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by Matthew Perry

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Assignment: Project Definition, Research and Quality Planning

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A good report covering all aspects of the project, mostly well written with some punctuation errors. Format of paragraphs is not always correct (should be fully justified text) Good solutions offered, correct one chosen Keep your eye on your costing spreadsheet so you don't go over budget and keep detailed record in your log book for the next phase of the project.

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1. Executive Summary

Paragraphs should be fully justified text as required in the brief

The project consists of developing a prototype for use in endoscopy and urology departments to address inefficiencies and risks associated with the current manual cleaning process of endoscopes. A sink accessory will automate key aspects of the cleaning process which consists of dosing, temperature monitoring, alarms and timers to enhance patient safety and streamline operations. The implementation phase is scheduled to begin on January 3rd and conclude on May 2nd.

Key project constraints were identified and addressed, including the requirement for calibration certificates in current systems. Additionally, after research the project will following the EDI handbook, minimise environmental waste and comply with relevant industry standards, legal regulations and commercial requirements.

A functional design specification and test plan was developed to define the projects requirements to be successful. *As a summary, you need to say what the 3 solutions are.* Three potential solutions were evaluated, where the controller and display differed in each. After a comparative evaluation, solution 2 which utilises an Arduino Mega 2560 and Nextion Intelligent Display was selected.

In this summary, you have covered many aspects of the project but it lacks detail. You had 300 words to do it in.

2. Introduction

Paragraphs should be fully justified text as required in the brief

This independent engineering project will be carried out within a healthcare company specialising in the servicing, validation and design of medical equipment mainly within the South Wales area. The focus of this project is to develop a prototype intended for the use in endoscopy and urology department, where endoscopes are manually cleaned. The prototype aims to automate part of this cleaning process by creating a sink accessory that manages dosing, enhances patient safety through temperature monitoring and incorporates alarms and timers to ensure optimal cleaning conditions. *This paragraph belongs in the summary*

Ensuring that the prototype is a success, various project constraints such as ethical, environmental sustainability, legal and commercial factors will be researched to prevent potential mistakes.

Three potential solutions will be investigated and assessed against a range of characteristics to determine the most suitable option, and a final solution will be selected.

Project management techniques such as risk assessments, Gantt charts and a cost breakdown will be created to ensure safe, timely completion and proactive risk management throughout the project.

Finally, a conclusion will summarise the project outcomes, evaluate the effectiveness of the selected solution and provide recommendations.

A good introduction

3. Project Background, Problem Definition and Constraints

3.1 Background

The project will be a prototype based within a medical engineering company to be later implemented in a medical decontamination facility where endoscopes are reprocessed after patient procedures. After each procedure, an endoscope undergoes manual cleaning, is processed in an automated washer and finally stored in a drying cabinet.

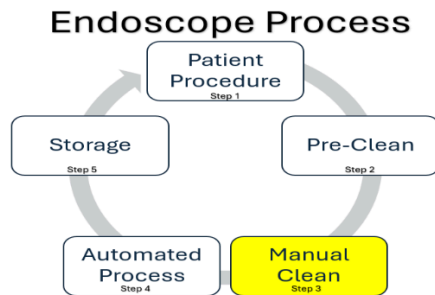


Figure 1; Endoscope Process

The manual clean (Step 3), an endoscope is submerged in approximately 20 litres of water at a temperature of 23-32°C, followed by an enzymatic solution either manually or automatically. Then the manual cleaning is carried out for a set period by a professional.

A system to assist healthcare professionals by monitoring and managing key parameters will be the selected independent project.

Don't stretch images, it distorts the text

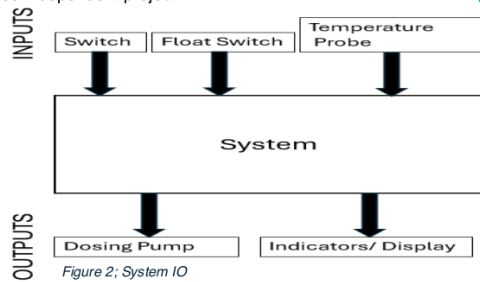


Figure 2; System IO

3.2 Problem Definition

At present, the systems on the market are separated from each other such as a temperature probe and a dosing pump. Although they are serviced each year, the temperature probes cannot be calibrated and must be renewed.

The discarded probe is then ~~considered to be~~ e-waste which is one of the fastest growing solid waste systems in the world (WHO, 2024). Additionally, due to hospitals implementing a low-cost solution, the new probes are not provided with a calibration certificates which does not adhere to BS EN ISO 13485 clause 7.6 which focuses on control of monitoring and measuring equipment (ISO, 2016).

This prototype will adhere to relevant standards, while informing medical professionals of cleaning time, dosing, temperature and visual indicators to follow a good infection prevention control procedure (Department of Health and Social Care, 2022).

3.3 Constraints

3.3.1 Ethical Engineering

An inclusive approach to equality, cultural diversity and inclusion (EDI) will be used throughout this project, whether it's for market research or within design by following the EDI engine handbook. This is because it is not only the right thing to do, but organisations in the engineering sector can outperform their less diverse counterparts and can lead to higher levels of performance and innovation. This will be achieved by developing an inclusive and accessible design, incorporating features like a footswitch, clear screen navigation routes and high-contrast colour schemes. Once the prototype is complete, it will undergo user testing with a diverse group of participants to identify and address any usability barriers. Ensuring the guidelines are followed with inclusivity in mind ensures that the needs of diverse end users are met effectively (Royal Academy of Engineering , 2024).

Often, the process that happens within the manual cleaning rooms can leave workers multi-tasking which is a known risk to patient safety (Douglas & Raban, 2017). This system will automate part of the process; however, it will not affect the job security of healthcare professionals, acting rather as a safety net to prevent mistakes that could compromise patient safety.

