



Euan Kelly

Mine Clearance Work-Based Group Project

University of Wales Trinity Saint David
Work-Based Group Project

Ordnance, Munitions and Explosives BEng

Supervisor: Dave Holley

April 2026

Table of Contents

1.	Introduction	4
2.	Literature Review	5
3.	Project Approach	5
4.	Working as a Team.....	6
5.	Developing a Solution & My Contribution.....	8
6.	Boundaries and Challenges	9
7.	Reflection & Feedback.....	10
8.	Conclusion	11

Figure 1 - Room Booking 1	7
Figure 2 - Function Means Analysis	8
Figure 3 - Systems Pugh Diagram	9
Figure 4 - Team Feedback	13
Figure 5 - Individual Feedback	14

Table 1 - Group Members Information	4
Table 2 - Group Member Roles	6

1. Introduction

This report details the process of working as a group through a systems engineering workbook to generate a solution to a provided brief. The group consists of 7 members from differing workplace backgrounds and specific Ordnance Munitions and Explosive (OME) pathways they are on. The information of the group can be seen in Table 1 below.

Table 1 - Group Members Information

Name	Pathway
Euan Kelly	Safety Pathway
Arron Simpson	Safety Pathway
Caspar Thurston-Smith	Safety Pathway
James Cawte	Safety Pathway
Shaun Malone	Test & Evaluation (T&E)
Theo Dunning	Manufacturing
Will Critchley	Research & Development (R&D)

The brief for this task is as follows: A medical supply convoy must pass through a mined desert passage where rerouting and helicopter support are not viable due to the terrain and threat of MANPAD. The mission requires a rapid, road-based solution to detect, clear and mark mines, enabling safe passage for the convoy. There is a restriction on heavy machinery and vehicles, and therefore a customised Land Rover-like vehicle must be used. There is already a constraint on the use of in-service mine clearance systems, such as Python, due to safety concerns about fragmentation. As a result, the task is to design a portable, effective mine clearance system that can be deployed using lightweight vehicles under time-critical conditions.

The Systems Engineering workbook provided a structured process to follow, supporting decisions from concept through to disposal for each member of the team. The workbook comprises each of the 4 QFD's that must be analysed in SE to ensure the safety, reliability and performance of a system [1]. The 4 QFD stages are:

- QFD 1 – Translating the customers' desires into technical requirements of what the system must output.
- QFD 2 – Converting technical requirements into specific subsystems and design features.
- QFD 3 – Defining how the product is manufactured and the operations processes.
- QFD 4 – The systems production controls, quality assurance and manufacturing reliability.

This workbook will be completed both as a group and individually once each member's role has been identified.

2. Literature Review

The sources I utilised when researching principles dealing with safety in manufacturing are largely key UK legislation and regulatory frameworks governing the use and handling of explosives. Key sources for this work included the Health and Safety at Work Act 1974 [2], which establishes the overarching duty of care for ensuring the health and safety of the whole workplace. In addition to compliance with the Control of Substances Hazardous to Health (COSHH) Regulations 2002 [3], which address the risks and requirements of safe handling and exposure of hazardous substances, in this case, explosive materials.

Further guidance was taken from the Dangerous Substances and Explosives Atmosphere (DSEAR) Regulation 2002 [4]. This focuses on the process of mitigating risks associated with explosive atmospheres, including ignition control and environmental management, all directly linked to scenarios associated with manufacturing explosives. Explosive Regulations 2014 is another source used to identify the hazards of explosive manufacturing and how to control the associated risk. It outlines requirements for manufacturing, storage and the security of explosive sites.

I chose to use these sources as it provides guidance in relation to safety by defining safe separation distances, licensing requirements to manufacture explosives and risk management during production, such as ensuring the appropriate ATEX kit is used [5]. Safety regulations in place are governed by the HSE, which is formed by the previously mentioned legislation. As such, it was deemed necessary to rely heavily on this as my main source of information when contributing to the manufacturing element of the brief. By taking this approach, it ensured that the solutions agreed on for manufacturing aligned with legal requirements and best practices. This supports the validity of the decisions made throughout this process.

