlangen: Publicis Publishing.

Clifton Craig, A. G., 2015. *Learn Android Studio*. 1st ed. New York City: Apress.

European Comission, 2019. *Waste electronic equipment - Environment - European Commission`*. [Online]

Available at: https://ec.europa.eu/environment/waste/weee/index_en.htm

[Accessed 22 November 2019].

Gibson, D., 2011. *Microsoft Windows Networking Essentials*. 1st ed. Hoboken: John Wiley & Sons.

Gilchrist, A., 2016. *Industry 4.0: The Industrial Internet of Things*. 1st ed. New York City: Apress.

Health and Safety Executive, 2019. *Cyber security - Electrical, Control and Instrumentation (E, C&I) - HSE*. [Online]

Available at: <https://www.hse.gov.uk/eci/cyber-security.htm>

[Accessed 7 December 2019].

Health and Safety Executive, 2019. *Work on electrical equipment, machinery or installations - Electrical safety at work*. [Online]

Available at: <https://www.hse.gov.uk/electricity/withequip.htm>

[Accessed 5 December 2019].

letsrecycle.com, 2019. '*Challenging*' 2019 WEEE targets confirmed - letsrecycle.com.

[Online]

Available at: <https://www.letsrecycle.com/news/latest-news/challenging-2019-weee-targets-confirmed/>

[Accessed 24 December 2019].

Mosely, R., 2007. *Developing Web Applications*. Chichester: Wiley.

Munier, N., 2014. *Risk Management for Engineering Projects: Procedures, Methods and Tools*. 1st ed. Valencia: Springer Science & Business.

Office for Product Safety and Standards [UK Gov], 2019. *Product safety advice for businesses*. [Online]

Available at: <https://www.gov.uk/guidance/product-safety-advice-for-businesses>

[Accessed 03 December 2019].

Papasidero, S. J., 2016. *Mobile Apps – Has the Marketplace Downloaded Potential Product Liability Risk?*. [Online]

Available at: <https://www.productliabilityadvocate.com/2016/08/mobile-apps-%E2%88%92-has-the-marketplace-downloaded-potential-product-liability-risk/>

[Accessed 03 December 2019].

Parliament of the United Kingdom, 2019. *Health and Safety at Work etc. Act 1974*. [Online]

Available at: <http://www.legislation.gov.uk/ukpga/1974/37/introduction>

[Accessed 4 December 2019].

Parliament of the United Kingdom, 2019. *The Electricity at Work Regulations 1989*. [Online]

Available at: <http://www.legislation.gov.uk/uksi/1989/635/introduction/made>

[Accessed 5 December 2019].

Parliament of the United Kingdom, 2019. *The Health and Safety (Display Screen Equipment) Regulations 1992*. [Online]

Available at: <http://www.legislation.gov.uk/uksi/1992/2792/introduction/made>

[Accessed 5 December 2019].

Parmley Graham, 2019. 6AV63812CA075AX0 / 6AV6381-2CA07-5AX0 - Siemens WinCC V7.5 SCADA - WinCC RT Client. [Online]

Available at: <https://www.parmley-graham.co.uk/siemens/software/wincc-v7-5-scada/6av6381-2ca07-5ax0>

Practical Law, 2019. *Brexit: EU legislation expected to apply or be implemented in UK pre-Brexit and during transition: tracker* | Practical Law. [Online]

Available at: [https://uk.practicallaw.thomsonreuters.com/2-631-7191?transitionType=Default&contextData=\(sc.Default\)&firstPage=true&bhcp=1](https://uk.practicallaw.thomsonreuters.com/2-631-7191?transitionType=Default&contextData=(sc.Default)&firstPage=true&bhcp=1)
[Accessed 24 November 2019].

Royal Academy of Engineering, 2017. *Engineering ethics - Royal Academy of Engineering*. [Online]

Available at: <https://www.raeng.org.uk/publications/reports/statement-of-ethical-principles>
[Accessed 5 December 2019].

Ruvalcaba, Z. & Delamater, M., 2017. *Murach's JavaScript and jQuery*. Fresno: Murach.

Smyth, N., 2019. *Android Studio 3.3 Development Essentials*. 1st ed. Plano: Payload Media, Inc.,

Stokes, S., 2019. *Digital Copyright: Law and Practice*. 1st ed. Oxford: Bloomsbury Publishing.

9 APPENDIX

SGEE6003 Major Project – Proposal Emyr Wyn Dyer

The Client and Location

The Project is to be developed for the Engineering Department of Coleg Sir Gâr, in Room G8 where an Automated Process Station called the CIM System is based.