3.3.2 Environmental & Sustainability

Energy efficiency will be a priority while designing the system. Where possible, low power components will be chosen as they significantly reduce the overall energy consumption (PCB Must, 2023). This will reduce the environmental damages while improving energy security cost effectively (Cristina Peñasco, 2023).
only the surname needed

Parts for this project will be sourced either from existing or reconditioned parts to keep cost and e-waste low. New parts will be sourced from reputable sellers as the quality assurance, reliability and environmental practices will be followed. Most companies at present hold an ISO 9001 certification that shows it has effective processes to deliver products and *Correctly cited* after time, meaning that the parts will be of high quality and come with reliable support (ISO, 2024). Using companies that follow ISO 14001 will ensure that the companies are taking proactive measures to minimize their environmental footprint while achieving their own environmental objectives (ISO, 2021). *Correctly cited*

Proven software will be used to ensure that the lifespan of the system is long, but also can be maintained in the future, for example, no legacy or outdated software will be implemented.
Punctuation Error

Meeting users need will be a priority within the design. As a prototype, the product must be ergonomic, ensuring ease of use in both software and physical access. Features like switch placement and activation methods will play a key role in making the product user-friendly while maintaining safety. While designing the layout, factors such as the size of text or overall arrangements can impact on how users process and recognise information (Leitz, 2022).
Correctly cited

3.3.3 Legal and Commercial

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The Health and Safety at Work Act 1974 will be followed & to ensure that employees and the public are safe guarded from potential hazards in the form of risk assessments, training and the implementation of preventative measures (Health and Safety Executive, 2024). The control of substances hazardous to health (COSHH) will be followed, as the dosing pump uses enzymatic detergents, the student will ensure what the health hazards are, providing control measures to reduce harm to health and keeping all control measures in good working order (Health and Safety Executive, 2024).

Electrical safety considerations will guide the design of the system, with adherence to the electricity at work regulations 1989 (Regulation 14). BS EN 60204-1:2018 Safety of Machinery requires that equipment should not be live when a person is exposed to it, which means an automatic trip system when an enclosure is accessed would be a suitable design feature (Health and Safety Executive , 2015). As the system will be portable, portable appliance testing (PAT) will be required to ensure that the electrical appliance used in the workplace is safe working.

Software will be either acquired or purchased from a reputable provider, including the correct licenses, certificates and documentation to complete this project. By doing this, it aligns with the industry's best practices and legal requirements and ensures compliance, while supporting the projects integrity and efficiency (British Standards Institution, 2020).

Lastly, it will be crucial to investigate intellectual property rights and determine whether a copyright, a patent or a design right can be obtained. A design right will protect the visual design of the objects, including the aesthetics of the prototype and its components. If it is not possible for this to be carried out after it is created for financial reasons, the design can still be safeguarded within the UK for up to 3 years from the date it is made public, this will protect it from others from copying or stealing the idea during this period (HM Government, 2024).

4. Functional Design Specification and Test Plan

4.1 FDS

Something went wrong

Error! Reference source not found. is a key for characteristics that will be referenced in the FDS to detail 5 different groups.

Functional Design Specification Key	
Reference	Characteristics
A	Physical
B	Software
C	Safety
D	Alarms
E	Performance

Table 1; FDS Key

Table 2 outlines fundamental features and functions that the prototype is required to meet. This table links features and functions to the corresponding tests to ensure a thorough evaluation of the prototype's performance.

Functional Design Specification	
Reference	Specification
A1	The system should consist of 3 main components: footswitch, pump and control box.
A1.1	The user should be able to initiate the dosing sequence using a footswitch.
A1.2	A digital screen should display relevant system information.
A1.3	The dosing pump must have a yellow cover near the tubing connections.
A1.4	Power supply connections should use a Type G (3-pin) plug.
A1.5	All components of the prototype must be capable of wall mounting.

Use centring of text for titles only

B1	The temperature must be displayed with a tolerance of +/-1 degree relative to the calibrated probe.
B1.1	Possibility to calibrate temperature probe.
B1.2	Reconfigurable for future maintenance.
B1.3	The wash time timer must be reconfigurable, with a range of up to 10 minutes.
B1.4	The dosing pump timer must be reconfigurable, with a range of up to 2 minutes.
B1.5	A manual purge button must be available for use for when bottles are replaced.
B1.6	The wash timer should be optionally removable from the user interface page.
C1	The settings page must be password protected.
C1.1	Power must be automatically disconnected when the front panel is removed.
C1.2	Guarding must be provided around the pump connections to prevent accidental spray.
C1.3	System should be able to be isolated at mains power (230V).
C1.4	Connections between the box, pump and footswitch must be designed to be hidden to prevent trailing leads.
C1.5	Clearly indicate potential electrical hazard.
C1.6	Control box must have a minimum IP rating of IP55 (IEC 60529).

D1.1	A low-level alarm must be indicated when the dosing supply bottle is low.
D1.2	A red and green out of limits indicator must be provided for temperature.
D1.3	Overdue service alarm (Annual alarm).
E1	Temperature accuracy must be within +/- 1 degree of calibrated probe.
E1.1	Timer accuracy must be within +/- 5% of recorded time.
E1.2	Dosing 100ml x3 with +/- 5% tolerance.
E1.3	Float switch repeatability x3.

Table 2; Functional Design Specification

E is the most interesting as it leads to practical measurements

4.2 Test Plan

A comprehensive test plan has been created based on the FDS, it includes 18 tests covering 5 key characteristics. Each test defines an expected result and an actual result, to be recorded once the prototype is operational, ensuring that it meets the design and performance requirements. This will also benefit proof of concept and testing the basic functionality to identify flaws and improvements ensuring the final product meets expectations (Qualaroo, 2024).

Test Plan					
Test Number	FDS Reference	Description	Expected Result	Actual Result	Pass/Fail
1	A1	Press the footswitch.	Dosing sequence starts immediately after pressing the footswitch.		
2	B1	Place calibrated probe next to systems temperature probe in a container filled with water at 27 degrees by using a calibrated probe.	The systems temperature reading is within 1 +/- degree of the calibrated probe reading between 26 and 28 degrees.	+/- 1	
3	B1.1	Fill container with water at 23 degrees referencing a calibrated systems digital display after offsets/potentiometers to match. Check display to ensure system is reading 23 degrees.	The systems temperature probe is calibrated accurately, matching the reading of the calibrated reference probe and on the system displays within +/- 1 degree (Between 22 and 24 degrees).		