3. Project Approach

To cover all aspects of the workbook and brief effectively, we needed to delegate to each member of the team a role to focus on specifically, whilst also being able to provide insight for others where required. As a group, it was identified that 5 key areas must be targeted: R&D, T&E, Manufacturing, Operational safety and disposal, with extra assistance to T&E and manufacturing for safety-focused work. This meant there were 3 safety-focused roles with 4 members on the safety pathway. Fortunately, Arron stepped up due to having experience with OME disposal through his career and willingly took on the role to support the team. It was agreed that everyone would assist in some form with the disposal form to remove the burden of a tougher subject to report on.

As Table 1 shows, the remaining roles were aligned with the team members' pathways and assigned accordingly. The three remaining safety members did not possess a detailed knowledge of the specific safety requirements for these areas, as their roles at MOD relate to a different type of safety. However, with support from their pathway partners and their

broader safety expertise, the role delegations were considered appropriate and as effective as possible.

The remaining roles can be seen in Table 2.

Table 2 - Group Member Roles

Name	Role
Euan Kelly	Manufacturing Safety
Arron Simpson	Disposal
Caspar Thurston-Smith	Operational Safety
James Cawte	T&E safety
Shaun Malone	T&E
Theo Dunning	Manufacturing
Will Critchley	R&D

Once the roles were decided, we investigated the workbook to identify the areas we had not managed to complete during lecture time, where we could form ideas as a group. For myself, we agreed that Theo and I would work through the manufacturing sections together to ensure we fully understand the process. It also provided me 1-1 time with Theo to ask further questions on manufacturing and key aspects I should be aware of before doing my own research, as it is an environment I have not experienced before.

The workbook was saved in a shared Teams area where all members would maintain access 24/7, allowing for flexible working hours away from university and allowing multiple team members to contribute to their allocated areas at once. It also allows the team as a whole to identify areas of weakness in the QFD decisions or where some stages may have accidentally been skipped over.

4. Working as a Team

My role within the team required regular interaction with other members across multiple functional areas, in particular the manufacturing and both T&E members. Close collaboration with Theo ensured alignment between the manufacturing processes and choices and what safety measures must be implemented to ensure risk was tolerable from the moment decisions were being made. Additionally, engagement with Shaun and James from the T&E pathways supported an understanding of how manufacturing decisions led to knock-on effects across the T&E stages, including which tests should be carried out and the constraints posed by our manufacturing methods. They could compare results to those manufactured similarly or, alternatively, if our self-produced product did not perform as well as other manufactured products made by other methods.

Responsibilities of this task were coordinated through an initial consultation with the group, with allocation of roles following on from here, primarily based on group members' pre-determined pathways influenced by their work organisation, as outlined in Tables 1 and 2. Although each member had their specific areas of focus for the workbook and design ideas, we

would use lecture time and out-of-study hours to meet up and discuss any challenges or queries we each had.

As a team, we used in-person and digital ways of communication and progress updates. As mentioned, class time was fundamental as the requirement of being in lecture ensured that all group members were available to meet with no out-of-study arrangements able to cause conflict. Post-lecture time, we agreed to pre-book rooms to ensure we had available and appropriate workspace to continue working as a group, allowing us to discuss key decisions, validate assumptions and ensure alignment through all QFD stages in the workbook. These sessions were particularly effective when we were resolving complex issues and agreeing on a unified approach for our concept. Shaun was delegated the role of booking the rooms once an agreed time was decided; evidence of this can be seen in Figure 1.

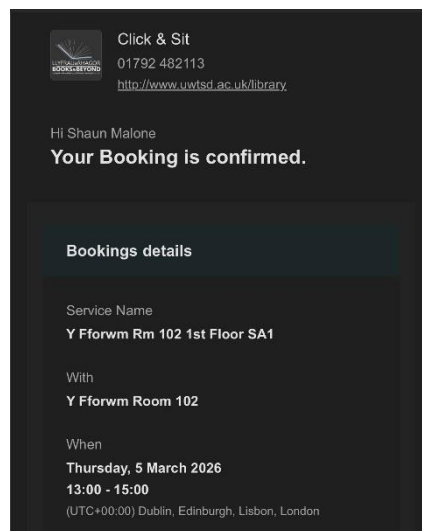


Figure 1 - Room Booking 1

Outside of lecture time, both at home and when at university blocks, we communicated through a WhatsApp group I had set up. This enabled quick, brief updates on progress and any small, low-level decisions to be easily communicated. Digital interaction was further improved using the team's shared area, allowing for multiple parts of the QFD to be worked on at once. However, challenges arose due to inconsistent file naming, where workbooks had incidentally been saved using 'save as', creating multiple iterations of the workbook and confusion about which was the most up-to-date version.

