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Collaborative Sense-making during simulated Intelligence Analysis Exercises

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Abstract

Sense-making plays an important role in Intelligence Analysis, but can be difficult to study in situ. Thus, it is useful to exploit training exercises to study this phenomenon. In this paper two versions of the same exercise are reported: one undertaken by participants at a conference and one undertaken by Military Intelligence personnel. The behaviour of groups of analysts (experienced versus inexperienced) is considered in terms the Data / Frame model of Sense-making. The paper illustrates how Intelligence Analysis often involves parallel and overlapping explorations of data, with multiple frames that might be minimal and sketchy. The use of representations, such as link diagrams, provides a means of externalizing frames and it is suggested that these can shift the style of reasoning exhibited by the teams as the exercise progresses. Such a shift was seen more clearly in the behaviour of the Military Intelligence Officers who also spent more time developing and refining the diagrams to support the presentation of their findings.

Keywords: Sense-making; Intelligence Analysis; Representations

1 INTRODUCTION

A perennial challenge for Intelligence Analysis, whether it is performed in business or military settings, lies in the need to draw useful conclusions from disparate data. Data can vary in their accuracy, their timeliness, or the reliability and validity of their sources, and often the source material is incomplete, inconclusive or ambiguous (Tecucci et al., 2010). While it is unlikely that there is a single, definitive way of 'doing' Intelligence Analysis (with each Intelligence Analyst adopting an approach from a broad range that is deemed appropriate to the task at hand), there are generic descriptions of how Intelligence Analysis could be performed. While there are different versions of the Intelligence (or Analysis) Cycle, NATO (2008) describes it in terms of four phases:

- Direction (i.e. definition of objectives for gathering intelligence through Intelligence Requirements and Requests for Information);

- Collection (i.e., gathering and receipt of information by agents in response to the Intelligence Requirements or through more spontaneous and serendipitous routes);

- Processing (i.e., compiling and interpreting information to produce intelligence);

- Dissemination (i.e., distribution of appropriate parts of the intelligence to relevant parties).

Although this sequence of phases implies a linear flow from collection to dissemination, the use of the term 'cycle' emphasizes the recursive nature of the analysis process in which information is sought, combined and reflected upon in order to create 'sense' as the basis for subsequent action. Heuer (1999) distinguishes between 'data driven analysis' (i.e., applying well understand analytic procedures to well defined data sets) and 'conceptually

driven analysis' (i.e., dealing with complex, ambiguous and uncertain data). Conceptually-driven analysis implies a cycle of activity that involves *"the reciprocal interaction of information seeking, meaning ascription and action"* [Thomas, Clark and Gioia, 1993, p. 240].

Elm et al. (2005) define this activity in terms of 'down-collect' (sample from the available data for material deemed to be 'on analysis'), 'conflict and corroboration' (ensure accurate and robust interpretation of findings, and modify the 'down-collect' accordingly), and 'hypothesis exploration' (construct coherent narrative to explain the findings, and reflect this narrative back to the 'conflict and corroboration' activity). Similarly, Kang and Stasko (2011), in a study of a 'strategic intelligence' project over 10 weeks, identified four main activities: Construct conceptual model of issues, Collect information, Analysis, and Report key findings (noting that these activities overlapped and intertwined as the project developed).

Given the nature of intelligence analysis, it is difficult to study this activity in vivo. Thus, research into this activity either involves interviews and discussions with Subject Matter Experts (Cook and Smallman, 2008; Pirolli and Card, 2005), or studies in which teams perform exercises (Kang and Stasko, 2011; Kang et al., 2009; Stasko et al., 2008). In this paper, we have opted for the latter approach, although this has been tempered by discussions with Subject Matter Experts where possible. Before explaining the Exercise that was used for this study, the next section presents the concept of sense-making explored in this paper.

1.2 Sense-making

As Wu et al. (2013) point out, sense-making is essential to all forms of knowledge work and *"occurs when people face new problem or unfamiliar situations and their knowledge is insufficient for the task. Sense-making finds critical patterns in a seemingly unstructured situation..."* [p.6]. Sense-making happens when you experience a 'gap', or contradiction, in your understanding of the context in which you are currently acting; it is a means by which uncertainty or discomfort can be dealt with through the recruitment of prior experiences or new information (Dervin, 2003). For Fishbein and Treverton (2007), sense-making *"...involves the application of expertise, imagination and conversation – and the benefit of intuition – within intelligence analytic organizations to identify changes in existing patterns of the emergence of new patterns, without systematic, consideration of alternative hypotheses"* (p.16) . The suggestion that sense-making need not involve 'systematic, consideration of alternative hypotheses' in this quotation might strike one as a little odd (because making sense inevitably involves dealing with competing ideas and explanations) but, we think, signals a distinction between an approach which is primarily heuristic, i.e., driven by expertise and intuition (sense-making) from other approaches which are more algorithmic, i.e., driven by procedures and data-analytic tools. There is a range of frameworks and theories of how sense-making underpins performance (for example, Dervin, 2003; Pirolli and Card, 2005; Weick, 1995). In this paper, we adopt the Data-Frame model (Klein et al., 2006a, b).

