

Development of 'Scattershot' Flare
Architecture
Research Proposal

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1. Introduction

Pyrotechnics are chemical compositions that burn to produce light, heat, smoke and sound [1]. The aim of using pyrotechnics as countermeasure is to spoof infra-red (IR) seeking threat by producing a specific IR signal so that the threat is directed away from the platform that launched the countermeasures. Early techniques involving the use of IR countermeasures can be dated back to the 1950's [2].

Pyrotechnic behaviour can be determined by the ability of the component chemicals to gain and lose electrons during the energetic reaction [3]. The greater the release of energy the greater the intensity of the burn of the pyrotechnic.

2. Background to the Proposed Research

The proposed plan is the second stage of testing for the novel multi-part flare architecture, 'Scattershot'. The project is part of a system of work aiming to produce an array of multi-part solutions for the purpose of defeating missile threats directed at rotary and fixed wing aircraft. The current payload is designed to fit within a standard 118 casing (1 inch x 1 inch x 8 inches).



Figure 1 - 118 Flare Casing [4]

The design, established in the initial stage of development, is a stack of Magnesium/Teflon/Viton (MTV) pellets sitting on top of a piston with a wad on the other end to act as a cushion to the ejection. The system is held in place by an endcap. The flare is ignited when an electrical impulse initiates the impulse cartridge which is a small propellant charge situated in the base of the flare can.



Figure 2 - Scattershot Concept Design

The aim for this architecture is to eject all of the pellets in a spread pattern to deliver a specific countermeasure effect. There are several methods in which pyrotechnic countermeasures can be employed to defeat an IR seeking threat such as a missile. The most common of these is through seduction, this is where a flare is ejected out of an air/ sea platform and produces a specific IR effect causing the missile to no hit the target. This spoofing method is increasingly becoming the focus of development as threat technology is evolving to ignore more simple countermeasure techniques so innovation in the way that flares are deployed and the signals they produce is required.

3. Aims & Objectives

The aim of the project is to develop an array of different architectures for the 'Scattershot' design so that various behaviours can be observed and recorded. The observations will influence further development and will improve the team's understanding on multi-part flare architectures

Objectives:

- Analyse data recorded by the cameras from stage 1 using the appropriate analysis software.
- Develop a number of different versions learning from the data in stage 1 each with individual changes so the effect of each change can be measured.
- Complete dynamic live trial dependent on the results of the firings from stage 1 as the focus will be on the assessment of the flares behaviour in a representative environment.

The live dynamic trials will be completed on a flare test track as seen below, this allows the flares to be tested in a representative way as the flares are able to be launched at speeds typical of that of the platforms they are launched from.



Figure 3 - Flare Test Track [5]

4. Experimental Design

The first stage of testing will act as a guide for what aspects are to be developed in the second stage of testing. Once the basis for the architectural design has been identified then a 3D CAD model of the architecture will be developed and manufactured. The areas for improvement will be discussed by various members of the team and with the manufacturing company so that their knowledge on the subject can be considered.

4.1 Outline of Experimental Procedure

The trial to determine the effectiveness of the novel design will be required. This involves a dynamic test where the payload is launched at a velocity similar to that of what it is likely to be launched at.

4.2 Data Collection

The output of the flare will be recorded by an array of high-speed cameras, IR imagers and radiometers; this ensures that an output can be seen in multiple spectrums meaning a greater understanding of the output. For the data collected by these pieces of equipment to provide accurate measurements they must have in-date calibration certificates. This will be completed by a member of the trials team before the start of the trial.

4.3 Data Evaluation

The data captured will be analysed to produce graphs of measured values, which will be compared against existing data to determine if that data collected is accurate, the data will also be compared to other existing multi-part architectures to observe how the spread of pellets differ between designs. The intended result will be a large cloud of high signal, produced by all of the pyrotechnic pellets successfully ejecting from the cannister.

4.4 Risks & Limitations

The two nominal types of risk expected in this task are the risk to personnel and the institutional risk. Institutional risk refers to risks from/ for the company. As the results are not likely to be published there is no reputational risk to the company. However, there is a financial risk given that the funding has the possibility to be withdrawn during the project.

There is a risk to the task if the results gained aren't as positive as expected or the avenues for development aren't available then there is the possibility that the task can be cancelled or put on hold.

4.5 Ethical Issues

A completed ethics form can be found in ANNEX A. This form is the standard form for the School of Applied Computing research activity ethics form. The university uses the definition "creative work undertaken on a systemic 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"[6].

6. Resources & Planning

The intended deliverable for this project is the development of the scattershot flare design. This will be measured by the delivery of data resulting from trials and other tests.

By the time the write-up of the project begins it is expected that the design has been confirmed for testing, and a live test has either been completed or is in the pipeline for completion.

6.1 Resources Required

This project will mainly be completed by myself with regular meetings from the relevant authorities. For trials and tests more staff will be required for the handling of the different measurement equipment.

The trials and testing will require a full team of competent staff trained on the various pieces of equipment used. The testing will either take place in a lab designed for testing energetics or outside on an explosive range which has all of the necessary jurisdiction to host a trial of this nature.

6.2 Gantt Chart

A completed Gantt chart can be found in ANNEX B. The Gantt Chart lays out an ideal timeline, though this may change as the project progresses. No information following November 2026 will be included in the report, instead the resulting steps will be stated which will allow for the final report to be written and cleared by the company within the proposed time frame of March 2027.

