

Data Capture Task 2

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Data Capture & Evaluation

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Critique

Introduction

This critique will highlight what Data capturing equipment was used on the small arena trial and how these were set-up and implemented to the trial. A description of each piece of kit used will be described in detail of what they are designed to do and how they worked for this trial. The strengths and weaknesses of each piece of kit will be highlighted showing why they were a good option as well as why other options may have been better. These possible alternatives will then be listed and the reasons why they would/could have been better will be described. The post-trial evaluation process will be written and flaws with the process as well as alternative ways to evaluate the data will also be shown. Some recommendations for future trials and what the group could have done differently to make the process easier with more accurate results will also be communicated. A conclusion will then be written about the arena trial listing the positives and negatives of the whole process from start to finish.

Types of Data Capture Equipment Used

Before conducting the trial, the team knew which Data Capture equipment would be used on the trial. This information was given to the team the day prior to the visit to COTEC from a member of the COTEC team who happened to be an ex-student from the same university course. The team was told that from the arena trial, fragmentation needed to be collected for analysis and evaluation post trial to help identify which munition was used. They were also told that velocities and pressures needed to be measured both again to help aid in the decision making process of which munition was used.

On the day of the trial the team began by setting up and installing straw packs to already existing metal frames that were set up by the COTEC team. These straw packs were used to collect the pieces of fragmentation from the OME event in order for the team to evaluate the piece's post trial in the lab. In order to calculate the velocity of the fragmentation the team had to attach velocity foils onto each straw pack. The velocity foils would then be able to calculate the velocities of the fragmentation as they pass through into the straw packs. In order to calculate the blast, the team installed blast gauges, in this case there were three. These were set up along the line of detonation perpendicular to the straw packs/velocity foils, allowing the blast to evenly pass through each gauge to get the truest readings possible. The gauges were positioned 1m, 2m and 3m away from where the munition was going to be placed.

Strengths and Weaknesses

Straw packs are a great way of preventing the fragmentation from escaping the test area. Especially when set up in the way the group was told to set them up, in a semi-circle formation allowing them to collect fragmentation from all possible angles. A positive with using straw packs is that they are easy to deploy and set up, meaning having them as part of the trial is a great way of saving time in preparation for the event. However, they can be quite expensive especially if they are part of a large arena trial in which hundreds of packs can be used. In this case only four straw packs were used, meaning the cost was low and they were easy to deploy. With the shrapnel pieces being so small, removing the fragmentation from the straw packs was time consuming although with being so small a large sample of evidence was captured.

Velocity foils are a great way to measure fragmentation velocities from detonation. They work when a fragment from the detonation strikes the foil causing them to rip and rupture, the size and pattern of this deformation are related to the velocity of the impact. By measuring these deformation sizes, it is possible to calculate the speed at which the fragmentation was traveling when it struck the foil. Using them provides a non-invasive method of calculating the velocities, as well as this they are very accurate and the data from them is very precise. Compared to other alternative methods of doing the same job they are relatively cost effective as well as being easy to deploy and attach to straw packs.

Although velocity foils have many positives they also have many negatives, some of these are. They are not as accurate at calculating velocities at higher speeds as the higher velocities of the fragmentation may cause the rupture of the foil to be too catastrophic in order to measure and get an accurate reading. Another downside to velocity foils is the fact that they are just a single impact measurement meaning that typically each foil only measures one impact point meaning the collection of data from multiple pieces of fragmentation may mean more layers of velocity foil. In this case it was a small arena trial meaning that the size of the rupture caused by the fragmentation wasn't significant enough to cause any severe damage to the velocity foils, therefore meaning the results were accurate and the velocities could be easily measured.

Using blast gauges in arena trials means very accurate data collection. As well as being extremely accurate blast gauges can be used in lots of different configurations. They can be placed/positioned at any distance or angle in the arena to calculate the pressures at various locations in order to gain a better understanding of the impact of the blast caused from the detonation of the munition within the arena. Although the pressure gauges can be placed almost anywhere within the arena it is vital that they are orientated in the correct way to enable them to obtain accurate results from areas where pressure wave reflection occurs. In this case the pressure gauges were placed perpendicular to the arena and were set up in a straight line around 1m between each pressure gauge.

Alternative Methods

There are lots of alternative methods to use for each data capture process the team used. There are many options for capturing and collecting pieces of fragmentation, as well as many ways of tracking pieces of fragmentation to measure velocities. Finally, there are lots of ways to measure the pressures for an arena trial.