To resolve this, we decided as a group to focus on improved file naming and increased awareness of maintaining a single working document. We agreed that Version 3 would be the final working version. Overall, this improved coordination of the task and resolved the issue of conflicting versions of the workbook as the project progressed.

5. Developing a Solution & My Contribution

Within the group, I was responsible for the safety in relation to manufacturing, particularly focusing on the hazards and controls associated with manufacturing plastic explosives. My role involved identifying key risks, such as the hazards surrounding a manufacturing facility, including both environmental and physical noises between facilities and operators. In addition to this, I identified and interpreted key regulations relevant to the stages of the workbook and shared them with the group to ensure safety and legality considerations were applied throughout the lifecycle of this product, rather than just at manufacturing alone.

I made a key recommendation from the start to base the concept around a drone, incorporating Ground Penetrating Radar (GPR). This decision provided a lightweight remotely operated solution, reducing risk to personnel and further increasing the safety of this task. I created a visual concept of this image by using artificial intelligence and providing prompts until a suitable concept was visually produced.

Through the workbook, I produced a P-diagram to identify the input, output, differing noise factors and the control factors associated with manufacturing plastic explosive. This enabled a structured understanding of how external influences and controllable variables affected the process. Following the identification of the noises and controls, I compared them in a what-why diagram. By scoring their relationship together, I was able to identify the key controls and noises. This approach ensured that critical controls and noises would be factored in when manufacturing this product, and how they would influence the wider system.

A key challenge encountered in my work was my very limited exposure to manufacturing in my life. This was addressed through clear communication with Theo, due to his in-depth knowledge of manufacturing, for any queries I had. By making clear communication and working as a team, I was able to make a more informed contribution to discussions and ensure that my proposed solutions were valid and appropriate for the system.

Ideas for this concept were generated through a Function Means Analysis (FMA). FMA is a systematic method for creating and evaluating a way a system can achieve its requirements [6]. Producing this in a table, it allows for easier comparison between solutions for a function. The table in Figure 2 shows the FMA completed for this project.

Functions	Means (PRE-PUGH OPTIONS)																
Deploy Clearance Capability	Drone	Man Portable	Unmanned Ground Vehicle (UGV)	Vehicle Mounted	Split Assembly	Animal Mounted											
Detect Explosive Hazard	Magnetometer	LIDAR	Ground Penetrating Radar	AI	Explosive Sniffing Animal	Crystal Ball	Tarot Cards	Foot Tapping	Prodding	Visuals							
Assess and Decide	AI	Visual		Radio Memory	Call a Priest	SD / CD	Ask the Audience										
Neutralise or Removal	Explosive effector	Rifle fire	Distractor	Laser	Sensory Deprivation	Foot tapping	EDD	Don't	Plow	Grapple and hook	Goats	Python	UGV	Dropper drone	Suicide drone	Drone delivered	Force of Nature
Verify Clearance	Visual	Repeat scan	Sniff it	Don't	AI	UGV	Explosive Sniffing Animal	Trained Personnel									
Mark Cleared Route	Flag	Paint	Rope / String	Glow Stick	Breadcrumbs	Rocks / stones / Environment	Barriers	Solar powered lights	Reflective markers								
Enable Convoy Transit	ATV / Hilux / Defender	Tank	HGV	Sand bags	Digger	Tamper	Plow	Steam roller	Concrete	Plants of wood	Roads	Helicopter	Clear new path	Mesh road			
Recover and Redeploy	Spare / replaceable parts	Fibre optic	Tow bar	Trailer	Return to home system	Self destruct	Bubble wrap	Big magnet	Flaming red / Grapple hook								

Figure 2 - Function Means Analysis

By producing this FMA as a team, we were able to incorporate multiple perspectives, ensuring that solutions were practical, safe, and considered all system aspects. Through this collaborative approach, more robust and well-informed decisions could be made about the system.