7. Reference List

- [1] A. A. Shidlovskiy, *Principles of Pyrotechnics*, 3rd Edition. American Firework News, 1964.
- [2] Naval Surface Warfare Centre, "GENESIS of INFRARED DECOY FLARES The early years from 1950 into the 1970s," Jan. 2009. Available: <https://apps.dtic.mil/sti/pdfs/ADA495417.pdf>
- [3] J. A. Conkling and C. J. Mocella, *Chemistry of Pyrotechnics: Basic Principles and Theory*, 2nd ed. Boca Ration, Florida: CRC Press, Taylor & Francis Group, 2010.
- [4] Chemring Countermeasures, *118A DSTL22 Flare*. 2017.
- [5] Cranfield University, "Flare Test Track - COTEC," *COTEC*, Nov. 03, 2025. <https://www.cotec.org.uk/capabilities/testing-evaluation/> (accessed Jun. 10, 2026).
- [6] OECD, "The Measurement of Scientific, Technological and Innovation Activities Frascati Manual," 2025. Accessed: Jun. 08, 2026. [Online]. Available: https://www.oecd.org/content/dam/oecd/en/publications/reports/2015/10/frascati-manual-2015_g1g57dcb/9789264239012-en.pdf

ANNEX A – SoAC Ethics Form

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:	Thomas Jonathan Appleby
2	Student Number:	2217664
3	Email address:	2217664@student.uwtsd.ac.uk
4	Programme of Study:	Beng (Hons) Ordnance, Munitions and Explosives ACCA 6020
5	Director of Studies/Supervisor:	Dr Ewa Kazimierska

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	UWTSD Research Ethics & Integrity Code of Practice	☒
2	UWTSD Research Data Management Policy	☒
3		☐

SECTION C: Details of Research Activity

1	Indicative title:	Development of ‘Scattershot’ Flare Architecture
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2	Proposed start date:	19/05/2026	Proposed end date:	19/03/2027
	Introduction to the Research (maximum 300 words in each section) Ensure that you write for a <u>Non-Specialist Audience</u> when outlining your response to the three points below: • <i>Purpose of Research Activity</i> • <i>Proposed Research Question</i> • <i>Aims of Research Activity</i> • <i>Objectives of Research Activity</i> Demonstrate, briefly, how <u>Existing Research</u> has informed the proposed activity and explain • <i>What the research activity will add to the body of knowledge</i> • <i>How it addresses an area of importance.</i>			
3	Purpose of Research Activity The purpose of this research activity is to develop a novel architecture for a pyrotechnic countermeasure. (this box should expand as you type)			
4	Research Question Is the developed architecture a viable countermeasure design? (this box should expand as you type)			
5	Aims of Research Activity The aim of the activity is to develop the flare architecture using what knowledge was gained from the initial stage of testing and develop that into a solution that can be trialled in both Inert and Live testing. (this box should expand as you type)			
6	Objectives of Research Activity To produce a flare architecture using the gained knowledge to be able to be trialled in both Inert and Live testing. (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	The data will be collected by the use of high-speed cameras and radiometers to capture the spread and intensity cloud of the pellets in the novel flare design. (this box should expand as you type)			

SECTION D: Scope of Research Activity

Will the research activity include:	YES	NO
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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?	☐	☒
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, mentally 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, agent 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: No participants will be involved in this task (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?	N/A (this box should expand as you type)
11	Who will the participants be?	N/A (this box should expand as you type)
12	How will you identify the participants?	N/A (this box should expand as you type)

	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			
	No participants will be involved in this task (this box should expand as you type)			

	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			
	This research is not funded by the university. Cameras will be used but there will be no participants involved.			

(this box should expand as you type)

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.	
	Risk to participants: N/A – There are no participants <i>(this box should expand as you type)</i>	How you will mitigate the risk to participants: <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	
	No personal information is obtained <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: Risk of burns when handling the flares Manual Handling risks when transporting the cameras and other trials equipment. <i>(this box should expand as you type)</i>	How you will mitigate the risk to the investigator: Appropriate PPE is to be worn whilst handling the flares Correct manual handling techniques should be employed and all conducting said handling must have completed the appropriate training course. <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: N/A – Dstl is undertaking the risks for this task	How you will mitigate the risk to the University:

	<i>(this box should expand as you type)</i>	<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: The flares have a chance to cause damage to the environment after ignition due to the high temperatures produced. <i>(this box should expand as you type)</i>	How you will mitigate the risk to environment: The tests will be conducted on a safe platform away from combustible materials. <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?	
	N/A <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.	
	N/A <i>(this box should expand as you type)</i>	
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.	
	N/A <i>(this box should expand as you type)</i>	

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
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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, cultural 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	(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:	☐	☒
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 will be stored in accordance with Dstl policy, only relevant information will be written up on the final report no other information will be able to be accessed from the university. The university report will be written on a personal laptop and will submitted via the university Turnitin portal. (this box should expand as you type)		

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):		
	The university will only have access to the relevant data, which will be attached to the final report, the remainder will remain under Dstl jurisdiction <i>(this box should expand as you type)</i>		
20	List all who will have access to the data generated by the research activity:		
	Myself (Principal Researcher) Dstl <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:		
	Myself (Principal Researcher) Dstl <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 stored in accordance with Dstl policy <i>(this box should expand as you type)</i>		
22	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtسد.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	☒	

ANNEX B – Gantt Chart

