

Matt S - Major Project Proposal

by Matthew Satterthwaite

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Major Project - L6 OME Test and Evaluation

Document: Project Proposal

The Utilisation of Existing Hardware and Facilities to Create a
Hybrid HESH Solution for the Rifled to Smoothbore Transition
of The Challenger Main Battle Tank



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Trinity Saint David

4 February 2023

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List of Acronyms	
APFSDS	Armour Piercing Fin Stabilised Discarding Sabot
CAD	Computer Aided Design
CH2	Challenger 2 Main Battle Tank
CH3	Challenger 3 Main Battle Tank
DAU	Delayed Arming Unit
E-FUZE	Electronic Fuze
HE	High Explosive
HESH	High Explosive Squash Head
MoD	Ministry of Defence
PST	Projectile Safety Trial
UK	United Kingdom

1 Introduction

1.1 Background

- 1.1.1 Since the announcement that 148 Challenger 2 (CH2) platforms will be upgraded to Challenger 3 (CH3) and fitted with Rheinmetall L55 Smoothbore Gun systems [1], there has been little to no conversation about the current war stock of rifled ammunition for the remainder of the CH2's service.
- 1.1.2 The collection of Armour Piercing Fin Stabilized Discarding Sabot (APFSDS) rounds have already been evaluated and fired through a Smoothbore system and the concept was original designed for such a platform. However, the remaining 120mm High Explosive Squash Head (HESH) war stock would be rendered obsolete.

1.2 Unforeseen Circumstances

- 1.2.1 The United Kingdom (UK) Ministry of Defence (MoD) last ordered 120mm HESH in 2010 and have since given approval for the decommissioning of the plant, to allow for other processes and products to develop.
- 1.2.2 At the time, this was not considered a risk and the 16000 of war stock was considered enough for the remaining life of the platform, with Tank warfare looking unlikely in future conflicts.
- 1.2.3 In January 2023 however, UK prime minister Rishi Sunak announce that 14 CH2 platforms, and accompanying ammunition will be send to Ukraine as part of a support package following their invasion by Russia in 2022. [2]
- 1.2.4 The potential knock-on effect of this decision is that current 120mm HESH war stock will deplete long before the CH3 delivery date of 2030. This could lead to the manufacturer and supplier having to restart and requalify old processes to replenish the war stock, whilst also investing time and money into manufacturing and supplying world leading 120mm Smoothbore ammunition.

2 Proposal

2.1 Concept

- 2.1.1 This proposal is to provide a hybrid solution that requires minimal modifications to the Shell and facility, offering a Shell that can both see out the CH2 service and then provide an immediate capability to the new CH3 platform without any additional qualification or modifications.

2.2 Document Scope

- 2.2.1 This document will also explain how these modifications can be quickly implemented through smart qualification methods, adoption of existing concepts and by utilizing existing hardware, components, and materials.

3 Areas of Research

3.1 Rifling Engagement

- 3.1.1 The first issue to look at would be the difference in gun systems. The CH2 has a rifled barrel and the CH3 has a smoothbore barrel. This means that there must be design changes around the driving band and Shell obturation system.
- 3.1.2 The current 120mm Rifled APFSDS utilizes a slipping driving band system [3]. Although they are lighter than the 120mm HESH they are fired at higher pressures and therefore all components are subjected to higher velocities during gun launch.
- 3.1.3 Modelling work will be required to determine if the concept can be adopted and scaled to fit the current driving band footprint on the 120mm HESH.

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- 3.1.4 Materials will also be required to manufacture an INERT demonstrator to undergo small scale testing. The total proposed time and cost for Rifling engagement research are shown in Table 3-1.