Whilst straw packs are a common way of collecting fragments from the detonation of munitions, there are lots of alternative methods that can be used but this depends on what the aim of the trial, the fragmentation being evaluated post trial as well as the availability of resources, ultimately the budget. Some of the alternative methods of collecting pieces of fragmentation from arena trials are:

Sand/ Gravel Pits:

The molecular makeup of the sand/gravel will help to stop the fragmentation in flight. Once collected the sand can be sieved revealing all of the fragmentation.

Some advantages of this method are that sand/gravel is much more durable than straw packs and are better at absorbing the impact of the fragmentation, which is handy when dealing with large high velocity frags. The process of collecting the fragmentation from the sand/gravel is much less time consuming than using straw boards. Using straw boards can take days to be able to remove and identify all of the frags, especially on larger arena trials however, sand/gravel can easily and quickly be sieved and sorted.

A downside to using sand/gravel is if there is too much sand/gravel, the fragmentation might become embedded too far into the sand meaning it would have to go through a full filtration process in order to retrieve certain pieces.

Foam Pads:

A lot like straw packs, foam pads can be used in the same way to collect fragmentation. These special high density foam pads are made for absorb and slow down the fragments and to prevent them ricocheting and having the chance to lose them.

Some advantages of using Foam Pads is that they are lightweight meaning they can be easily deployed, they are also reusable and can be custom cut and made to fit certain areas within the arena. A downside of the Foam Pads is that they can degrade overtime with multiple use as well as this the collection process of removing the frag from the foam requires careful handling.

Blowers or Vacuum Systems:

A big alternative to straw packs that are a complete different route of fragmentation collection are blowers and vacuum systems. These fine blowers and vacuums contain a fine mesh filter can be used to collect lightweight fragments by sucking up all the debris and the filter traps the fragments.

A big advantage to this method is that it ensures that all the fragments are collected even the smallest ones. It can be automated to certain settings allowing it to be used for the users' needs to match the requirements of the trial.

This method can be very expensive and are rarely used, the process of cleaning the filters is also very time consuming.

Other than velocity foils, there are a number of techniques that can be employed in arena trials when the goal is to measure the fragmentation velocities of projectiles or materials (for example, in ballistic or military applications). Every technique has benefits of its own and might work better with particular projectile kinds or trial configurations. Below are alternative ways for determining fragmentation velocities:

High Speed Cameras (Photographic or Video):

The idea is to utilise high-speed cameras to record fast-paced events in brief bursts. When fragments are discharged during fragmentation, these cameras capture their motion.

How it works: By detecting the displacement between frames, multiple frames per second (fps) enable the calculation of the velocity of individual pieces.

Advantages:

- High resolution for tracking the motion of fragments.
- Can capture detailed trajectories and velocities of fragments from multiple angles if multiple cameras are used.
- Can also provide insights into the fragmentation process and patterns.

Limitations:

- Requires high-speed cameras and precise calibration.
- Post-processing time is necessary to analyse the footage.

Radar and LIDAR Systems

Principle: During and after the fragmentation event, fragment motion can be monitored using radar or LIDAR (Light Detection and Ranging).

Here's how it functions: These systems produce waves (either radio or light) that bounce off objects in motion, enabling the calculation of speed by assessing the Doppler shift or the duration it takes for the waves to return.

Advantages:

- It is non-invasive and capable of measuring speeds over extended distances.
- It can simultaneously monitor multiple fragments.

Limitations:

- It is more intricate and costly compared to some alternative methods.
- It necessitates a clear line of sight and may not be effective in environments with obstacles or specific materials.

Infrared or Thermal Imaging

Infrared cameras or thermal imaging technology can monitor the heat signatures of fragments in motion. This is especially beneficial when the fragments become heated as a result of impact force or air friction.

How it functions: Infrared cameras monitor the movement of heated particles, allowing for the calculation of their velocity based on their changing position over time.

Benefits:

- Non-invasive and offers a distinct view of motion.
- Operates effectively in dim lighting or complete darkness.

Drawbacks:

- Only useful for pieces that emit a considerable heat signature.
- Resolution and precision are restricted for tiny fragments.

In small arena trials, where the goal is to measure pressures generated during events such as explosions, impacts, or fragmentation, there are several alternatives to using traditional pressure gauges. These alternatives can provide accurate and detailed pressure data and may be more suited for specific experimental conditions, fragment sizes, or trial setups. Here are some common alternatives to pressure gauges for pressure measurement:

Strain Gauges:

How they work: Strain gauges measure the deformation/strain of a surface under pressure. This strain is proportional to the pressure applied.

The strain gauge is affixed to a surface that bends when pressure is applied. The strain is monitored electronically through variations in resistance, allowing for the estimation of pressure.