4	B1.1	Fill container with water at 27 degrees referencing a calibrated probe for accuracy. Using the systems digital display alter offsets/potentiometers to match. Check display to ensure system is reading 27 degrees.	The systems temperature probe is calibrated accurately, matching the reading of the calibrated reference probe and on the system displays within +/- 1 degree (Between 26 and 28 degrees).		
5	B1.1	Fill container with water at 32 degrees referencing a calibrated probe for accuracy. Using the systems digital display alter offsets/potentiometers to match. Check display to ensure system is reading 32 degrees.	The systems temperature probe is calibrated accurately, matching the reading of the calibrated reference probe and on the system displays within +/- 1 degree (Between 31 and 32 degrees).		
6	B1.3	In the settings page, set the wash timer to 5 minutes, return to home, then back to settings page and set to 10 minutes.	Wash timer begins counting down from 10 minutes after initiation.		
7	B1.4	The dosing timer can be reconfigured to any duration up to 2 minutes.	The timer is set from 0 to 120 at 30 second intervals and the pump doses for the correct time.		
8	B1.5	Manual purge option to prime pump by pressing the manual purge button.	Press manual purge button, pump switches on and primes pump tubing.		
9	B1.6	Check the wash timer can be removed from the user interface by disabling in the settings page.	The wash timer is removed from the user interface page.		
10	C1	Select settings page, password should be requested and enter wrong password.	Entry is denied and a message states that the password is incorrect.		

11	C1.1	Power will be automatically disconnected to components when opening the front panel of the control box.	Testing with a multi-meter that the power is isolated and reads 0V.			
12	C1.3	System should be able to be isolated at mains power 230V by turning off switched socket.	Testing with a multi-meter should show that the system is not energised (0V).			
13	D1.1	Fill a container and insert the dosing lance. Remove the lance and then check the display.	An alarm indicates that the bottle is empty on the digital display.			
14	D1.2	Check red and green indicator for temperature out of limits. Using calibrated reference probe ensure the water is below 23 degrees and then check the indicator. Increment the temperature by 1 degree up until 32 and check the indicator. Lastly, increase the temperature past 32 degrees and check the indicator.	The indicator shows the following: Below 23 degrees = Red Between 23-32 degrees = Green Above 32 degrees = Red			
15	D1.2	Check the service alarm by setting the calibrated date, then amend the current date to a year later in the settings page.	Annual service alarm will appear on user interface.			
16	E1.1	Set the wash timer to 5 minutes, press start and record the time separately using a stopwatch.	Recorded and indicated results are within +/- 5% of each other. (Between 04:45 to 05:15 minutes).			

17	E1.2	Set dosing time to achieve 100ml, insert lance into a 500ml cylinder and press footswitch to commence dosing. Record result and repeat the action 3 times.	Recorded results are within +/- 5% of each other. Results read between 95ml to 105ml.		
18	E1.3	Check the repeatability of the float switch by removing and inserting the lance from a container filled with water, while checking the display. Repeat the action 3 times.	A low-level alarm indicator is shown each time after removal and then cleared after re-inserted.		

Table 3: Test Table

A good testing table with detailed descriptions of how the tests will be carried out

5. Literature Review & Choice of Solution

Three potential solutions have been investigated and compared to determine the most suitable option for meeting the requirements in the FDS. Key characteristics of each solution were analysed to assess their ability to meet the project requirements successfully.

The primary differences among the 3 solutions are in the choice of controller, software and display. Solution 1 uses an Arduino Uno R3 paired with a 3.5-inch TFT Display, Solution 2 employs an Arduino Mega 2560 with a Nextion Intelligent Display and Solution 3 utilises a Siemens Logo! PLC with a KTP400 Basic HMI.

5.1 Solution 1

Solution 1 utilises an Arduino Uno R3 that is based on the microchip technology ATmega328 8-bit micro-controller (Mouser Electronics, 2024). This microcontroller is well suited for small to medium scale projects due to its simplicity, cost effectiveness and widespread support REF. The control will be paired with an Arduino 3.5-inch FT display, which serves as an intuitive interface for displaying information and interacting with the system.

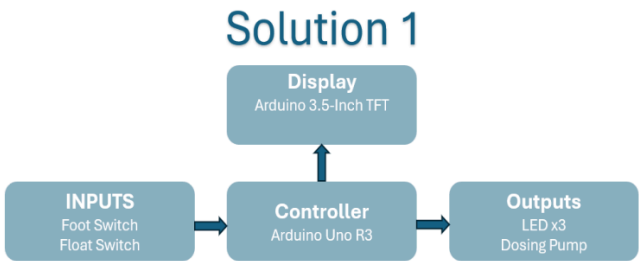


Figure 3; Solution 1 Block Diagram

The controller processes inputs through the digital and analog pins, utilizing its built-in analog-to-digital converter for the temperature sensor reading. Based on the processed input data, the microcontroller determines the actions dependent on the program such as activating outputs like dosing pumps or illuminating LEDs for visual feedback including relevant notifications on the TFT display.

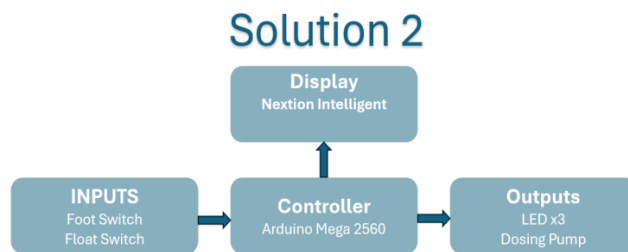
Communication between both devices consist of using serial peripheral interfacing, where pins are connected to the TFT display (Arduino, 2024). Pin layout from each device is shown in Table 4.

Table 5 & Table 6 display compiled technical data for the controller and display, this will be used for reference for comparison in selecting the final solution.

This is a good solution showing clear thinking. However, there is no temperature sensor

5.2 Solution 2

Solution 2 uses an Arduino Mega 2560 Controller that processes inputs from sensors or user actions based on the programmed logic. The Nextion intelligent display will serve as the user interface showing real-time data processed by the Arduino and enabling user interaction through touch control.



how is the temperature sensed?

Figure 4; Solution 2 Block Diagram

Inputs are processed by the controller which interprets the data and communicates with the display to trigger appropriate outputs such as the LED's or dosing pumps *one pump?*

The communication between devices uses an UART serial interface. The Arduino uses its hardware serial ports to exchange data with the display. The display processes these commands and updates the interface. If inputs are carried out by touch on the display it can trigger call backs within the Arduino code (eTechPath, 2018).

Table 7 outlines the pin configuration between both devices that involves supply voltage, ground and send/receive data pins.

Furthermore, Table 8 & Table 9 displays the technical specifications for the controller and the display.

