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Thematic Synthesis of Post Activity Reviews: Lessons Relating to Management of the Simulation Environment Supporting Activity Vital Fire in May 2014

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ABSTRACT

Activity Vital Fire ran from 19 May 2014 to 30 May 2014. The Land Vehicle Simulation Environment (LVSE) was constructed to enable five Human Sciences experiments to be carried out on a single cohort of 14 military personnel. While the activity was broadly successful, and large amounts of quality data were generated, stability issues affected the schedule during the first week and significant effort was required to meet the requirements of the researchers. In order to extract lessons learned from formal and informal Post Activity Reviews (PARs) we applied a hybrid Thematic Synthesis methodology. The process identified four common themes in the data; Communication, Project Management, Experimental Design, and Testing. Within these themes we extract key observations and recommendations.

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Executive Summary

Activity Vital Fire ran from 19 May 2014 to 30 May 2014. The Land Vehicle Simulation Environment (LVSE) was constructed to enable five Human Sciences experiments to be carried out on a single cohort of 14 military personnel. While the activity was broadly successful, and large amounts of quality data were generated, stability issues affected the schedule during the first week and significant effort was required to meet the requirements of the researchers. In order to extract lessons learned from formal and informal Post Activity Reviews (PARs) we applied a hybrid Thematic Synthesis methodology.

Each review was decomposed into a list of observations. These were sorted into an initial list of thematic groups. To ensure completeness, new groups were created to fit observations outside the initial set. This larger set was reviewed to combine strongly related themes, and then the final list was tested for balance by comparing the number of observations in each group.

The process identified four common themes in the data; Communication, Project Management, Experimental Design, and Testing. Within these themes we extracted key observations and the following recommendations:

1. Clearly identify roles and responsibilities.
2. Disseminate meeting minutes and key decisions.
3. The Research Activity Information Development (RAID) document should be reviewed post-activity to ensure relevance.
4. The RAID should be used as a living document to record a history of key decisions.
5. Identify and adopt management best-practice.
6. Experiments should either be designed to use the existing and tested simulation capability or submit requirements to be integrated into the development program.
7. All experimental protocols should be piloted to confirm:
   - Equipment functionality and reliability,
   - Data collection and validation, and
   - Contingency planning.
8. To assist systematic post-activity review, the PAR should be formatted to address the identified theme headings.

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Acronyms and Abbreviations

BMS	Battle Management System
LVSE	Land Vehicle Simulation Environment
PAR	Post Activity Review
RAID	Research Activity Information Development

1. Introduction

Activity Vital Fire ran from 19 May 2014 to 30 May 2014. The Land Vehicle Simulation Environment (LVSE) was constructed to enable five Human Sciences experiments to be carried out on a single cohort of 14 military personnel. While the activity was broadly successful, and large amounts of quality data were generated, stability issues affected the schedule during the first week and significant effort was required to meet the requirements of the researchers. In order to improve the capability it is important to reflect on the conduct of the activity and to document the lessons learned.

2. Experimental Requirements

The LVSE was configured to provide 16 motion-actuated seats to simulate eight vehicles, each with a driver and a co-driver. Audio and video were recorded at each station, and the systems were to be networked. The technical team was responsible for managing the construction of the capability, and configuring the computer infrastructure to support the operation of the experiment. The research team was responsible for developing the experimental design, and through negotiation for developing a set of requirements.

However, the research team did not formalise their requirements until the introduction of the Research Activity Information Development (RAID) document. This also required the research team to identify research leads for each experiment. The final implementation of the environment needed to meet the specified requirements of each of the five concurrent studies, described below.

2.1 Cognitive and metacognitive performance

This study called for the administering of a battery of cognitive tests to be presented over the internet on tablet PCs. The tablets were required at designated times around the clock. Data collection was managed off-site.