Central to sense-making in the Data / Frame model (illustrated by Figure 1) is the relationship between the data to which the analyst has access and the different 'frames' that can be used to interpret, make sense of, or explain, these data. Klein, Moon and Hoffman (2006a) point out that,

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*"When people try to make sense of events, they begin with some perspective, viewpoint, or framework – however minimal. **For now, let's use a metaphor and call this a frame.***" (p. 88, emphasis added).

FIGURE 1 TO BE INSERTED HERE

The suggestion of a 'frame' as a metaphor, rather than a literal description of a knowledge structure, is particularly important to this paper. For example, cognitive psychology has used the concept of 'schema' to describe knowledge structures that are based on past experiences (Bartlett, 1932; Taylor and Crocker, 1981; Stanton and Plant, 2012). A schema can help reduce the mental workload associated with making sense of situations by "…*providing a ready-made knowledge system for interpreting and storing information…*" (Lord and Foti, 1986, p.38). A key stage in sense-making is therefore deriving a sufficient understanding of the situation in order to be able to match it to an appropriate schema. In the Data / Frame model the relationship between data and frame is both reciprocal and parallel. In other words, a frame could be applied to a set of the data, or a set of the data could suggest a frame. This reciprocity points to the continuous interweaving of activities of exploring data and generating interpretations. What is particularly useful about the notion of a frame is that it need not imply a 'solution' or final 'product' but can serve as a temporary explanatory model of aspects of the data.

The suggestion that people will seek to apply frames to fit data might also sound like the concept of heuristics in decision making (e.g., Tversky and Kahneman (1974) which assumes that 'framing' of information can influence, or bias, decision making.   In this instance, 'framing' is the manner in

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which the data is presented (as opposed to the interpretation of these data by the person). This is an important distinction: for the decision-making literature, 'framing' is the external representation of data (i.e., it is how the data is presented to the person) and for the Data / Frame Model, the frame is (usually) the internal representation of data (i.e., it is how the person perceives the data). The danger of assuming that frames have an ordered structure is that this could lead to the belief that one simply needs to design support (in terms of procedures, training or technology) that reflects this order, or that Intelligence Analysis is simply a matter of following well-defined steps from unstructured data to a structured analytic 'product'.

Kang and Stasko (2011) note that *"…analysis is about determining how to answer a question, what to research, what to collect, and what criteria to use."* [p.25]. The point at issue is not how people answer questions but how they define them in the first place (Roth et al., 2010). While the Intelligence Cycle might begin with 'Direction', this only gives a high-level sense of what the analyst might be looking for. As 'Collection' and 'Processing' progresses, new problem opportunities arise through 'discovery-led refinement' (Attfield and Blandford, 2010). Thus, one could read figure 1 in terms of a 'Direction' providing a tightly specified frame (so that the analyst will only collect and process data which are directly relevant to this frame), or in terms of a familiar problem (so the frame could be based on previous experience of similar cases), or in terms of a problem opportunity (so combinations of data would suggest particular frames which could be expanded and explained).

1.3 Strategies, Styles and Expertise

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One implication of the distinction between 'frames' (as internal representation of knowledge_ and 'framing' (as the external representation of information) is that it is possible to present data in very different ways which *could* lead to the person perceiving these data in different ways. The expert sense-maker, with a rich experience of their work and the type of problems that they typically encounter, is likely to be able to bring to bear a wide range of frames with which to interpret data. In other words, expertise is often characterised by the ability to take the external representation that is presented to the person and evaluate this against an appropriate internal representation. This evaluation could take the form of 'hypothesis exploration' (Elm et al., 2005) or 'elaborate a frame' / 'question a frame' in figure 1.

Differences between experienced and less experienced analysts could, therefore, depend on how they move through the Data / Frame cycle, to search for frames (which could become a matter of following procedures or could be a matter of drawing analogies with previous cases), or how they respond to problem opportunities. In this latter aspect, one might anticipate the differences one finds in comparison of expert / novice problem solving, i.e., where novices tend to respond to many features unselectively and work with any hypotheses which the features might fit, while experts work far more selectively and focus on a small set of high-level hypotheses (Baber and Butler, 2012; Chase and Simon, 1973; Didierjean and Fernand, 2008). While this implies that the differences might be between low-level and high-level detail in the analysis, it is important to note the importance of analytic style.