Table 3-1: Driving Band Research and Development

Task	Hours (@ £45 p/h)	Purchase Cost	Total
Purchase Driving Band Material	1	£250	£295.00
Modelling and Computer Aided Design (CAD) Work	37		£1665.00
Machining, Preparation, and Installation	9.25		£416.25
Packaging trials and Environmental Testing Procedures	37		£1665.00
Total Cost			£4041.25

3.2 In Flight Stability

- 3.2.1 Another issue that would need addressing is the in-flight stability of the round. This is critical to Round accuracy and safety. The existing 120mm HESH is gyroscopically stabilized due to the rifling within the CH2 barrel whereas Smoothbore ammunition is fin stabilized, like a traditional rocket [4].
- 3.2.2 Additional modelling and CAD work would be required to determine the flight stability using the outputs from the driving band development. Again, in an attempt to continue with the smart qualification method, research in to current and existing fin stabilized artillery will be required in an attempt to utilize existing technology – reducing development time.

Table 3-2: Flight Stability Research and Development

Task	Hours (@ £45 p/h)	Purchase Cost	Total
Materials : Rod	1	£285.00	£385.00
Materials : Sheet		£55.00	
Modelling and CAD) Work	55.5		£2497.50
Machining, Preparation, and Installation	37		£1665.00
Packaging trials and Environmental Testing Procedures	37		£1665.00
Total Cost			£6212.50

- 3.2.3 Table 3-2 details the cost and time requirements of calculating the fin details, fixtures and deployment mechanisms required for flight stability. Small scale tests would again be conducted at a subcomponent level.

3.3 Fuze Technology

- 3.3.1 The existing 120mm HESH uses a base percussion fuze [5] which detects three separate scenarios before arming, one being the minimum spin rate.
- 3.3.2 With a slipping driving band, and stabilizing fins the proposed Shell would have a reduced spin rate through the CH2, and even less from the CH3. To requalify a new fuze variant, without spin detection, would incur huge costs and time delays.
- 3.3.3 Electronic Programmable Fuze (E-Fuze) technology is an on-going development within the defence industry [6] and is proving a fast and reliable replacement for mechanical fuze workings and extensive explosive initiation trains.
- 3.3.4 Computer aided electronic circuit design would be required to create a functioning firing safety circuit that fits within the currently delayed arming unit (DAU) area of the fuze body.

Table 3-3: Fuzing Research and Development

Task	Hours (@ £45 p/h)	Purchase Cost	Total
CAD Work and simulation	37		£1665.00
Concept Manufacture	18.5	£300	£1132.50
Total Cost			£2797.50

4 Qualification Timescale

4.1 Development Time

- 4.1.1 A total of 270 engineering hours are required to prove this concept, which equates to just over 7 weeks total.
- 4.1.2 Manufacturing timescales will reduce once the concept has passed proofing.
- 4.1.3 The benefit to the Smart Qualification process is that the Fuze proof firing can be combined with the Projectile Safety Trial (PST) firing due to the abundance of data gathered from small scale subcomponent testing and computer simulations that are constantly updated every time something new is learned.

4.2 7 Box Method

- 4.2.1 The 7-box smart qualification process is detailed in figure 4-1 and details how the new round variant can be qualified with minimal, large scale firing trials.

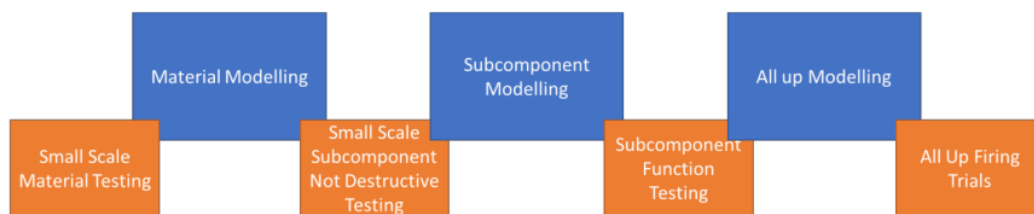


Figure 4-1 : 7-Box Method

- 4.2.2 All modelling blocks are originally run using the information presented on material data sheets. The models are to be run again – for verification – once physical tests have been completed to ensure all data is accurate at every level.
- 4.2.3 The use of this method will greatly reduce the time required to formally qualify a munition meaning that this proposed Shell can be replenishing the war stock levels within months, not years.