Advantages:

- Effective for indirectly measuring pressure by monitoring the changes in a surface or material.
- Can offer high sensitivity and precision.

Limitations:

- The sensor must be affixed to a structure that alters shape in response to pressure.

- Not suitable for dynamic or quickly fluctuating pressures unless used alongside other sensors.

Accelerometers:

Principle: Accelerometers detect the acceleration that an object experiences when subjected to pressure. These instruments can indirectly assess pressure by capturing the forces impacting a surface.

How it works: When pressure is exerted on an object or surface, it causes movement or acceleration that the accelerometer senses. By examining the acceleration information, pressure can be deduced (alongside the properties of the material).

Advantages:

- Valuable for assessing forces in motion and comprehending dynamic pressure situations.
- Applicable in scenarios involving high-speed or quickly fluctuating pressure changes.

Limitations:

- Gives an indirect measurement of pressure and necessitates precise calibration.
- May not perform effectively in low-pressure or static environments.

Ballistic or Shock Tube Sensors:

Principle: During high-impact or explosive experiments, devices such as shock tubes can be utilized to observe the shockwave produced by the event. These shockwaves are usually linked to quick alterations in pressure.

How it works: Shock tubes or comparable systems create a regulated shockwave, and sensors positioned along the tube or throughout the area can gauge pressure based on the characteristics of the wave.

Advantages:

- Capable of accurately measuring extremely high pressure events, such as explosions or shockwaves.
- Suitable for conducting trials on a larger scale.

Limitations:

- It may be difficult to assess localized pressures using this method.

The method selected for pressure measurement in small arena trials is influenced by the particular conditions of the experiment, which include the type of pressure (either dynamic or static), the testing environment, the dimensions of the object being evaluated, and the required accuracy level. Common alternatives such as piezoelectric sensors, fiber optic sensors, and strain gauges are

favoured for their precision, rapid response, and capability to manage dynamic pressure situations. Nevertheless, more specialized techniques like acoustic sensors or capacitive sensors may be better suited for certain cases, depending on the goals of the trial.

Alternative Methods of Evaluation

In small arena trials, especially those involving blasts, impacts, or the fragmentation of projectiles, measurements of pressure and velocity are essential for comprehending the dynamics of the occurrences. Aside from conventional numerical approaches or direct analysis, various alternative assessment techniques can assist in deriving more nuanced insights from the data. These methods typically seek to enhance precision, interpret intricate data, and offer a more profound understanding of physical phenomena. Below are alternative strategies for analysing the outcomes from pressure measurements and velocity readings in such experiments:

Time Frequency Analysis:

Principle: Time-frequency analysis, particularly through the Wavelet Transform, is effective for examining pressure and velocity data that are non-stationary or exhibit rapid changes over time.

How It Works: The Wavelet Transform enables the breakdown of pressure and velocity signals into various frequency components as time progresses. This technique can effectively capture transient events (such as shockwaves or abrupt impacts) that fluctuate in both time and frequency, offering valuable insights into the changes in pressure and velocity during these occurrences.

Advantages:

- Works well for managing data with unpredictable and temporary patterns.
- Can uncover both high-frequency and low-frequency elements of the signal that traditional Fourier analysis might overlook.
- Assists in comprehending the traits of short-lived, high-energy occurrences such as explosions or fragmentation.

Limitations:

- Needs specialized software for conducting the analysis (e.g., MATLAB or Python with wavelet libraries).
- Might complicate interpretation, especially if several wavelets overlap.

Impulse Momentum Analysis:

Principle: The impulse-momentum approach enables the evaluation of the relationships between force and velocity through the work-energy principle, assisting in the calculation of energy exchanged during an event.

How It Works: Impulse represents the accumulation of force over a period of time and is connected to changes in momentum. During an arena trial, the pressure applied during an impact or explosion can be integrated throughout the duration of the event to determine the total impulse. Subsequently, by applying the object's momentum (mass $\times$ velocity), one can compute the energy transfer and estimate the dynamic forces at play.

Advantages:

- Offers a clear understanding of interactions based on energy.
- Assists in determining the force acting on an object, which is beneficial for analysing the impact of pressure on materials or projectiles.

Disadvantages:

- Needs precise information on mass and velocity.
- Presumes ideal circumstances and might not consider specific material effects or energy dissipation (such as friction and heat).