Tetlock (2005) noted that a "fox" will work on many ideas, revising opinions in the light of new evidence, while a "hedgehog" will apply a single grand theory, tending to apply this in well-

defined modes of thinking. His analysis of political forecasting suggests that 'foxes' tend to outperform 'hedgehogs' in the ability to make long-term forecasts. In terms of applying this to Intelligence Analysis, one could imagine that 'foxes' could skitter between information sources, either on the basis of encountering information in a piecemeal and ad hoc manner or on the basis of continually shifting in their interpretations, and that 'hedgehogs' could seek a high-level analyses and apply a clear strategy to marshal evidence in support of these. From Figure 1, sense-making is viewed as a set of processes in which the evidence presented to participants is interpreted. In broad terms, we propose that the interpretation could take one of three forms. First, participants could simply select two pieces of evidence and seek to link them. This would involve the positing of a *frame* in which two pieces of evidence can be joined. This could be done by placing the pieces of paper containing the evidence next to each other, or could involve people making statements which draw on two pieces of evidence, or could involve the construction of diagrams, such as timelines or network diagrams. Second, participants could seek to draw inferences from the evidence, e.g., in terms of positing a *hypothesis* from the combination of evidence. Third, participants could seek to develop these conclusions into *rules* which would inform subsequent interpretation. In this case, a 'rule' would be a generalizable association between pieces of evidence and could be considered to serve as a hypothesis that had been supported.

From this perspective, one might expect a process by which pieces of evidence are combined to form a frame and, as further evidence is introduced and explanations develop, this could become an hypothesis which, once the team was confident in its support of the hypothesis, could be used as a rule to inform subsequent analysis. We will use this distinction between frame, hypothesis and rule in our interpretation of teams' activity. One could imagine, that 'hedgehogs' would apply their

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efforts to seek and apply the 'rules' which could be used to solve the puzzle. Indeed (as explained in section 2.4), the assumption underlying the design of the Exercise used in this paper was that effective performance could involve finding the *modus operandi* of the gang and using this as a 'rule' to interpret the evidence. In contrast, 'foxes' would shift between frames and hypotheses, possibly not always seeking rules.

2 METHOD

The studies reported in this paper use an Exercise developed for a Visual Analytics Summer School 2012 (Baber et al., 2013). Initial analysis was derived from ad hoc observation of group performance and it was felt that a more controlled approach to data collection would be beneficial. This paper presents the approach to data collection and analysis that was developed to study this Exercise.

2.1 The "North by South West" Intelligence Analysis Exercise

The "North by South West" Intelligence Analysis Exercise (referred to in this paper as 'the Exercise') provides an opportunity for participants to engage in sense-making about criminal activity. The UK National Intelligence Model defines four levels of criminal investigation: Level 0 relates to neighbourhood (street-level) crime; Level 1 relates to Local (town or city level) crime; Level 2 relates to Serious and Organized Crime; Level 3 relates to National and International crime. While levels 0 and 1 would be dealt with by local Police units, levels 2 and 3 are dealt with by National Crime Agencies and related organizations. The Exercise was developed to cover all

four levels, but with primary focus on the interface between levels 1 and 2, i.e., a fictitious case in which a consignment of drugs will be smuggled into England (and distracter material at the interface between levels 0 and 1, i.e., car thefts and burglary). Before elaborating on this Exercise, it is worth considering comments made by Subject Matter Experts who reviewed the Exercise.

2.2 Subject Matter Experts' Comments on the Exercise

Treverton (1994) drew a distinction between 'puzzles' (which have a definable solution) and 'mysteries' (which are problems without an obvious solution). This Exercise was designed as a puzzle, in that there was a solution and the evidence could be made to fit that solution. Though puzzles are not necessarily representative of intelligence analysis, they allow us to consider aspects of 'performance' (i.e., the degree to which the groups get close to the solution), and we have taken steps to ensure that the exercise provides demands that are found in a real intelligence analysis task environment. What made the Exercise challenging was the presence of competing explanations and the fact that data were missing.

In order to validate these claims, experienced Police Officers and Police Intelligence Analysts reviewed the Exercise and agreed that it was a fair reflection of the challenges faced by Intelligence Analysis. However, they raised several crucial differences between the Exercise and actual situations which we feel are important to note before reporting the studies.

First, the Exercise did not have consequences for the decision that a group reached. Thus, the constraints inherent in both the material and the setting meant that there was no requirement for the

groups to come up with a solution which was not only 'correct' but also to which they would be prepared to commit real resources in a course of action. The Police groups identified four activities in the scenario (petty crime, local drug dealing, drug smuggling, fraud). It was noted, by the Police officers, that there would be a Senior Investigating Officer to whom analysis would be reported. They also pointed out that they would have expected an opportunity to make requests for information or to propose lines of enquiry to gather more data. This led to the second point.