5.3 Solution 3

This solution differs most from the first two, where a Siemens Logo! PLC is implemented as the controller and a Siemens HMI KTP400 for the display. Inputs will be processed by the controller and the code will determine the appropriate outcomes such as activating outputs or displaying real time data. The ability to activate outputs directly from the PLC makes this solution more beneficial than the previous solutions.

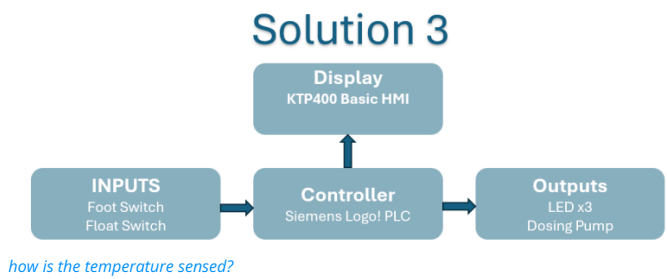


Figure 5; Solution 3 Block Diagram

The devices communicate with each other primarily through ethernet using the industrial standard PROFINET protocol. The PLC & HMI are connected to the same ethernet network and are assigned IP addresses which allows them to identify and communicate with each other (Siemens , 2012).

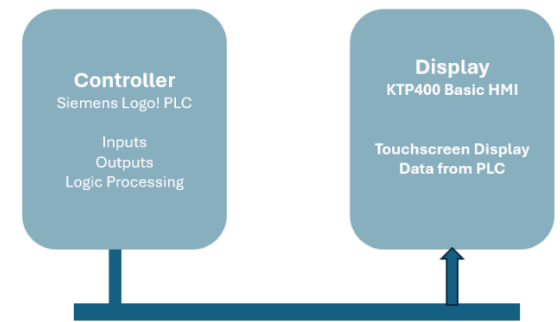


Figure 6; Solution 3 Communication

Lastly, technical data for the controller and display can be seen in Table 10 & Table 11.

5.4 Chosen Solution

Three solutions were compared and rated on a scale of 1 (poor), 2 (good) and 3 (excellent) based on their technical and overall characteristics. The scores were summed, with the solution achieving the highest total being determined the best overall.

The comparison of controllers in Table 12 revealed that solution 1 had the lowest score of 25, while solution 2 achieved the highest score of 32. Solution 1's score was primarily due to its limited flash memory size and generally average ratings across most characteristics. However, solution 2 only lost a single point due to ease of use making it the best overall.

Table 13 presents the comparison of displays, showing solution 1 again with the lowest score, whereas solution 2 had the highest. Solution 3 followed closely but was hindered by the higher cost and longer delivery times.

Table 14 combined the cost and total scores, indicating that solution 2 offered a balance between performance and price. It had the highest overall score while being priced in the mid-range compared to the three solutions.

Lastly, a radar graph was produced for an overall view that displays a score of 1 (poor), 2 (good) and 3 (excellent).

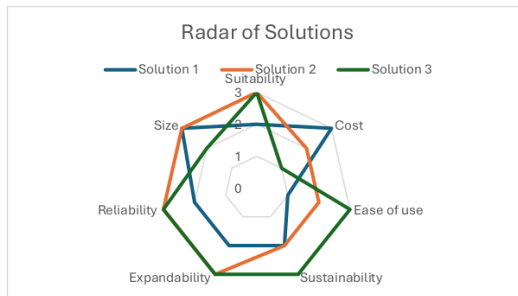


Figure 7: Radar Graph

Solution 2 was selected as the optimal choice. After evaluation, it was determined it offers the flexibility of expansion with the Arduino Mega 2560 and the user-friendly graphical capabilities of the Nextion Intelligent display. This solution is cost-effective, well supported with extensive libraries and allows for easy adjustments. These qualities make it ideal for testing, refining, simulating and demonstrating concepts efficiently and effectively. Lastly, the complete estimate cost breakdown in Figure 9, states that this solution will be under the project proposals budget by £65.49 with short delivery times.

6. Project Planning, Work Breakdown Structure & Management Techniques

6.1 Work Breakdown Structure

Figure 8 shows the work breakdown structure (WBS) which divides the project into smaller, mutually exclusive tasks during the implementation stage, focusing on major sections such as sourcing materials, hardware development, software development and testing. This approach simplifies project planning while ensuring clear assignment of responsibilities (Krasteva, 2024). Correctly cited

6.2 Gantt Chart

Following the WBS, the Gantt chart in Table 15 will be an effective tool to manage the project consisting of 8 tasks to be completed between January 3rd and May 2nd. It visually breaks down the timeline into months and weeks for effective progress tracking (Gurnov, 2024). The top horizontal row represents the expected deadline (D) where the task is planned for completion, versus the horizontal bar below which is the actual progress, updated throughout the project and finally marked as completed.

6.3 Risk assessment

Table 16 & Table 17 shows the scoring and description matrix for potential hazards associated with the design and construction of the prototype. These tables evaluate hazards bases on their likelihood and potential consequences, resulting in a risk score that is the basis for implementing control measures. By identifying and assessing risks in terms of both probability and severity, it becomes easier to mitigate them effectively while ensuring compliance with company standards (Vicente, 2024). Table 18 provides a risk assessment, outlining each potential hazard, the initial risk score before control measures and the improved risk score after implementing the control measures.

You could also have mentioned your costing spreadsheet and log book

7. Conclusion and recommendations

This assignment outlines the project definition, research and quality planning for the independent project. The project aims to develop a prototype of endoscopy and urology departments to improve the efficiency and safety of the manual cleaning process of endoscopes. This prototype will automate key processes such as dosing, temperature monitoring, and alarms ensuring that healthcare professionals can maintain high infection control standards. *none of your solutions contain a temperature sensor*

Three potential solutions were analysed, and solution 2 which uses an Arduino mega 2560 and Nextion Intelligent Display was selected as the best choice in comparison to the 3 solutions. It was shown in Table 14, that this solution scored the highest in most categories while being the mid-range price choice. Lastly, the solution offered the best balance of flexibility, user-friendliness and cost effectiveness staying within the projects budget while providing scalable capabilities.

To manage the project effectively, tools such as the WBS and Gantt chart were created to be used within the implementation stage. The WBS helped break the project into smaller manageable tasks, where the Gantt chart provides a clear timeline for project execution. *Also, costing spreadsheet for monitoring spending and log book for progress and decision making* A comprehensive risk assessment was conducted in Table 18 to evaluate potential hazards in the design and construction of the prototype. By assessing the risks based on their likelihood and potential consequences that resulted in a risk score helped guide the controls measures.