2.2 Impact of sleep loss, task demand and task demand transition on driver, co-driver and crew performance

The support requirements of LVSE were to:
> Set up and configure the laboratory hardware and equipment in such a manner as to:
>> o Provide two-person 'vehicle crew' stations with driver and co-driver positions
>> o Allow customisability in configuration, to provide flexibility in the allocation of participants/crews to different experimental conditions
> - Integrate the driving scenario used in a previous Caffeine study with the existing experimental framework to provide an acceptable simulation environment for the driver

- Provide equipment allowing for an acceptable emulation of a Battle Management System (BMS) task for the co-driver
- Enable capture of data relating to all required measures of participant performance and state (e.g. input devices, audio recording, Optalert)
- Store and manage experimental data collection from the simulation environment
- Process and provide experimental data in a format appropriate for analysis by the research team

2.3 Sleep restriction and driver performance

- Time stamped audio from the microphones to record sleepiness ratings at 5-minute intervals.
- Driving performance data (speed, lane deviations, and crashes) across the five drives.
- Collect data from sleepiness monitoring devices.

2.4 Sleep restriction and co-driver performance[1]

- Load the BMS software and associated csv. session files onto a set of tablets
- Enable eight co-driver headsets to record audio
- Enable eight co-driver headsets to receive live audio instructions
- Set up eight driver/co-driver vehicle simulation bays
- Load BMS files and audio files onto shared drive

2.5 Convoy team study

The experiment was to simulate a 4-vehicle M113AS4 armoured platoon across a minimum of seven, 2-hour scenarios in an immersive simulation environment on the fictitious island of Sahrani. Each vehicle was to contain a driver and a commander/gunner. The command vehicle for each platoon was also to contain a platoon commander, giving a total of nine experiment-subjects in the platoon. The experiment was to be duplicated across two platoons for a total of 18 subjects. The two platoons were to operate in isolated VBS2 "worlds", so there would be no interaction. Although the platoons were to complete the same scenarios at the same time, they would be in separate parallel simulations
The convoy team study also supplied a further 91 documented requirements in a Functional Performance Specification document. This highlights the variance in expectations and the level of detail specified.

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[1] The co-driver is the non-driving crew-member in a two person crew. In this case their task was to complete BMS interaction instructions provided on a tablet PC.

3. Method for extracting themes

3.1 Data Collection

The RAID document formalised the description of each study and assisted the technical team and the researchers in confirming the requirements of each study upon the environment. Following the activity all research leads were requested to complete a Post Activity Review (PAR). The PAR elicited discrepancies between the support requested and delivered, feedback on the support process and on the execution of the experiment during the activity. This provided the primary source of data for lessons learned. The limitations inherent in this data source are the variability of the detail of the responses and the unstated assumptions and context.

The technical team also supplied a report of the issues they encountered, areas they felt needed improvement and the errors they observed during the conduct. These reports provided deep insight, but were informally structured. The author also includes insight from personal experience, understanding of best practice and unstructured interviews with stakeholders and members of both teams.

The data provide a tapestry of sometimes contradictory insights, due in part to context and exposure to different parts of the project development. The data also were captured after the fact and mostly discussed the issues and failings perceived of the completed Simulation Environment without taking into account that the environment and the team developing it were assembled very late in the project plan.

Figure 1 –A simulated land vehicle during the C2 on the Move component of the activity

3.2 Data Analysis

Simply collating the assessments can provide benefit to other practitioners, but only if they spend the time and effort to assess which insights, observations and suggestions to act on given the variance of context and conflicting opinions. A systematic approach is needed to provide a synthesis of the assessments, allowing the lessons to be translated to other contexts. Thomas & Harden (2008) describe a method to integrate the findings of multiple qualitative assessments called Thematic Synthesis. It involves codifying each assessment

line by line, then constructing a tree of analytical themes. However, the method relies heavily on a single software tool and a single source of structured data.

Ryan & Bernard (2003) describe the following 12 scrutiny techniques to apply to empirical data in order to extract themes.