Second, the Exercise took place in a compressed time period, and this was to create feasible opportunity to run studies with professionals, and to create a degree of pressure. This meant that all information for the Exercise was provided in a single collection, rather than through Requests for Information or through sporadic drip-feed of further information, should it be collected as part of ongoing operations, or in relation to other cases. The provision of all material in a single collection was a deliberate attempt in the Exercise design to ensure that all groups performed the activity under the same conditions. Thus, the trade-off between having some form of consistency in conditions versus the ebb and flow of the dynamics of a normal investigation was made in favour of the quasi-experimental approach. This led to the third point.

Third, Intelligence Analysis takes place in a dynamic context in which new information needs to be processed and triaged before it can be used. The Exercise provided participants with fairly 'clean' data. For example, the telephone logs were neatly tabulated with relevant information easily available. Often the collection of information does not result in such neatly presented material. Requests for telephone logs could, for instance, result in several pages of information relating to a specific handset. The job of the analyst involves collating and compiling these data before the

analysis can begin. The Exercise omitted this aspect of the work, primarily to keep the duration of the Exercise tractable and to keep the nature of the material consistent across groups.

2.3 Procedure

The "North by South West" Exercise was designed with the assumption that the correct solution could be arrived at by defining a *modus operandi* (M.O.) of how a drug-smuggling gang operated. The M.O. was as follows: the gang uses a yacht to transport drugs from Roskoff (France) to a marina in Exmouth (UK)[1]. The yacht also carries a passenger who puts the drugs into a van hired by the marina's management and drives to a warehouse in Leeds (UK). The drugs are then distributed to drivers in a mini-cab company in Leeds and sold. In order to make the exercise challenging, the data also relate to three other stories (as described in 2.4).

The Exercise began with a brief explanation of the aims of the study and the University of Birmingham ethics protocol followed (i.e., participants were free to withdraw at any time and all data collected (including images and video) would be anonymized before reporting). Participants were given a briefing, which was intended to simulate the 'Direction' phase of the Intelligence Cycle, and the Exercise concluded with a presentation by each group, which was intended to simulate the 'Dissemination' phase of the Intelligence Cycle. All groups, in both versions of the Exercise, received the same briefing as follows:

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[1] We should make very clear that the place names Exmouth, Leeds and Roskoff were included in an entirely fictional capacity and that there is no implication that any of these towns, or indeed Exmouth Marina, have been involved or implicated in any of the events in the Exercise.

2 A complete pack of materials can be obtained from the lead author on request.

"Muriel Grosby is a businesswoman who lives in Leeds and runs a road haulage and mini-cab firm. While she has no criminal convictions, local police have long been suspicious of her acquaintances and believe that she has links with criminal activity, particularly relating to drug smuggling and people trafficking. A known contact of Grosby, called Calabrese, was sentenced, on 14th June, to 9 years for drug smuggling.

Intelligence suggests that there is likely to be a shipment of class A drugs being delivered to a port in the South-West of England in the next few weeks. Given resource and personnel constraints, it is not possible to follow every suspect so you need to determine who should be arrested and where the best place might be to make such arrests.

Following your investigation, you will give a presentation on your findings. The presentation will include:

1. *Name of individual, or individuals, to target as Suspects.*

2. *The FIVE pieces of evidence that best support your proposal to 1.*

3. *Location of the arrest or arrests.*

In order to make this exercise easier, you will select suspects from a set of nine people:

- *Muriel Grosby, who I have already described;*

- *Jennifer Garlica who is Grosby's sister-in-law and whose husband was killed last year in what looks like a gangland hit;*

- *Vanessa Munoz who is the assistant manager of Exmouth Marina;*

- *Martina Sarti who works at the marina and is the girlfriend of the marina manager (Xavier David);*

- *Pierre Pasquidini who lives in Roskoff and travels regularly to the UK;*

- *Kenny Chiappe who drives a mini-cab in Leeds;*

- *Jake Ajachinsky who is a petty criminal;*

- *David Pico who is Jake's best friend, is also a petty criminal and has a tempestuous on-off relationship with Jake's twin sister, Denise Ajachinsky, who is also a suspect.*

For this Exercise, 'today's' date is September 10th 2012 (this will help you make sense of the dates and times on the documents you have)."

Following the briefing, participants were allocated to groups of 4-6 members[2] and then taken to their own incident rooms to complete their investigation. These rooms were equipped with whiteboards, large notepads, pens, post-it notes and paper. Each group was provided with a pack of 49 slides. The pack included nine suspect cards (with picture of the suspect and their correct addresses), together with a combination of telephone logs, harbourmaster logs, maps, business accounts, witness and arrest statements, newspaper articles etc. Figure 2 provides an illustration of the types of evidence supplied. Each sheet of evidence contained several topics, e.g., dates, phone numbers, names, locations etc.

FIGURE 2 ABOUT HERE

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[2] Contemporary approaches to Intelligence Analysis often rely on groups of people working together in 'Fusion' centers (Roberts, 2011; Treverton and Gabbard, 2008). For example, the US Army All-Source Analysis System (ASAS) involves four analysts working together to provide data for a senior analyst. We took this as a template for our study and had people working in teams of 4-6 people.