Overall, this document will provide a practical approach to the implementation stage where it can be referred to for guidance. Recommendations that can be made are further research into programming resources would be beneficial to time constraints, and starting the Gantt chart at an earlier date would give a more rounded overview of the project's lifecycle.

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9. Appendix

9.1 Technical Data Solutions

Solution 1; Communication		
Uno R3 Pins		TFT Display Pins
5V	-->	VCC
GND	-->	GND
D10	-->	CS
D9	-->	RST
D8	-->	DC
D11	-->	MOSI
D13	-->	SCK

Table 4; Solution 1 Communication

Solution 1; Arduino Uno R3	
Cost	£25
Delivery Time	3-5 Days
Ease of Use	Adequate
Suitability	Optimal
Expandability	Adequate
Weight	25g
Size	L68.6mm x W53.4mm
Technical Data	
Programming Language	IDE
Input Voltage	7-12V
I/O Voltage	5V
Digital I/O	14
Analog I/O	6
Flash Memory	32 kB
Processor	ATMega32P
Communication	UART, I2C & SPI

Table 5; Solution 1 Controller Overview (Arduino , 2024)

Solution 1; 3.5-Inch TFT LCD Screen	
Cost	£18
Delivery Time	7-9 Days
Ease of Use	Questionable
Suitability	Adequate
Touch Type	Yes, Resistive
Weight	55g
Size	L85 X H55 X W6mm (3.5 Inch)
Technical Data	
Programming Language	C++/ Arduino IDE
Input Voltage	2.8-3.3V
Resolution	320x480
Interface	Parallel (16-bit), SPI
Libraries	MCUFRIEND_kbv, Adafruit_GFX or TT_eSPI

Table 6; Solution 1 Display Overview

(Arduino, 2024)

Solution 2; Communication			
Arduino 2560 Mega		Nextion Intelligent HMI	Description
GND	-->	GND	Common ground.
5V	-->	VCC	Power supply.
RX1	-->	TX	Nextion transmits, Arduino receives.
TX1	-->	RX	Nextion receives, Arduino transmits

Table 7; Solution 2 Communication

Solution 2; Arduino Mega 2560	
Cost	£40.99
Delivery Time	3-5 Days
Ease of Use	Adequate
Suitability	Adequate
Expandability	Optimal
Weight	37g
Size	L101.52mm x W53.3mm
Technical Data	
Programming Language	IDE
Input Voltage	7-12V
I/O Voltage	5V
Digital I/O	54
Analog I/O	16
Flash Memory	256KB
Communication	UART, I2C & SPI

Table 8; Solution 2 Controller Overview (Arduino, 2024)

Solution 2; Nextion Intelligent	
Cost	£54
Delivery Time	3-10 days
Ease of Use	Adequate
Suitability	Optimal
Touch Type	Yes, Resistive
Weight	100g
Size	L120.5 x H74 x W9.3mm (4.3 inches)
Technical Data	
Programming Language	Nextion Editor Scripting
Input Voltage	5V
Resolution	480x320
Interface	UART
Libraries	Nextion Library
Flash Memory	16MB

Table 9; Solution 2 Display Overview (Nextion, 2024)

Solution 3; Siemens Logo! DC 24V RCE	
Cost	£94
Delivery Time	1-3 Days
Ease of Use	Optimal
Suitability	Adequate
Expandability	Optimal
Weight	H90 x W72 x D55mm
Size	250g
Technical Data	
Programming Language	Ladder or FBD
Input Voltage	24VDC
I/O Voltage	24V
Digital I/O	8
Analog I/O	4 configurable analog inputs.
Memory	400 Blocks (Estimated 8kB to 16kB)
Communication	Ethernet (TCP/IP)

Table 10; Solution 3 Controller Overview (Siemens , 2023)

Solution 3; Simens KTP400 Basic HMI	
Cost	£330
Delivery Time	3-7 days
Ease of Use	Optimal
Suitability	Optimal
Touch Type	Yes, Resistive
Weight	360g
Size	H104 x W135 x D38 (4.3 inches)
Technical Data	
Programming Language	WinCC Basic (TIA Portal)
Input Voltage	24V
Resolution	480x272
Interface	Profinet, EtherNet/IP
Flash Memory	128MB

Table 11; Solution 3 Display Overview (Parmley Graham, 2024)

9.2 Comparisons

Comparison of Controllers			
Characteristic	Solution 1	Solution 2	Solution 3
Cost	2	3	2
Delivery Time	3	3	3
Ease of use	2	2	3
Suitability	2	3	3
Expandability	2	3	3
Weight	3	3	3
Size	3	3	2
Digital I/O	2	3	2
Analog I/O	2	3	1
Flash Memory	1	3	2
Communication Protocol	3	3	3
Total Score	25	32	27

Table 12; Comparison of Controllers

Comparison of Displays			
Characteristic	Solution 1	Solution 2	Solution 3
Cost	3	3	1
Delivery Time	2	2	2
Ease of use	1	3	3
Suitability	2	3	3
Resolution	2	3	3
Weight	3	3	3
Size	2	3	3
Graphical Design Capabilities	1	3	3
Total Score	16	23	21

Table 13; Comparison of Displays

Combination of Solutions Comparison			
Characteristic	Solution 1	Solution 2	Solution 3
Cost	£38	£94.99	£424
Total Score	41	55	48