Table 1 - Scrutiny Techniques

1. Repetitions	7. Missing Data
2. Indigenous Typologies	8. Theory-Related Material
3. Metaphors	9. Cutting & Sorting
4. Transitions	10. Word Lists & Key Word Lists in Context
5. Similarities & Differences	11. Word Co-occurrence
6. Linguistic Connectors	12. Metacoding

Ryan & Bernard (2003) also developed a method to identify which techniques to apply using the following flow-chart.
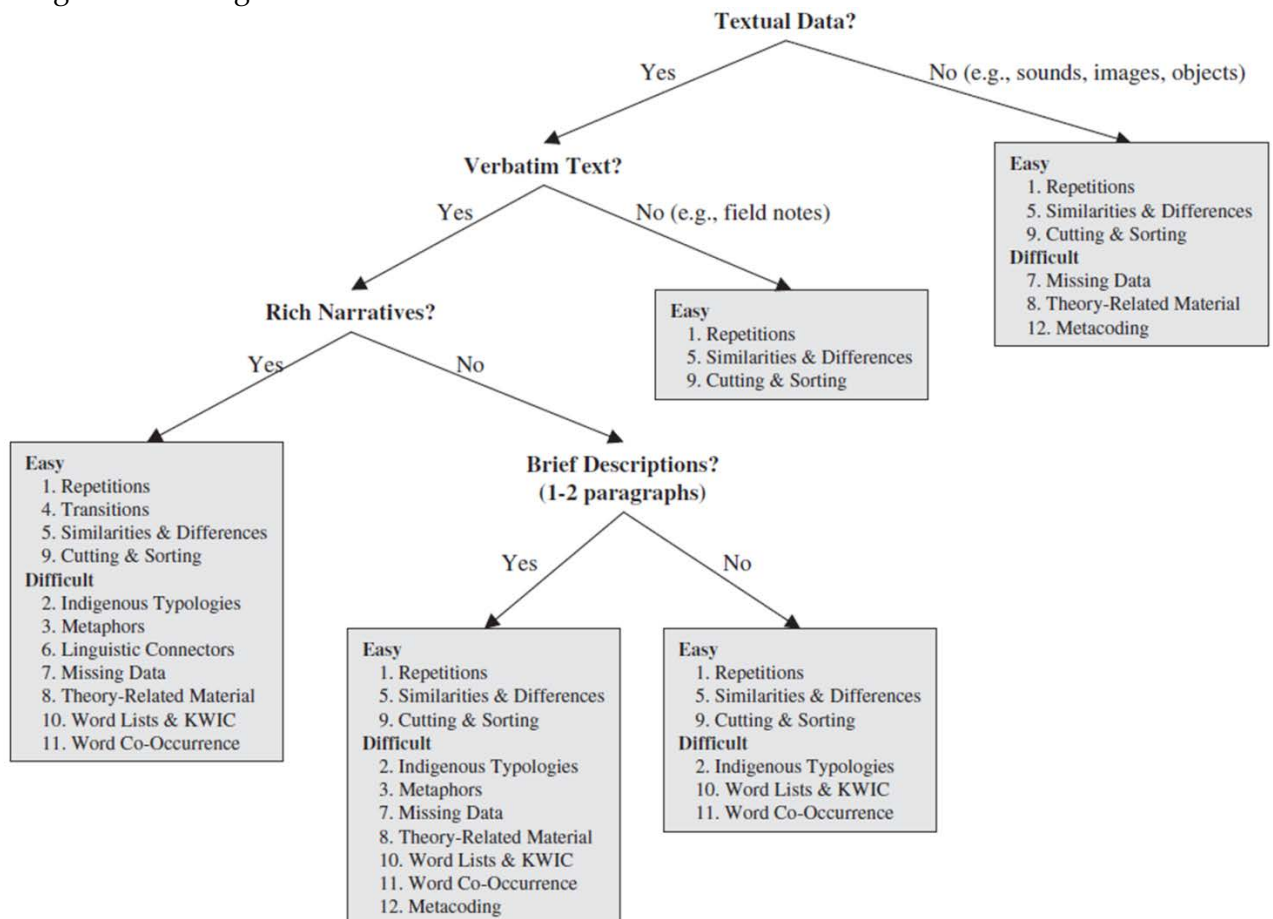

Figure 2 –Selecting among Theme-identification Techniques

In this paper we have taken a hybrid approach. The procedure is taken from Thematic Synthesis, and the scrutiny techniques identified by the above flow chart were applied to generate and validate the themes.