2.4 The Solution and Possible Approach to the Exercise

1. The Solution is to arrest Pasquidini (the passenger on the yacht, as outlined in the M.O. above). The puzzle is to place Pasquidini in Exmouth and to see him as the van driver. There is no direct evidence to this effect (which is why the Exercise is challenging). However, the combination of M.O. and evidence from today and yesterday (in the passage of time for the exercise) should help the groups narrow down their set of suspects and realise that the yacht's passenger is the van driver and that Pasquidini travelled from France.

2. There are three people who could be viewed as dubious but who have insufficient information to justify arrests:

   a. Muriel Grosby has been involved in the deal to buy the marina and has a wide range of highly suspicious transactions in her business accounts. She also owns the mini-cab firm which is dealing the drugs. On the other hand, she is involved in charitable events with the Marina and with making donations to it. The accounts and client list of Ricord Accountancy Services link many of the characters together suspiciously – but not in sufficient detail to clearly indicate nefarious activity.

   b. Martina Sarti hires the vans which are used for transporting the drugs – but it is likely that she hires vans on a regular basis for people coming into the marina and

not specifically for the smuggling operation. She has received money from Grosby but it is not obvious why this is suspicious, given their relationship with the marina.

c. A petty criminal (Cobo a.k.a Pico) who comes from Leeds, is living next to Martina Sarti (although it is likely that she is spending most of her time in Exmouth with David, the marina manager), and is being paid as a chauffeur by Grosby's accountant, Ricord.

In order to arrive at the solution, the best approach examine the arrest of Calabrese, who (as pointed out in the briefing was sentenced on 14th June 2012). The newspaper article detailing Calabrese's sentencing notes that he was arrested in November 2011. Two statements dating from November 2011 (one from Calabrese and one from Bocognani, the former manager of the Marina) suggest that the gang's M.O. is to ship drugs from Roskoff on a yacht skippered by Perrin, to arrive at Exmouth in the early hours and for the drugs to be moved by van to the Angel Warehouse in Leeds. A record of van hire shows that Sarti hired a van in early November 2011. A review of other van hire logs shows that Sarti hired a van in August 2012 and hired a van yesterday (9th September 2012). The Marina log shows that the only yacht due in today is the 'Sunny Jim', owned by Condiere. The other evidence that corresponds to 'today' is the phone logs of Pasquidini, who calls Condiere, Perrin, Angelleti, Munoz and Sarti. Pasquidini's 'suspect card' shows that he lives in Roskoff.

2.5 Data Collection and Analysis

The analysis involved three forms of data: activity sampling, process analysis and review of groups' answers to the challenge. First, each group had a dedicated observer who recorded the activity on the group on an activity sampling sheet (Appendix 1) every 10 minutes. We propose that this gives us an overview of how the different groups approached the exercise. Our purpose here was to see if there were any identifiable patterns that could warrant further investigation. Second, each observer, when they were not completing the sampling sheet, took photographs of the diagrams that the groups were making, or of group activity, and made contemporaneous notes of the group discussions. Third, at the end of the exercise, each group presented its findings and these were recorded and analyzed.

This paper presents an analysis of quantitative data drawn from observed activity. In these data, counts of activity (related to number of topics discussed, number of actions performed etc. during the sampling window) are presented in the form of graphs to provide a convenient means of comparing groups. While such an approach inevitably misses the nuances of the activity, it does provide a coarse measure of performance that encourages deeper analysis to explain the observed phenomena. This deeper analysis is provided in the form of extracts from qualitative analysis of specific events in the exercises. It is felt that, while such extracts can only provide a snapshot of very specific instances of activity, they offer a basis for interpreting the observed phenomena.

2.6 Participants

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The study involved two versions of the Exercise. Each version involved groups of participants attempting to solve the Exercise, and each version ran for approximately 3 hours (from initial briefing to final presentation by groups).

Version one of the Exercise took place during a Visual Analytics Summer School 2013 at Middlesex University. Seventeen participants of the workshop agreed to be observed during the Exercise. The participants were divided into four groups each having four or five members. Twelve of the participants were currently studying for their PhDs, while the remainder had either completed their PhD or post graduate studies and were working as researchers in academia or industry. Five participants were female and the remainder were male. Participants came from UK, Europe (Malta, Spain, Vienna, Austria and Germany) and the US. To our knowledge none of the participants had previously participated in a similar investigative activity prior to this study.

Version two involved a workshop with serving UK Military Intelligence personnel, as part of a weekly Intelligence Analysis exercise programme. Sixteen Officers and other ranks agreed to be observed during the investigative study. The participants were divided into three groups, with two groups of five and one group of six. Five participants were female and the remainder were male.