Table 14; Combination of Solutions Comparison

Work Breakdown Structure

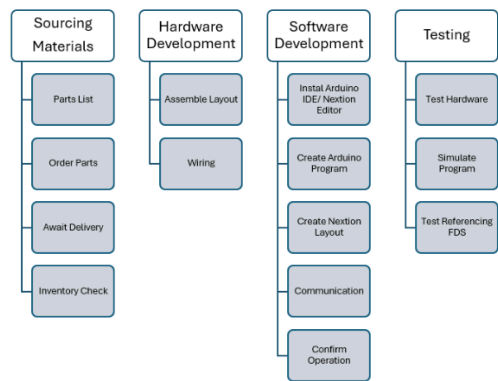


Figure 8: Work Breakdown Structure

9.4 Gantt Chart

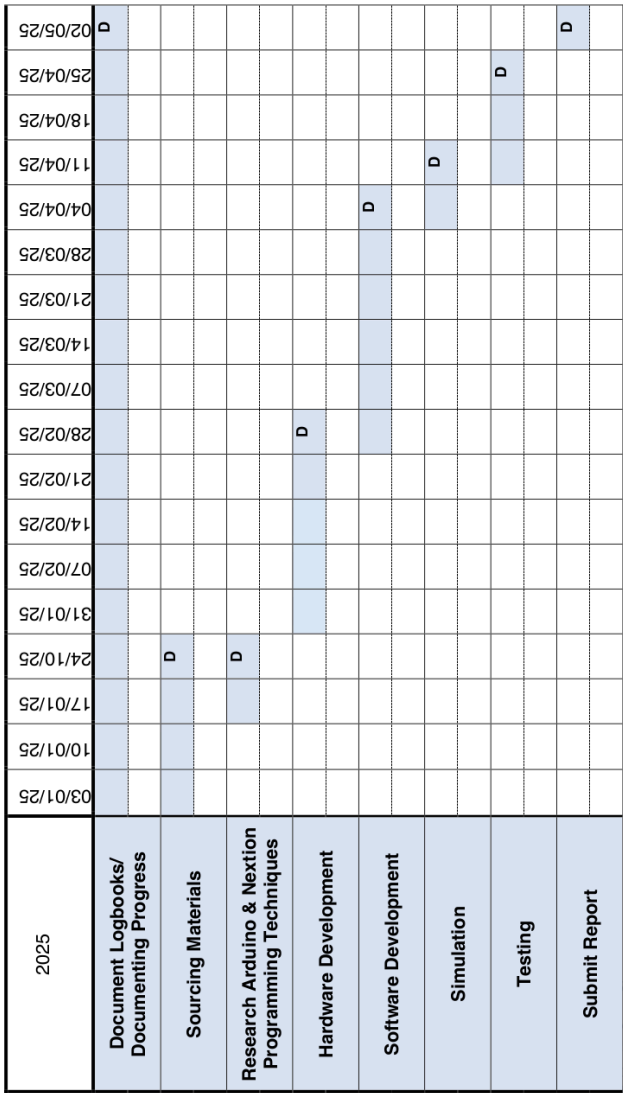


Table 16; Gantt Chart

9.5 Final Solution Cost Breakdown

Cost Sheet: Final Solution						
Part Description	Quantity	URL	Delivery Time	Cost (exc. VAT)	Order Date?	Delivered?
Arduino Mega 2560	1	vfmB0oq	1-2 Days	£30.00		No
xtion Intelligent Disp	1	r-43-inte	1-3 Days	£57.50		No
Footswitch	1	n/web/p	0	£24.70	On Site	Yes
RGB LED 5 Pack	1	om/web/	1-2 Days	£1.66		No
LED Bezel	2	web/p/le	1-2 Days	£5.00		No
Peristaltic Pump	1	ts/perist	2-4 Days	£17.20		No
Float Switch	1	web/p/flo	1-2 Days	£19.86		No
PVC Pipe	1	E3NTY2a	5-7 Days	£5.50		No
Panel Switch	1	icts/schr	7 Days	£24.79		No
24VDC Power Supply	1	/din-rail	1-2 Days	£24.72		No
Mains Plug	1		1 Day	£2.00		No
12VDC Power Supply	1	b/p/din-r	1-2 Days	£11.74		No
Wiring Arduino	1	totyping-	5-7 Days	£11.99		No
Enclosure	1	p/genera	1-2 Days	£50.43		No
Miscellaneous	-	-	-	£75	-	No
Total				£362.09	Inc. VAT	£434.51

Figure 9: Cost Breakdown Final Solution

9.6 Project Proposal

SGEL6000 INDEPENDENT PROJECT

PROJECT PROPOSAL DOCUMENT

Student Name: Matthew Perry
Project Title: Sink Accessory Pre-Clean
Date: 04/10/2024
Completion Date: April 2025
Budget: £500

Description of Project

The project is based in a medical decontamination facility where endoscopes are re-used after patient procedures. Following a completed procedure, each endoscope is manually cleaned, processed in an automated washer and then stored within a drying cabinet.

The manual cleaning process involves submerging an endoscope in a sink filled with approximately 20 litres of water at a temperature of 23-32 degrees. An enzymatic solution is either added manually or automatically and the cleaning is carried out for a set period of time. However, the current process uses isolated devices that monitor temperature and dose solutions which lack calibration capabilities while placing a lot of responsibility on the healthcare professionals.

The prototype will assist healthcare professionals within the manual wash stage by automating part of the manual cleaning process to increase efficiency, consistency and patient safety by incorporating features such as temperature monitoring, automatic dosing, timers and low enzyme alerts.

Matthew Perry will be completing this project. Financial support for carrying out this project will be supplied by the company.

Agreement for project proposal

Student Signature:



Date: 04/10/2024

Industrial Supervisor Signature: P.p

Date: 12/10/2024

Academic Tutor Signature: R. Davies

Date: 04/10/24

Figure 10; Project Proposal

9.7 Risk Assessment

Risk Assessment Matrix							
Likelihood (L)	Consequence (C)	Risk					
		L/C	1	2	3	4	5
1 = Very Unlikely	1 = Insignificant	1	1	2	3	4	5
2 = Unlikely	2 = Minor	2	2	4	6	8	10
3 = Fairly Likely	3 = Moderate	3	3	6	9	12	15
4 = Likely	4 = Major	4	4	8	12	16	20
5 = Very Likely	5 = Catastrophic	5	5	10	15	20	25

Table 16; Risk Assessment Matrix

Response Levels Based on Risk	
Risk Range	Risk Status
1 to 2	Acceptable with the controls maintained.
3 to 4	Acceptable, but consider control improvements.
5 to 9	Adequate, but discussion required at project review.
10 to 16	Tolerable, but improve controls with a fixed time scale.
17 to 25	Unacceptable, stop activity until control improvements are carried out.