		Relative Importance Equal	Relative Importance Weighted	Solution 1 (Python)	Solution 2 (Animals)	Solution 3 (Drone)	Solution 4 (Metal Detector)
WHATs - Customer Requirements	How much:- From QFD 1						
The system shall detect buried or surface-laid mines typical of legacy and improvised mine threats.		1	11.54159738	0	1	2	1
The system shall render detected mines safe by removal, destruction, or permanent disabling.		1	11.60976813	0	-1	0	-1
The system shall be transportable and operable using light vehicles (Land Rover, Hi-Lux, or equivalent).		1	11.42239274	0	2	1	2
The system shall clearly mark mines cleared lanes and boundaries in a way visible to follow-on with light wheeled vehicles		1	11.53251289	0	1	2	1
The system shall function in high dust, sand, heat, and vibration conditions without degradation of performance.		1	11.02086541	0	-1	0	-1
The system shall clear the required route length within a time window compatible with urgent medical convoy movement.		1	11.24494995	0	-1	-1	-1
The system shall limit blast, fragmentation, and collateral damage within the confined pass.		1	10.80770156	0	2	2	2
In the event of malfunction, the system shall default to a safe condition without creating additional hazards.		1	10.43955157	0	-1	1	2
The system shall be designed to enable safe, compliant breakdown and disposal of all system components, including explosive payloads, electronic subsystems and structural elements in accordance with applicable environmental, explosive safety, and hazardous waste regulations at end of life.		1	10.38066037	0	0	2	1
				0	2	9	6
				0	23.2191638	99.14193875	64.91847888
Ranking		100		0	-21.219164	-90.1419388	-58.9184789

Figure 3 - Systems Pugh Diagram

Once we had identified possible concepts to achieve our goals from the FMA, we used a Systems Pugh Diagram to compare 3 solutions against an existing, but not appropriate to our brief, mine clearance system. This is shown in Figure 3. The results showed that my suggestion of a GPR drone would be most effective at meeting the customers' requirements.

6. Boundaries and Challenges

As a group, we faced various boundaries and challenges through this process. Primarily, the issue around timing and availability for all members was a large burden on this task due to out-of-university commitments. By making room bookings, online team calls out of university time, and our group WhatsApp chat, we were eventually able to combat this.

Ensuring all team members were confident and comfortable with their roles was an initial challenge at first due to limited knowledge on certain aspects, such as manufacturing and T&E. This was addressed through open discussion and alignment

with individual pathways, where other members could provide support and input with any queries.

Limited knowledge of the landmines specified in the brief was an initial hurdle for the team. To combat this, we individually went away and completed our own research on landmines, including their detectability and performance characteristics. We gave an appropriate time to do this to ensure all members were able to complete their research before coming back to discuss and share what they had found. From here, we worked as a team to gain a full understanding of what we were dealing with and how to produce a system to overcome and defeat the landmines, a key requirement of the system we had identified at the start.

Finally, in preparation for the final presentation to the SQEP panel, confidence and delivery of our presentation were identified as areas for development. This was addressed by booking rooms that support the ability for group presentations, such as size-appropriate rooms and media access. This allowed members to refine their personal areas of the presentation and ensure the overall length was within the time set. Drawing on prior workplace training for presenting confidently, I was able to share tips with the team for a smooth performance and overall delivery.

7. Reflection & Feedback

Overall, as a group, we worked effectively to apply a structured systems engineering approach to the problem presented to us. Collaboration between different pathways in the group strengthened decision-making where some knowledge was lacking. Tools used throughout the workbook, such as the FMA, enabled us to work effectively as a team and contribute our own ideas to identify as many potential solutions to functions as we could. Communication ended up proving to be very solid through in-person sessions at university, Teams calls, and WhatsApp; this helped maintain progress despite scheduling clashes.

Feedback aimed at the team and individually was provided post presentation and can be seen in full in Appendix A. This feedback showed both strengths and weaknesses. As a team, the presentation was considered professional and supported by effective visual content. However, some slides contained excessive text and occasional readability issues. In addition to this, we had exceeded our time limit allocated, which showed that further rehearsal time would have been beneficial.