3 RESULTS AND ANALYSIS

From the activity sampling data, the two versions of the Exercise are compared in terms of the number of topics discussed at each sampling period, which specific topics were considered and

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how representations were used. From the contemporaneous notes, the two versions are compared in the manner in which groups discussed specific topics. Space constraints limit the number of instances that can be reported, but we have selected examples which illustrate some interesting differences between the groups. Finally, the answers provided by the groups in each version are presented and discussed.

3.1 Activity Sampling Results

The evidence cards contained information which can be classified in terms of Suspect, Date / Time, Locations (Exeter, Roskoff, Leeds, Exmouth), Vehicle (yacht, van) Action (payment, social activity, business, crime). This classification (see Appendix 1) defines the set of topics that groups discussed. In the activity sampling, each mention of a topic was counted in the sampling period. Thus, if the group said 'Condiere owns the yacht called Sunny Jim', we would count 1 for 'suspect – Condiere' and 1 for 'vehicle – yacht'.

Figure 3[3] plots the number of different topics mentioned by different groups at each sample point during Version one of the Exercise[4]. Figure 3 shows that the number of topics considered, for groups 1A, 1B and 1D, rose over the first 8 sample periods, and then alternated, until periods 13 and 14 when the groups were preparing their presentation. This is supported by the video recordings which show that all groups began to tie up the loose ends of investigation within the last 10-15 minute period. The pattern for group 1C is very different, with a focus on a far smaller

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[3] We recognise that discretely sampled data ought to be presented in the form of a histogram but have chosen to present these as line graphs to illustrate the trends in the ways that groups referred to topics.

[4] The fifth team in the VASS study has been omitted from the analysis as the observation data was incomplete, due to issues with the sampling.

number of topics throughout the task. Averaging across the entire exercise, groups 1A, 1B and 1D were working with a similar number of topics, i.e., 1A = 5 (± 4), 1B 6 (± 4) and 1D 6 (± 3), while group 1C was working with fewer topics, i.e., 1C = 1(± 1). On average groups worked with a handful of topics at a time, typically around 5. Once the groups accumulate evidence, they narrow their search to a subset of evidence. Once this subset has been exhausted, they return to a broad sweep of evidence.

FIGURE 3 ABOUT HERE

Figure 4 plots the number of topics mentioned at each sampling period in version two. Overall, the average number of topics is consistent across the groups, i.e., 2A = 6 (± 3), 2B = 5 (± 4) and 2C = 5 (± 3), which are similar to the results of three of the groups in version one. Figure 4 shows that the teams in Version two appear to expand and then narrow the focus of their discussions (at the sampling intervals) with more regularity than those in version one, creating a distinctive 'sawtooth' pattern.

FIGURE 4 ABOUT HERE

3.2 Processes of Sense-making

From the activity sampling data, it is possible that the groups in version one were primarily concerned with accumulating pieces of evidence and then seeking to define links between these,

e.g., as implied by the increasing range of topics which were discussed. In contrast, groups in version two tended to alternate between broad (several topics) and narrow (few topics), which suggests movement from making frames to the development of hypotheses and rules.

To explore these forms of interpretation, the following section presents extracts (in the form of tables of statements) of discussion between participants. The discussions are verbatim records of participants' statement. In all of these extracts, items in italics indicate an error in interpretation by a participant.

3.2.1   SEEKING A FRAME

In Table 1, the key question that Group 1A (4 participants) is attempting to address is one which confused all of the groups at some point in the activity: one of the suspects was using an alias as well as his own name (David Pico is also known as David Cobo).

In the extract in Table 1, the discussion begins with the question "Has anyone come across Calabrese?" and develops into a debate about whether Cobo and Pico are the same person.

[TABLE 1 ABOUT HERE]

In order to determine who Pico / Cobo might be, participants work from specific sources, such as 1ACi "Cobo is Denise's boyfriend who is 19 years old", 1ADii "David is the first name, Cobo is the surname", to links between pieces of evidence, such as when 1AC and 1AD discuss the

attempted burglary for which Cobo and Ajachinsky were arrested (1ADiv, 1ACiii, 1Adv), and then to hypotheses, e.g., 1AAiii "It could be his fake name?" and 1ABiv "So it is possible that Pico is Cobo?". The discovery that Pico is an alias used by Cobo is then used as a rule in future discussion. Table 1 also indicates several unsupported hypotheses, e.g., 1ADi "Cobo has some relationship with this guy", 1ADii "In November he was arrested in Denver, because he was a suspect in some drug thing", 1ADii "He (Calabrese) contacted Cobo."