The Problem

The popular method for controlling processes is through the use of a SCADA System, which is costly to implement and problematic when linking within existing network infrastructure. The CIM System is controlled by the S7 series of PLCs which have a Web Server facility that is underutilised due to a lack of understanding of how to configure and operate with a degree of smooth operation. Recommended HTML coding has been proven to work however, does not provide the smooth operation desired due to a page refresh issue. There is an issue with reading multiple tags simultaneously on the S7-1200 on page load. Implementation of a VLAN with access control will provide a level of security needed. The proposed solution is called the Automation Browser Application (ABA).

Problem's Impact

Currently in industry, the options for using a networked PLC relies on additional hardware manufactured by the PLC manufacturer (HMI), however using a networked Web operated Siemens S7 PLC, is enticing as the potential for streamlining the performance of a plant could improve with flexible terminal access to the PLCs and the bespoke nature of building a Web Page.

Responsibilities for Development

The Author/Project Developer will have responsibility for developing the ABA, with advice being provided by a Technical Advisor (Robert Jenkins) with additional monitoring of progress being carried out by the Academic Supervisors (Robert Davies and Michael Hall). The deadline for submitting the Final Report for the ABA is the 24/04/2020 and work on implementation should not begin later than January 2020.

Budgeting

Exact costing of the solution is dependent on how much equipment will need to be procured. A memory card is needed, with Parmley-Graham valuing a 12MB Memory Card Expansion at £169.00. If the ABA can be developed on an S7-1200, then there should be no further expenditure, however, if an S7-1500 is required, then an additional cost of £635.00 will be placed upon the budget. In any case, it is not expected that a cost of £1000 will not be exceeded.

Emyr Wyn Dyer (Project Developer):

Signature: 

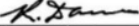
Date: 04/10/2019

Robert Jenkins (Technical Advisor):

Signature: 

Date: 04/10/2019

Robert Davies (Academic Supervisor):

Signature: 

Date: 4/10/19

FINAL GRADE

GENERAL COMMENTS

Instructor

64/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

PAGE 27

GRADING FORM: NEW CSG-RUBRIC

EMYR
DYER

64

1. ENGAGEMENT WITH LITERATURE



Good evidence of engagement in research with some critical evaluation of sources but there are instances where information has not been applied to the project. Good use of research for literature review. Evidence of research was demonstrated, particularly for wider issues such as ethical engineering and H&S. (7/10) Engagement with an extensive range of relevant and credible literature, informed by the latest research. Consistently

11

accurate application of referencing. Extensive range of relevant and reliable academic sources. (4/5) Total = 11/15

2. KNOWLEDGE AND UNDERSTANDING



Very good explanation given. Project explained as a modification to the existing CIM system at Coleg Sir Gar by replacing the touchscreen HMIs. (7/10) Very good details given for all aspects. All aspects covered in detail in the report, although some aspects were generic and did not relate to the project specifically. (7/10) Some consideration given but information not always applied to the project. Generic European requirements rather than anything specific to the project. (3/5) Detailed look at project risks and some consideration given to H&S but there is no risk assessment while working around the machine. A bulleted list of internal and external risks to the project's success was included. (3/5) Total = 20/30

20

3. COGNITIVE AND INTELLECTUAL



Good explanation given. An overview of the system was described in the introduction, not much detail on the actual "problem". (2/5) Detailed points made but perhaps the requirement for hosting on the PLC limits the solutions. Written at a high level and didn't include many specifics. (5/10) Good plan but there should be more tests to cover all aspects of the FDS. A short test plan with minimal performance metrics to gauge success. (3/5) Clear conclusions given with recommendations for moving forward. Light on

12

technical detail going forward, written a bit too generically. (2/5) Total = 12/25

4. PRACTICAL APPLICATION



A basic table of comparison enabled selection of best solution. However, this was the only one that could meet the FDS. A short scoring system was used to compare the 3 solutions, but this was light on detail and only covered 3 aspects. (2/5) Good detailed WBS but the Gantt does not contain all tasks to be completed and should be more detailed. A very good risk matrix and no risk assessment for health and safety. A detailed WBS was devised and a simple linear Gantt was used to control timings. (6/10) Total = 8/15

8

5. TRANSFERABLE SKILLS



A good summary but a bit too long. A well written executive summary. (4/5) Generally well written, good diagrams. Generally well written and presented. (4/5) Word count not exceeded by more than 10%. 3756 words declared. (5/5) Total = 13/15

13