Most of the data under analysis was formatted as dot-points; which are textual, but not verbatim text. Using the flow-chart we identify three techniques to apply: repetitions, similarities & differences, and cutting & sorting.

Repetition is performed by searching for "topics that occur and reoccur". There is no defined threshold of repetition, only subjective assessment.

Similarities and differences are also called the "constant comparison method" and include making systematic comparisons across units of data. These units can be line, by line, random pairs of expression or whole texts.

Cutting and sorting traditionally involved writing quotes on index cards and sorting these into piles. In this case we relied on software rather than a sorting table.

1. Extracting data from studies.

    Each report was broken down into lists. Most reports presented these as a list of dot points, but continuous text was initially broken into paragraphs or sentences depending on a subjective assessment of intent. The lists were then separated into observations through subjective assessment. Some of these observations were reworded to retain context.

2. Coding text and developing descriptive themes.

    Starting with an a priori set of themes the list of observations for each report were assessed to determine if an observation and its root cause could be attributed somewhere within the set. If not, a new theme was added. Report codifications were compared to see if common themes were identified with contradictory observations or if any theme was found to be trivial.

3. Context and rigour.

    Once complete the set of themes was reviewed. Ideally the final set would include the key areas of observation (completeness), not allow for multiple codifications (orthogonality) and contain a similar number of observations (balance). The lists of themes provide areas for discussion, and ensure that dissenting observations are highlighted.

4. Results

Using an a priori list of themes[2] the 154 observations were coded using the method described. At the end of the first pass the themes had expanded in number to include:

- Communication,
- Project Planning,
- Experimental Design,
- Documentation,
- Skills,
- Capability Confirmation,

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[2] Communication, Project Planning, Experimental Design, Data Validation, & Technical Faults.

- Procedural Practice,
- Flexibility,
- Data Validation,
- Contingency Planning, and
- Technical Faults.

These themes satisfied the criteria of completeness in that all observations were coded, but were neither orthogonal, nor balanced. Several observations relating to **Project Planning** for instance, also related to communication and management of skills. In this case **Project Planning** was renamed **Project Management** and observations falling outside its reduced scope where reassessed and coded again.

Finally the themes were assessed for balance. While the number of observations relating to a theme does not necessarily correlate to its importance, it does indicate a greater proportion of the discourse. Several of the themes with smaller numbers of observations could be considered repetitions of one of the main points of another theme. For instance **Skills** and **Documentation** each had less than nine observations, but both themes could be considered repetition of a major point under the **Project Management** theme.

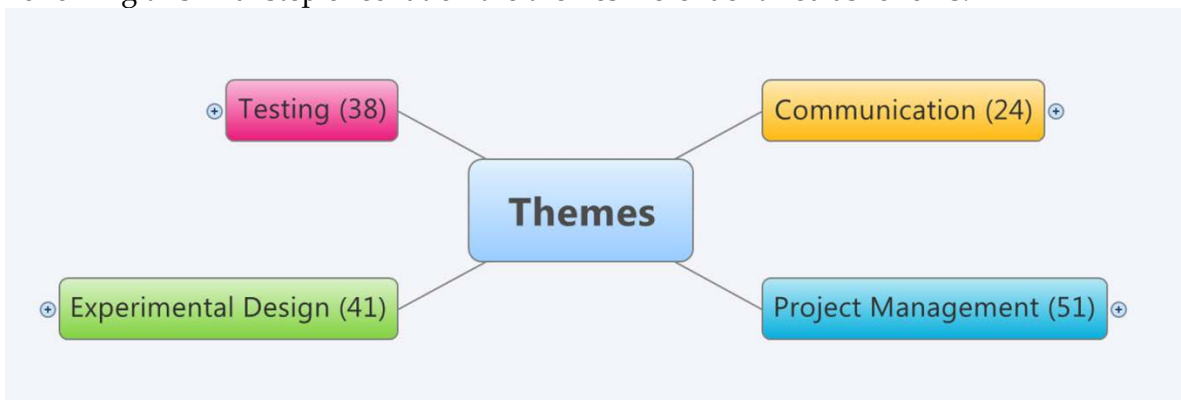Following this final step of collation the themes were identified as follows:

Figure 3 –Identified Themes (number of observations in brackets)

4.1 Communication

Communication problems were identified between most stakeholders.
- Lines of communication were poorly defined,
- Requirements were delivered late and with insufficient detail,
- Requirements were delivered with no room for flexibility,
- Flexibility was specified as a requirement in its own right,
- The technical team failed to communicate their progress,
- Assumptions of the simplicity of implementation were insufficiently challenged.

There were also positive assessments;
- Intent was well understood and supported,
- The RAID was highly effective in precipitating clear roles.

4.2 Project Management

Many of the failures in communication were linked to the lack of well-defined management structure and an entirely ad-hoc management process. Staff management and decision making occurred without formal record or communication again, until late in the project.

- Lack of coordination,
- Additional work being taken on without consideration of impact.

Skills were identified as an area of concern.

- Single points of failure led to the overwork of technical team members,
- Lack of project management skills within the technical team initially,
- Team members taking on tasks outside scope and expertise.

A history of poor documentation led to repetition of previous work.

- RAID introduced too late in the process,
- No documentation of key decisions affecting design,

Furthermore, failure to manage interacting timelines impacted confidence between teams and hindered the finalisation of experimental design.

4.3 Experimental Design

Experimental design suffered significantly from poorly defined lines of communication. Disagreement on responsibilities delayed the development of requirements, and poor communication led to the formation of incorrect assumptions.
The tight timelines also removed much of the opportunity for experiment rehearsal.

- Researchers didn't fully appreciate their own requirements until after they had piloted their protocols,
- Lack of practice left researchers with low confidence in the running of their experiments,
- Procedural errors led to data loss.

This theme highlights the interaction between all themes, poor project management hinders communication leading to compressed timelines, hindering successful experimental design and reducing opportunities for sufficient testing.

4.4 Testing

Technical faults significantly upset timelines, and their unpredictable nature left the technical team exasperated. Of key concern was the failure to fully test the capability in advance as some faults did not present until the full system was under stress.

- Audio devices failed when removing specific keyboards,

- User error, particularly with muting the headset, presented the same perceived fault,
- Tablets exhibited "ghost touches" rendering data unusable,
- There were no contingency plans for most studies.

Finally some of the issues experienced impacted data collection and were not uncovered until the completion of the study.
- Sleepiness assessment data could not be processed by the provided software calling into question all of that study's results,
- Data collection software crashed silently leaving gaps in the data.

5. Recommendations

5.1 Communication

Good communication is essential for any project and it is essential that project management supports it.
1. Clearly identify roles and responsibilities.
2. Disseminate meeting minutes and key decisions.

5.2 Project management

The RAID document was overwhelmingly supported for its ability to formalise requirements.
3. The RAID should be reviewed post-activity to ensure relevance.
4. The RAID should be used as a living document to record a history of key decisions.

The management of staff was also a concern. As on-going development is required to provide flexibility to experimental design this development should be conducted in a formal manner, rather than ad-hoc.
5. Identify and adopt management best-practice.

5.3 Experimental Design

6. Experiments should either be designed to use the existing and tested simulation capability or submit requirements to be integrated into the development program.

5.4 Testing

Researchers need to proceed with confidence in the systems that support them and with enough practice to be confident in their own procedures.
7. All experimental protocols should be piloted to confirm:
    - Equipment functionality and reliability,
    - Data collection and validation, and

o Contingency planning.

Finally,

8. To assist systematic post-activity review, the PAR should be formatted to address the identified theme headings.

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References

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. *Field methods , 15*(1), 85-109.

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC medical research methodology, 8*(1), 45.

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