3.2.2   REPRESENTATION AS FRAMING

Group 2B (5 participants) began by discussing the Angel warehouse and then split into two sub-groups. One subgroup searched for more information about the warehouse, while the other subgroup (consisting of Participants 2BB and 2BE) developed a social network diagram on the whiteboard (figure 5). Thus, Group 2B treated the task as a social network problem, and sought to develop a frame accordingly. They identified a possible American connection (presumably in terms of the purchase of the marina by a US company in a deal brokered by Grosby). Participant 2BE adds "American connection?" to the bottom of the social network diagram (Figure 5). No new representations were created, and the idea of a timeline was raised but then dismissed.

[FIGURE 5 ABOUT HERE]

3.2.3   DEVELOPING A FRAME

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In Table 2, an elaboration on Condiere (the owner of the yacht 'Sunny Jim') leads group 1B to make their first hypothesis about how the drug trafficking happens. The discussion begins with a question about the identity of Condiere, and concludes with a description of the gang's M.O: 1BAvi "A boat arrived, a van moved" and 1BBiii "there was some drug delivery…at the Angel Warehouse…it must be in Leeds". The date of the yacht arriving (18th June) is recognized as important to the investigation: 1BDi "So that's evidence". In this extract, the group appears to be working towards a rule which reflects the gang's M.O., but it is interesting to note that this was not then used as the basis for subsequent discussion; having established a trafficking route, the group turned its attention to other questions.

[TABLE 2 ABOUT HERE]

This extract begins with an unsupported hypothesis 1BAi "He is married to Martina", which was repeated later 1BAii "The boat owner's wife is Martina." The discussion moves to the statement that 1BAii "If we look at the boat records [harbour logs], it (Sunny Jim) leaves [arrives] on the 18th". This raises the question of other deliveries, i.e., 1BAii "Do we know of any other drug delivery. 1BBiii replies that "There was some drug delivery on 12th December 2011 at the Angel Warehouse". Along with these questions, the group develops two hypotheses: 1BBiii infers that the Angel Warehouse is in Leeds, and 1BAiv notes that "A boat arrived, a van moved. We have a name around that." This suggests that the group is working towards rules that could represent that gang's modus operandi.

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In Table 3, group 2C argue between arresting Sarti and arresting Pasquidini (Table 4). In particular, group 2C discuss the role of Pasquidini and present hypotheses that feature him as a shadowy figure (2CBi "the anonymous Frenchman") who 2CAiii "connected…He has links", and 2CDi "He's been calling all over the joint". Against this hypothesis is the concern of 2CBiv that "All we have is the phone records" which raises the issue of what would constitute evidence to support the arrest of an individual in this exercise. This discussion leads to the development of a rule, 2CAii "We need to take out the source in France to bring down the whole network."

[TABLE 3 ABOUT HERE]

The initial link diagram, figure 6, being drawn by group 2C resulted in Pasquidini being in the centre of the network (this was by coincidence, not by design).

[FIGURE 6 ABOUT HERE]

This was erased and a new diagram drawn starting with Sarti in the centre (Figure 7).

[FIGURE 7 ABOUT HERE]

[TABLE 4 ABOUT HERE]

Table 4 illustrates how 2C moved between different suspects (Condiere, Sarti, Calabrese, Ricord, Pico and Grosby) and attempt to define associations between these suspects. This extract also shows several hypotheses about Sarti: 2CEi Sarti is receiving unusual payments, 2CDii Sarti is "linked to everyone", 2CCiv Sarti "lives next door to Pico" and 2CBiii Pico "obviously knows her", but conclude that 2CBii "there's not enough evidence" and that 2CBi "Sarti can't be the driver because Calabrese was arrested. He took the van to Exeter." They also consider Pico and that 2CCiv "They paid his bail so they don't want him talking". This illustrates how, even in the space of the 5 minutes over which these exchanges took place, the team worked with multiple frames but did not necessarily develop these into concrete hypotheses.

3.2.4 COMPARING, ELABORATING AND QUESTIONING FRAMES

In version one, the elaboration of frames appeared to happen at the end of the Exercise, i.e., just before the groups needed to give their presentation. At this point, the groups would review the lines of enquiry that they had been following and select the one about which they felt most confident.

In contrast, groups in version Two would regularly (i.e., every 20 minutes or so) gather around the representation that they were creating and run through their analysis to date. At one level, this could be seen as rehearsal of their final presentation. At a deeper level, we propose that this run through provides an opportunity to elaborate and question the story that best explains the analysis. The rehearsals seemed to support both the clarification of assumptions being made (in terms of ensuring that there was appropriate evidence to support an hypothesis) and the logic of the

relationships being described (again in terms of evidence). From this perspective, the representation externalized the frame that was being developed during the Exercise. From this, one can see why the groups focused on their selection of evidence in the presentations; the use of a link (social network) diagram showing relations between individuals was supported by the phone logs and accounts, and the use of a timeline was supported by the harbour logs. In other words, the experienced groups, in Version two, applied more effort to elaborating and questioning the frames they were using (i.e., 'conflict and corroboration' and 'hypothesis exploration' (Elm et al., 2005), and their rehearsals could be seen as ways of testing the coherence of their hypotheses.