Table 17; Risk Assessment Description

Risk Assessment									
Hazard?	Who may be harmed?	Risk Rating			Additional controls	New Risk Rating			Actioned/Monitored by?
		L	C	R		L	C	R	
Manual Handling	Student	2	4	8	Student is trained and competent in safe manual handling/lifting techniques. Boxes/Components will be checked for weight limits <16kg.	1	4	4	Student
Trips, Falls & Slips	Everyone	2	3	6	Ensure workspace is clean, walkways are clear & cordon off areas for non-authorised access.	1	3	3	Student
Electrocution	Student, User	3	5	15	Electrical systems to be checked before use during implementation stage. Tools will be VDE insulated. No work on live circuits, and closed enclosure before user interaction.	2	5	10	Student
Power Tools	Student	4	4	16	Student is trained and competent in power tool use. Tools to be inspected for damage and safe working order before use.	2	4	8	Student
Chemical Burns	Student	1	3	3	Reference COSHH basics, wear appropriate PPE such as gloves, eye protection and armlets if required. Store data sheets of any chemicals used for reference.	1	3	3	Student
Noise	Student	1	3	3	Hearing protection to be used for sound at or above 85 decibels.	1	3	3	Student
Eye Injuries	Student	3	4	12	During implementation, for moving parts, liquids or power tools, manual tools such as cutters eye protection will be worn.	2	4	8	Student

Table 18; Risk Assessment

SGEL6000
Independent Project
Log Book

A good log book, many entries have detail, some however, are very brief

Matthew Perry
Prototype
2024 - 2025

Summary of Entries

Log Entry	Date	Brief Description of Activity	Duration (hrs)	Accumulated time (hrs)
1	20-09-24	Considering Independent Project Ideas	2	2
2	27-09-24	Discussing Independent Project	2	4
3	04-10-24	Considering New Idea (Project Proposal)	2	6
4	11-10-24	Reading Guidance, briefly investigating 3 methods	2	8
5	18-10-24	Reading relevant standards and task 4	4	12
6	25-10-24	Completing task 4	6	18
7	01-11-24	Half-term, deciding what to include in fds.	2	20
8	08-11-24	Completing task 5	4	24
9	15-11-24	Amending task 6	4	28
10	22-11-24	Research into 3 Solutions	7	35
11	29-11-24	Completing 3 solutions	8	42
12	06-12-24	Completed literature review, WBS,Gantt	8	50
13	13-12-24	Checking assignment	8	58

Log Entry Sheet

Log Number	1
Date	20-09-2024
Duration (hrs)	2
Accumulated time (hrs)	2

Record of activities and achievements

While considering a suitable independent project relevant to the student's industry, an idea of developing a prototype that could be taken to the marketplace and sold in large quantities was proposed.

During training, the student learned about periodic testing of endoscope drying cabinets in accordance with Health Technical Memorandum 01-06. It was discussed that many current manufacturers of these cabinets do not meet the required specifications or desired characteristics, making them unsuitable for use in UK hospitals.

This idea was proposed to the student's management, who agreed that it had potential however, concerns were raised about the financial strain the project might place on the business, which could complicate its execution. To address this, the use of simulation was suggested to relieve some of the financial pressure and substituting expensive components such as the exterior of the cabinet.

Plans for next week

Discuss with the lecturer whether part simulation would be suitable, then investigate what specifications the machine needs to meet to be suitable for the environment and how this can be achieved such as controllers, sensors and other hardware.

Signed:



Signed: *R. Davie*

Log Entry Sheet

Log Number	2
Date	27-09-2024
Duration (hrs)	2
Accumulated time (hrs)	4

Record of activities and achievements

For this prototype to be successful it requires the system to have a large specification list which will be hard to fulfil in the time frame dictated for this project.

Instead, I have thought of other issues that are present within my work environment ready to discuss with my employer to see if it a suitable idea.

Staying within the medical decontamination sector, endoscopes are manually cleaned in a sink filled with approximately 20 litres of water at 23-32 degrees, dosed (manually/ automatically) with enzymatic solution, and cleaned for a set period. Temperature and dosing are isolated devices that either calibration capabilities or monitoring.

The new proposed project will focus on automating part of this process (No temperature or level control) to increase efficiency, consistency and patient safety. This will be done by temperature monitoring, automatic dosing, timers and low enzyme alerts.

Plans for next week

Think more about the project.

Signed:



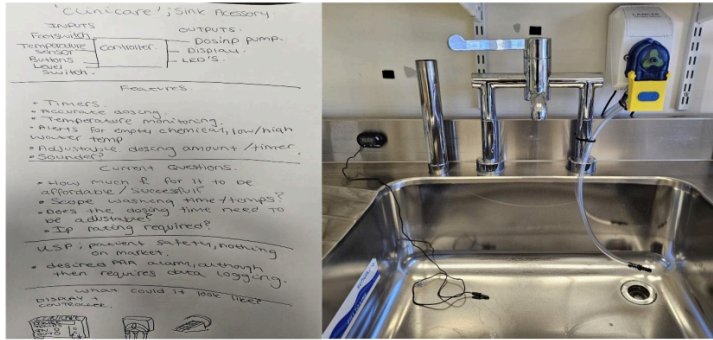
Signed: *R. Davies*

Log Entry Sheet

Log Number	3
Date	04-10-2024
Duration (hrs)	2
Accumulated time (hrs)	6

Record of activities and achievements

Creating project proposal.



Plans for next week

Research manual clean procedures, and controllers to implement.

Signed: 

Signed: R. Davies

Log Entry Sheet

Log Number	4
Date	11-10-2024
Duration (hrs)	2
Accumulated time (hrs)	8

Record of activities and achievements

Reading manual clean sink procedures supplied by NHS to understand what needs this system needs to meet for it to be successful. Briefly, investigating 3 ways how the system can be implemented using different methods which could be PLC, Embedded systems or relay logic.

Proteus

Plans for next week

Create spreadsheet that compares the 3 methods on different characteristics and decide on a solution.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	5
Date	18-10-2024
Duration (hrs)	4
Accumulated time (hrs)	12

Record of activities and achievements

Researching and reading relevant standards to follow while completing the project. Working on task 4.

- BS EN ISO 13485: Medical Devices
- Health & Social Care act 2008
- HMT /WHTM 01-06

Plans for next week

Complete task 4 by the end of 25/10/2024.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	6
Date	25-10-2024
Duration (hrs)	6
Accumulated time (hrs)	18

Record of activities and achievements

Completing task 4.

Plans for next week

Read notes on fds.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	7
Date	01-11-2024
Duration (hrs)	2
Accumulated time (hrs)	20

Record of activities and achievements

Half-term this week, no in person college. Created first part of task 5.