5 Conclusion

5.1 Benefits

- 5.1.1 Due to the depleting war stock issue, it is ever more likely that production is going to need to restart for the 120mm HESH. Since the majority of the production facility and hardware has been utilized elsewhere, investment will be required to reestablish the capability.
- 5.1.2 The major benefit – from a company point of view – to this proposal is that this investment does not have to be repeated once the stock is replenished and smoothbore development begins. This product will be designed to provide immediate backfill and future capabilities.
- 5.1.3 Additionally, there is no Squash Head variant in service from any smoothbore supplier. Given the enhanced performance of the Squash Head function, over generic High Explosive (HE), this also opens up an export avenue, to smoothbore operators.

6 Annex

6.1 Annex A : Project Gantt Chart

Hybrid HESH Solution Project Planner

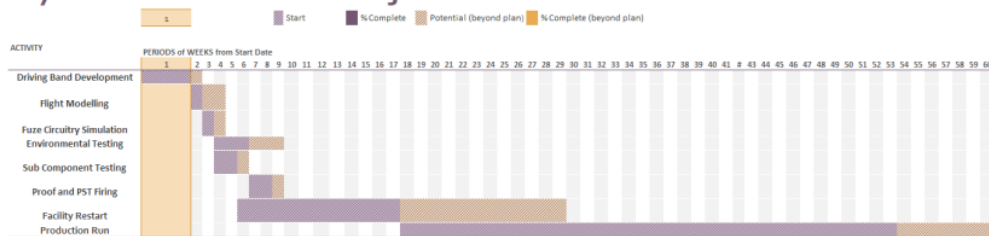


Figure 6-1: Project Gantt Chart

7 References

- [1] Army, "Challenger 3 to be a real smooth operator," British Army, 21 September 2021. [Online]. Available: <https://www.army.mod.uk/news-and-events/news/2021/09/challenger-3-to-be-a-real-smooth-operator/>.
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- [3] T. Defence, "Challenger LEP," [Online]. Available: <https://thinkdefence.wordpress.com/2012/11/04/the-tank-is-dead-long-live-the-tank-part-4-sdsr-army-2020-and-the-challenger-lep/>. [Accessed 23 03 04].
- [4] D. E. C. a. S. S. Jacobson, "Ballistics," in *Theory and Design of Guns and Ammunition*, New York, CRC Press, Second Edition 2014, p. Chapter 4.
- [5] Editor, "L31 HESH," Steel Beasts, 13 04 2019. [Online]. Available: <http://steelbeasts.com/sbwiki/index.php?title=L31>.
- [6] T. Energetics, "Modular Artillery Fuzes," Teledyne Aerospace and Defence Electronics, [Online]. Available: <https://www.teledyneenergetics.co.uk/products/Pages/Modular-Artillery-Fuzes.aspx>. [Accessed 2023].

8 Ethics Form

ETHICS FORM – OME STUDENTS ONLY

APPLICATION FOR ETHICAL APPROVAL

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically.

The University follows the OECD Frascati manual definition of **research activity**: “creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications”. As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the “principal researcher”.

This form must be completed and approved prior to undertaking any research activity.

SECTION A: About You (Principal Researcher)

1	Full Name:	Matt Satterthwaite
2	Student Number:	1910596
3	Email address:	1910596@student.uwtsd.ac.uk / matt.satterthwaite@baesystems.com
4	Programme of Study:	BEng Ordnance Munitions and Explosives – Test and Evaluation
5	Director of Studies/Supervisor:	Kaplan Radhakrish / Gareth Collett

SECTION B: Internal and External Ethical Guidance Materials

	Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, location-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines. You may add rows to this table if needed.	
1	UWTSO Research Ethics & Integrity Code of Practice	☒
2	UWTSO Research Data Management Policy	☒
3		☐