Assessing pressure and velocity data in small arena experiments involves more than merely gathering raw information. Employing alternative techniques such as time-frequency analysis, impulse-momentum evaluation, energy distribution, computational simulations, clustering, and correlation methods enables researchers to gain a more profound comprehension of the dynamics at play. The selection of an evaluation technique is contingent upon the nature of the experiment, the intricacy of the data, and the particular objectives of the research. The integration of various methods typically provides the most extensive insights into the behaviour of materials or systems subjected to pressure.

Recommendations for Future Trials

In future arena trials, expanding beyond conventional instruments such as straw boards, velocity foils, and pressure gauges presents chances for more precise, comprehensive, and varied data collection. Innovations in sensor technology, computational methods, and experimental configurations can offer deeper insights into intricate processes like fragmentation, impacts, explosive occurrences, and material responses in extreme conditions.

Rather than using straw packs, the idea of using sand and gravel pits may work as well. This method has many advantages which were stated above. These advantages make it an ideal method to capture the fragmentation from small arena trials.

Another way of measuring the velocities for small arena trials that stands out as a great method that could be easily implemented would be using RADAR and LIDAR Systems. Although quite expensive

they can be used more than once which is a downside of velocity foils. Overtime these will be a good introduction to the arena trials. They are also very accurate and will give you results in any data form the user requests.

Although there are many ways of measuring pressures for small arena trials. The method used by the group in the trial stands out to be the best method. They come with lots of different advantages. Not only are they very accurate but they can be used in lots of different configurations depending on the nature of the arena trial.

References

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Data Capture Task 2

GRADEMARK REPORT

FINAL GRADE

42/100

GENERAL COMMENTS

Hi Finn,

This was a better submission than part 1, which laid out the strengths and weakness of each element of the trial at COTEC. It is still not a Level 6 submission I'm afraid and you need to really examine what is written on the assignment specification. Your submission provides generic descriptions and lists, not analysis of the most appropriate alternatives or enhancements.

The English used is non-technical in description and used words such as 'kit', 'lots of', 'here's how'. There are also missing words and poor sentence construction suggesting that it was rushed and not peer reviewed. Therefore, this is a marginal pass I'm afraid. Detailed comments below and marks against rubric provided.

In detail:

1. Your contents do not match the submission headings. For example, there is no conclusion.

2. You have not conducted extensive research outwith that which was provided on the module. This is evident from the same references (4 in total) being used as Task 1. And, these are all internet references, not textual documents of academic publications.

3. Why did you not split out the submission into a strengths and then a weaknesses sub-headings under the overarching heading of Types of Data Capture Equipment Used? This would have optimised your layout and allowed the reader to discern what are the

key aspects you want to portray. Given that your referencing is at a minimum, how do I know strawpacks are a great way of collection. Same for velocity foils.

4. How would you have employed the alternatives suggested to enhance the trial results? For example, sand/gravel pits. Would you have placed this below the munition to replace the strawboard used?

5. You mention the advantages and disadvantages of blowers/vacuums/foampads etc, but how do I know from your statements that they are better/worse than what is being used currently? There are no academic references to support your statements.

6. Agree, HS-Camera would be useful in this context, and easily usable along with flash x-ray, but how could you use radar/LIDAR for a trial on an RGD-5?

7. For infra-red or thermal imaging, would the heat of explosion and fireball, which extends out to about 1.5 m for an RGD-5 not obfuscate the use of infrared or thermal imaging in the near field? The fragments would be hotter from the heat of explosion as opposed to drag and impact.

8. Your pressure improvement suggestions were more realistic for the exercise, but again they were lists with no additional rigour applied to explanation or referencing.

9. For evaluation, I agree that improved statistical analysis would have refined the data obtained, but how would you have used them in this specific instance. Again it is just a list of 'how it works', advantages and disadvantages with no broader context.

10. Your recommendations are workable for the most-part, but why not simply consider increasing the number of firings with existing items, adopting ricochet traps, refining the strawboard, velocity and pressure sensors, and using some of the analysis techniques you described.

11. Nothing offered for improvements to FTIR.

Overall you have demonstrated:

1. Engagement with a limited range of non-credible sources. Some omissions and minor errors. Referencing conventions not always applied accurately or consistently. 3/10

2. Limited knowledge and understanding of the relevant concepts and principles within the subject area. 10/20

3. Limited attempt at critical thinking, analysis, synthesis and evaluation, tending towards description. Some evidence to support emerging arguments and judgements but these may be underdeveloped or with a little inconsistency / mis-interpretation. Asserts rather than argues a case. Over-reliance on lists with no academic underpinning. 10/30

4. An adequate awareness and mostly appropriate application of well-established methods, materials, tools and/or techniques. 14/30

5. Can communicate in a suitable medium but with some room for improvement. 5/10

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