Personal feedback on manufacturing safety showed positive mention and use of the P-diagrams to identify noises and controls linked to key industry regulations. However, to further improve on this, I could have explained in more detail how this influenced key decisions. Although during the workbook process, the decisions were influenced by regulations, I failed to capture this in my final presentation due to timing constraints and next time I would look to remove parts of my introduction which may not have added critical value.

For future work, a greater depth of research from the beginning on all our systems involved in the task would further support decision-making and eliminate time spent working through the FMA with fewer ineffective suggestions for the task. In an ideal situation, the overall groups

allocated would feature a better spread of safety pathway members in each team to allow further knowledge input from the start.

8. Conclusion

In conclusion, collaboration between team members through different pathways was a key factor in the success of this project. Enabling knowledge, sharing, and more informed decision-making allowed the process to run as efficiently as it could. Despite challenges relating to time constraints and knowledge gaps, we were able to effectively overcome our boundaries through good organisational skills and planning, as evidenced by our shared team area and regular additional room bookings to catch up.

The final design solution was formed using the toolsets in the workbook, and key areas such as the FMA allowed us to work as a team to come to the final idea of a drone using GPR. This solution met the requirements of the user set out in the brief and ultimately allowed our team to succeed, further showing the importance of working effectively and allowing all members to have their ideas heard.

Overall, the project highlighted the importance of teamwork, early-stage planning and the application of key systems engineering principles to achieve and develop effective and practical solutions.

9. References

- [1] Quality-One, “Quality Function Deployment,” [Online]. Available: <https://quality-one.com/qfd/>. [Accessed 16 April 2026].
- [2] Health and Safety Executive, “Enforcement: Health and Safety at Work etc Act 1974 Section 3,” [Online]. Available: <https://www.hse.gov.uk/enforce/hswact/>. [Accessed 26 April 2026].
- [3] Health and Safety Executive, “Control of substances hazardous to health (COSHH) 2002,” Health and Safety Executive, 2002.
- [4] Health and Safety Executive, “The Dangerous Substances and Explosive Atmospheres Regulations 2002,” Health and Safety Executive, 2002.
- [5] Health and Safety Executive, “Explosives Regulations 2014,” Health and Safety Executive, 2014.
- [6] S. Burge, “The systems Engineering Tool Box,” 2006.

10. Appendices

Appendix A

Euan Kelly	Team 1
Team feedback / Questions	
Jenni. Cost of the system. Gareth. Shaped charge (PE-8) notoriously bad. Complicated filling process. Dave. Human factors assessment Jacko:- Legislation when using drones. Programming etc. Placement of the charge again. Balancing forces when the charge, how are ensuring it's all gone? Ewa. Taggant? What is it? All suitably professional in appearance. Simplistic and effective slide design, good use of visual images to help with audience understanding throughout. Many slides have a lot of writing on, this could make it difficult for audience to read, try practicing from the back of a large room to ensure your text is an appropriate size. Some very limited areas (it final square on trials safety slide) have a low text to background contrast making it very difficult to read, consider a darker text on a light background or lighter text on dark background as you have done well in the rest of the presentation. Try and avoid using acronyms where possible in the slides as not everyone who will be seeing these will be an expert, whilst you articulate very well in the presentation itself (well done!), it could be that not everyone who needs to see the slides will be present at the time. References slides included, this pleases Jenni! Overran by about 8 minutes.	
Feedback / Comments Dave	

Figure 4 - Team Feedback

Safety in manufacturing. Needed a slide to go through principles Legislation highlighted. Might be a good idea to break these down and put the comments against each in your report P-diagrams to analyse noises (Good) Noises well described. Good approach to look at processes. Perhaps not text book definitions, but good enough. Control measures identified Noises quantified. Key noises around people. Human factors assessment. Training as top control might demonstrate need for the HFA.
Feedback / Comments Jenni Good volume and pace. Nice open body language, good attempts at interacting with the audience. Some reading from the slides but not an overreliance, this should that you are prepared and familiar with material. Identification of manufacturing risk and related regulations for manufacturing safety. Noises identified and broken down into external, unit-to-unit and deterioration. Each category defined and key noise factors identified. Control measures identified and related back to H&SWA and COOSH. A mistake was made but recovered quickly and didn't allow it to fluster you, this is a very important skill to have, well done.

Figure 5 - Individual Feedback