SECTION C: Details of Research Activity

1	Indicative title:	The Utilisation of Existing Hardware and Facilities to Create a Hybrid HESH Solution for the Rifled to Smoothbore Transition of The Challenger Main Battle Tank		
2	Proposed start date:	01.01.2023	Proposed end date:	22.03.2024
	Introduction to the Research (maximum 300 words in each section) Ensure that you write for a Non-Specialist Audience when outlining your response to the three points below: • Purpose of Research Activity • Proposed Research Question • Aims of Research Activity • Objectives of Research Activity			

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	Demonstrate, briefly, how <u>Existing Research</u> has informed the proposed activity and explain. - What the research activity will add to the body of knowledge - How it addresses an area of importance.
3	Purpose of Research Activity To create a hybridised version of a rifled munition that make work on both new and old gun platforms. (This box should expand as you type)
4	Research Question Can the existing 120mm tank munition be modified so that it can fire through both rifled and smoothbore barrels in theatre. (This box should expand as you type)
5	Aims of Research Activity To create a hybridised version of a rifled munition that make work on both new and old gun platforms using new modelling, manufacturing the testing techniques. (This box should expand as you type)
6	Objectives of Research Activity - Create slipping driving band concept and prove through modelling and small-scale tests. - Develop a flight stabilising solution using the current hardware as a base. - Integrate new electronic technology into existing fuze furniture (This box should expand as you type)
	Proposed data collection methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity to collect data, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. You do not need to justify the methods here but should instead describe how you intend to collect the data necessary for you to complete your project.
7	Data collection will be from material data sheets and verified from small scale testing before being fed back into the modelling software. (This box should expand as you type)

SECTION D: Scope of Research Activity

	Will the research activity include:	YES	NO
1	Use of a questionnaire or similar research instrument?	☐	☒
2	Use of interviews?	☐	☒
3	Use of focus groups?	☒	☐
4	Use of participant diaries?	☐	☒
5	Use of video or audio recording?	☐	☒
6	Use of computer-generated log files?	☐	☒
7	Participant observation with their knowledge?	☐	☒
8	Participant observation without their knowledge?	☐	☒

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9	Access to personal or confidential information without the participants' specific consent?	☐	☒
10	Administration of any questions, test stimuli, presentation that may be experienced as physically, <u>mentally</u> or emotionally harmful / offensive?	☐	☒
11	Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
12	Investigation of participants involved in illegal activities?	☐	☒
13	Use of procedures that involve deception?	☐	☒
14	Administration of any substance, <u>agent</u> or placebo?	☐	☒
15	Working with live vertebrate animals?	☐	☒
16	Procedures that may have a negative impact on the environment?	☐	☒
17	Other primary data collection methods. Please indicate the type of data collection method(s) below.		
	Details of any other primary data collection method:	☐	☒
	(This box should expand as you type)		

If you have ticked NO to every question then the research activity is (ethically) low risk and you may skip section E and continue to section F.

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION E: Intended Participants

Who are the intended participants:		YES	NO
1	Students or staff at the University?	☐	☒
2	Adults (over the age of 18 and competent to give consent)?	☒	☐
3	Vulnerable adults?	☐	☒
4	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☐	☒
5	Prisoners?	☐	☒
6	Young offenders?	☐	☒
7	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
8	People engaged in illegal activities?	☐	☒
9	Others. Please indicate the participants below, and specifically any group who may be unable to give consent.	☐	☒
	Details of any other participant groups:		
	(This box should expand as you type)		

Participant numbers and source	
Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?	
10	How many participants are expected?
	Up to 20
	(This box should expand as you type)

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11	Who will the participants be?	Trials engineers, material scientists, electrical engineers, modelling department, drawing office. <i>(This box should expand as you type)</i>
12	How will you identify the participants?	Job role and availability <i>(this box should expand as you type)</i>