Plans for next week

Complete task 5.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	8
Date	08-11-2024
Duration (hrs)	4
Accumulated time (hrs)	24

Record of activities and achievements

Completed task 5, using task 5 to create a test plan for task 6.

Plans for next week

Amend task 6 throughout the week and await feedback.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	9
Date	15-11-2024
Duration (hrs)	4
Accumulated time (hrs)	28

Record of activities and achievements

Amending task 6 and adding an introductory paragraph into task 5. Compiling all previous work into a main document.

Plans for next week

Ensure task 6 is completed, investigate literature review.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	10
Date	22-11-2024
Duration (hrs)	7
Accumulated time (hrs)	35

Record of activities and achievements

Completed task 6, discussing literature review & selecting 3 solutions.

Possibility of controllers; Siemens S7 1200, Arduino or PIC Microcontroller.

Possibility of displays?

Plans for next week

Carry on research into 3 solutions and create block diagrams.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	11
Date	29-11-2024
Duration (hrs)	8
Accumulated time (hrs)	42

Record of activities and achievements

Decided on using an Arduino micro-controller, however still completing 3 solutions due to connectivity and cost.

Controller

- Arduino R3
- Arduino Mega 2560
- Siemens Logo PLC

Displays

- Arduino 3.5" TFT LCD Shield
- Nextion Intelligent
- Siemens KTP400

Plans for next week

Complete literature review with amendments.

Signed:



Signed *R. Davies*

Log Entry Sheet

Log Number	12
Date	06-12-2024
Duration (hrs)	8
Accumulated time (hrs)	50

Record of activities and achievements

Completed literature review, already started WBS which I'm going to use for the Gantt chart. Been on annual leave this week, so it has been hard to complete work.

Plans for next week

Compile report again, finish exec summary, conclusion and if possible, risk assessment.

Signed:



Signed: *R. Davies*

Log Entry Sheet

Log Number	13
Date	13-12-2024
Duration (hrs)	8
Accumulated time (hrs)	58

Record of activities and achievements

Read through assignment, ensured that nothing was left out which consisted of a cost breakdown and introduction.

Plans for next week

Compile, check and submit.

Signed:



Signed: *R. Davie*

74

/100

PAGE 1

Text Comment. A good report covering all aspects of the project, mostly well written with some punctuation errors. Format of paragraphs is no always correct (should be fully justified text) Good solutions offered, correct one chosen Keep your eye on your costing spreadsheet so you don't go over budget and keep detailed record in your log book for the next phase of the project.

PAGE 2

PAGE 3

PAGE 4

PAGE 5

QM

Paragraphs should be fully justified text as required in the brief

Text Comment. As a summary, you need to say what the 3 solutions are.

Text Comment. In this summary, you have covered many aspects of the project but it lacks detail. You had 300 words to do it in.

PAGE 6

QM

Paragraphs should be fully justified text as required in the brief

Text Comment. This paragraph belongs in the summary

Text Comment. A good introduction

PAGE 7

Text Comment. Don't stretch images, it distorts the text

PAGE 8

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. only the surname needed

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

QM

Punctuation Error

Punctuation error

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. This page has the correct paragraph forming

Text Comment. Something went wrong

Text Comment. Use centring of text for titles only

Text Comment. E is the most interesting as it leads to practical measurements

Text Comment. +/- 1

QM

Punctuation Error

Punctuation error

Text Comment. A good testing table with detailed descriptions of how the tests will be carried out

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. how is the temperature sensed?

Text Comment. This is a good solution showing clear thinking. However, there is no temperature sensor

PAGE 20

Text Comment. how is the temperature sensed?

Text Comment. one pump?

PAGE 21

Text Comment. how is the temperature sensed?

PAGE 22

PAGE 23

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. You could also have mentioned your costing spreadsheet and log book

PAGE 24

Text Comment. none of your solutions contain a temperature sensor

Text Comment. Also, costing spreadsheet for monitoring spending and log book for progress and decision making

PAGE 25

QM

Wide Range of Sources

You have shown good evidence of reading from a wide range of sources.

QM

Correct method of listing.

You have listed your sources correctly according to the Harvard method.

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

PAGE 31

PAGE 32

PAGE 33

PAGE 34

PAGE 35

PAGE 36

PAGE 37

PAGE 38

Text Comment. A good log book, many enties have detail, some however, are very brief

GRADING FORM: NEW CSG-RUBRIC

MATTHEW PERRY

74

1. ENGAGEMENT WITH LITERATURE



Sections 3 and 5: Engagement in research, judicial use and critical evaluation sources for project constraints and literature review of solutions

Excellent evidence provided (7/10)

Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing

Wide range given, mostly cited correctly and listed according to the Harvard method. (8/10)

15

15/20

2. KNOWLEDGE AND UNDERSTANDING



Section 3: Project background and problem definition

Excellent, well described and explained with detail.
(4/5)

Section 3: Project constraints: Ethical.

Excellent, well described and explained with detail.
(4/5)

Section 3: Project constraints: Sustainability

Excellent, well described and explained with detail.
(4/5)

Section 3: Project constraints: Legal/Commercial

Excellent, well described and explained with detail.
(4/5)

16/20

16

3. COGNITIVE AND INTELLECTUAL



Section 4: Functional Design Specification

Clearly specified (4/5)

Section 4: Test planning

Very detailed (4/5)

Section 5: Evaluation of solutions and justification of final solution

Very good review of solutions with reasons given and well justified choice (4/5)

Section 7: Conclusions and Recommendations

Very good, clearly stated (4/5)

16/20

16

4. PRACTICAL APPLICATION



Section 6: Project Plan

Some detail given but not all tasks from the WBS are in the plan (2/5)

Section 6: Working breakdown structure, costing exercise and management techniques

Good evidence given (3.5/5)

Appendix: Risk assessment for implementation phase

Very good evidence given (3.5/5)

Appendix: Planning phase log-book entries.

Some entries are detailed, some are brief, more hours should have been allocated (3/5)

13/20

13

5. TRANSFERABLE SKILLS



Section 1: Executive summary

Good but could be longer and could have contained more information about the project (3/5)

All Sections: Presentation quality of the report, diagrams, charts, tables, figure numbering, page, and section numbering etc

Generally good (though you should not stretch images) (3/5)

All Sections: Quality of the writing style, use of punctuation and grammar

Generally well written with a few errors (3/5)

Word count limit not exceeded

Not exceeded (5/5)

14

14/20