	Information for participants:	YES	NO	N/A
13	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☒	☐	☐
14	Will you tell participants that their participation is voluntary?	☒	☐	☐
15	Will you obtain written consent for participation?	☒	☐	☐
16	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☒	☐	☐
17	If the research is observational, will you ask participants for their consent to being observed?	☒	☐	☐
18	Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
19	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☒	☐	☐
20	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
21	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☒	☐	☐
22	If NO to any of above questions, please give an explanation			
	<i>(This box should expand as you type)</i>			

	Information for participants:	YES	NO	N/A
24	Will participants be paid?	☐	☒	☐
25	Is specialist electrical or other equipment to be used with participants?	☐	☒	☐
26	Are there any financial or other interests to the investigator or University arising from this study?	☐	☒	☐
27	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☒	☐
28	If YES to any question, please provide full details			
	<i>(This box should expand as you type)</i>			

SECTION F: Anticipated Risks

	Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.	
1	Risks to participants For example: sector-specific health & safety, emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information. If you have identified in section D that there are no participants, then enter N/A and go skip to question 3.	

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	Risk to participants: Standard trials safety risks when handling heavy components or live munitions. <i>(This box should expand as you type)</i>	How you will mitigate the risk to participants: Work based risk assessment and range safety procedures. <i>(this box should expand as you type)</i>	
2	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities <i>(This box should expand as you type)</i>		
3	Risks to the investigator For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest Risk to the investigator: Investigator will have no access to live munitions. <i>(This box should expand as you type)</i>		How you will mitigate the risk to the investigator: Correct PPE if handling inert model. <i>(this box should expand as you type)</i>
4	University/institutional risks For example: adverse publicity, financial loss, data protection Risk to the University: Access to proprietary data <i>(This box should expand as you type)</i>		How you will mitigate the risk to the University: Pre submission security screening. <i>(This box should expand as you type)</i>
5	Environmental risks For example: accidental spillage of pollutants, damage to local ecosystems Risk to the environment: <i>(This box should expand as you type)</i>		How you will mitigate the risk to environment: <i>(This box should expand as you type)</i>

SECTION G: Feedback, Consent and Confidentiality

If you have identified in section D that there are no participants then enter skip this section and continue to section H.

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when? Live project tracker <i>(This box should expand as you type)</i>
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation. Signed online – cloud-based document storage. <i>(This box should expand as you type)</i>

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3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	No names – just job titles in any reporting. (This box should expand as you type)

SECTION H: Data Protection and Storage

	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 "GDPR" and the Data Protection Act 2018 "DPA")?	YES	NO
1	"Personal data" means any information relating to an identified or identifiable natural person ("data subject"). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, <i>cyfryra</i> or social identity of that natural person. Any video or audio recordings of participants is considered to be personal data.		X
	If YES, provide a description of the data and explain why this data needs to be collected:		
2	(This box should expand as you type)		
	Does it involve special category data (as defined by the GDPR)?	YES	NO
3	"Special category data" means sensitive personal data consisting of information as to the data subjects' – (a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life, (g) genetics, (h) biometric data (as used for ID purposes).	X	
	If YES, provide a description of the special category data and explain why this data needs to be collected:		
4	Some data will be proprietary and will be withheld. (This box should expand as you type)		

	Will data from the research activity (collected data, drafts of the thesis, or materials for publication) be stored in any of the following ways?	YES	NO
5	Manual files (i.e., in paper form)?	☐	☒
6	University computers?	☐	☒
7	Private company computers?	☒	☐
8	Home or other personal computers?	☐	☒
9	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☐	☒
10	"Cloud" storage or websites?	☒	☐
11	Other – specify:	☒	☐

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12	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of backup procedures, password protection, encryption, anonymisation and pseudonymisation:
	All data encrypted and held within security cloud-based storage. <i>(This box should expand as you type)</i>

Data Protection			
	Will the research activity involve any of the following activities:	YES	NO
13	Electronic transfer of data in any form?	☒	☐
14	Sharing of data with others at the University outside of the immediate research team?	☐	☒
15	Sharing of data with other organisations?	☐	☒
16	Export of data outside the UK or importing of data from outside the UK?	☐	☒
17	Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
18	Publication of data that might allow identification of individuals?	☐	☒
19	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and Data Protection Act (2018) (and/or any international equivalent):		
	All data encrypted and held within security cloud based storage. <i>(This box should expand as you type)</i>		
20	List all who will have access to the data generated by the research activity:		
	Matt Satterthwaite Christopher Carr – Agile Qualification Lead Stuart Jones – Modelling Department Lead Andrew Burn – Chief Technologist Christopher Jenkins – Senior Fuze Engineer Matthew Smith – Engineering Manager Robert Mahoney – Lead Engineer (Tank) Andrew Williams – Drawing Office Manager <i>(This box should expand as you type)</i>		
21	List who will have control of, and act as custodian(s) for, data generated by the research activity:		
	Matt Satterthwaite Only <i>(this box should expand as you type)</i>		
22	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form.		
	All data will be encrypted and kept in password protected cloud storage on the University Office 365 system which will not be shared. <i>(This box should expand as you type)</i>		
22	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtss.ac.uk/library/research-data-management/)	☒	
23	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	☒	

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	The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants.	
	In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtsd.ac.uk/research/research-ethics/	
1	Signature of applicant:	<i>MSatterthwaite</i>
		Date:
		04/03/2023
2	Director of Studies/Supervisor:	Kapilan Radhakrishnan
		Date:
3	Signature:	

FOR INTERNAL USE ONLY:

	Ethical approval given	
1	Signature of assessor:	Date:
2	Name:	
3	Role:	

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

72/100

Intro / Aim & Objectives (150 words)		
Project title.		
Identification of a specific problem to be investigated.		
Well-defined aims and SMART objectives.		
Explaining why this project is worth doing.		
Discussion of what the project needs to do in order to be a success.		
Description any deliverables that will be produced at the end of the project	20	18
Specific problem has been identified. Aims and objectives have been documented and fulfil SMART criteria. Clear statement of project benefits. Project success requirements outlined with reference made to end of project deliverables.		
Background to the Project / Literature Review (450 words)		
Description of how the work to be done in the project relates to the work identified in the literature review.	20	10
Discussion of any ethical issues raised by the project Identifying what has already been done within the field. Topic familiarity.		

Brief literature review using appropriate sources – 6-8 journal papers and book chapters rather than just websites. Selection of relevant models & concepts. No real literature review provided in relation to the research, this limits the evidence of engagement however knowledge of current issues necessitating this project does demonstrate familiarity with the topic. A range of references have been used, however some are of questionable integrity for use in an academic context, try and stick to peer reviewed sources where possible.		
Project Design (200 words)		
Clear statement of which development methods are to be used and why they are appropriate. Clear statement of which tools are to be used and why they are appropriate. Clear description of how data collected will be analysed The issues that require investigation are well-documented however the actual research methods are lacking in detail. More focus on how modelling and CAD can be used would have been beneficial. Diagrams of the existing models and proposed changes being made	30	18

may have aided in reader understanding.		
Resources / Planning (200 words)		
List of any deliverables. Clear diagram showing both timing and resource use. Completed ethics form. Limited and relevant appendices Deliverables discussed throughout. Gantt chart included clearly detailing time requirements for this project including time for potential delays, this is always good to consider. Comprehensive consideration of resources that would be required have been provided. Completed ethics form included but it may have been more appropriate to include this as an annex/appendix as was done with the gantt chart.	15	13
Document Presentation		
Correct spelling. Grammar and punctuation. Flow of narrative/fluency. Coherence. Word processed. Correct use of referencing with bibliography. Strict word limit for main text – 1000 words.	15	13

Correct spelling throughout, some minor grammatical errors. Narrative has a good flow. IEEE referencing used correctly throughout. Annexes/appendices should come at the end of the document after the references, not before. Kept within the wordcount +/- 10%.		
TOTAL	100	72

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