3.3 Comparison of Solutions

Table 5 shows the choice of suspects, location and evidence made by the groups in the two versions of the Exercise.

[TABLE 5 ABOUT HERE]

In version one, the prime suspect for all groups was Sarti (4/4). The suspicion was that she was the van driver and that she could be arrested at the Angel Warehouse in Leeds (2/4). The groups also named Pico / Cobo as someone to arrest (3/4). Group B mention Denise Ajackinsky several times, but do not want to arrest her, they believe she is an innocent party. Condiere is mentioned by groups as the yacht's owner (3/4). Only group A mentioned Pasquidini in their presentation but not as someone to arrest. Groups C and D did not mention the location where they would make the

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arrests. In terms of evidence, the groups tended to focus on Accounts (3/4) and Phone Records (3/4) which provided evidence of links between suspects (implying that many of the groups saw the exercise as being, at least in part, a social network analysis challenge) but also the harbour logs (3/4) providing evidence of the dates when drugs were being imported to the country. None of the groups used newspaper reports and only group C referred to statements.

For version two, table 5 shows that all three groups identified Sarti (3/3) as a prime suspect (because she was central to so much of the exercise) and all three teams named Pasquidini (3/3). Two of the groups proposed that Pasquidini should be arrested in France by Interpol, suspecting his involvement in supplying the drugs and loading them on to the yacht. The groups also discussed Pico / Cobo (2/3), as a possible driver of the van, and mentioned Calabrese (2/3) in support of this proposal; Calabrese was Ricord's chauffeur and had been arrested driving the van, and now Pico / Cobo was Ricord's chauffeur so looked suspicious. All three groups used the Harbour Logs (3/3) and Accounts (3/3) to provide evidence of who was linked to whom and when events occurred, with the phone records (2/3) supplementing the links.

4 DISCUSSION

In this paper, two versions of the "North by South West" Exercise have been reported, designed to provide a challenging problem for sense-making. The design of the Exercise had assumed that people would identify the *modus operandi* (M.O.) of the gang and then look for information as to when this M.O. was likely to be applied. However, while there are instances where the groups (in

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both studies) described the M.O., this did not seem to be the primary focus on their analysis. Rather, in both studies data were combined into sets, or frames, and these frames explained or represented. Comparison of the two versions of the Exercise reveal differences between novice and experienced analysts, in terms of the use of frames, hypotheses and rules, and the use of representations.

4.1 Using Frames

Frames begin in a sketchy (minimal) manner, either through the linking of data in representations or through the linking of concepts in response to questions. This might be a function of the nature of the evidence provided for the exercise, with all groups beginning their processing with the sorting of sheets into piles. An interesting point to note here is when, or if, the piles of evidence became 'frames'.

In Version one, a piece of evidence would initially serve as a high-level item of 'data', e.g., evidence about Cobo (table 1). As the analysis progressed, the evidence would be a container (or anchor) for lower-levels of data, e.g., Cobo's alias is 'Pico'. In this way, the evidence is decomposed into data of increasing granularity.

It was (possibly) the view that the Exercise was primarily a social network challenge that led the groups to focus so much attention on Sarti; she had the most evidence associated with her, was well connected to many of the suspects and appeared to play a crucial role in supplying the van used to transport the drugs. This suggested that groups in Version one were being swayed by the

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quantity of material rather than necessarily developing critical narrative of the M.O., and points to problems associated with the common knowledge effect (Gigone and Hastie, 1993).

Groups in version one, recognised the need to develop hypotheses and rules for their investigation, such as 1ABiv "So it is possible that Pico is Cobo?" (table 1) or 1BAvi "A boat arrived, a van moved." (table 2). However, these rules did not appear to be explored or developed further by the groups. This suggests that the less experienced groups knew that they had to sample data to build their analysis (what Elm et al., 2005) termed 'down-collect'), and generate hypotheses for the investigation but did not seek to engage in what Elm et al. (2005) termed 'conflict and corroboration' or 'hypothesis exploration' through which these hypotheses were tested and developed into either rules for further exploration or a narrative of the investigation.

In version two, the groups not only sought frames for sampled evidence, but also developed their hypotheses through testing them. Thus, tables 3 and 4 shows group C not only raising hypotheses about Pasquidini, Sarti and Calabrese but also challenging these. This suggests that these groups were not only engaging in the 'down-collecting of material but also in 'conflict and corroboration'. Further, the observation that all the groups in Version two would rehearse their presentation at intervals during the Exercise suggests that they recognised the value of or 'hypothesis exploration' as a core part of their analytical work.

This paper offers some supporting evidence in terms of the Data / Frame concept of sense-making. The observational data suggest that teams prefer to work with a small number of pieces of evidence (i.e., a mean of 5 pieces, irrespective of experience). Further, the less experienced groups tend to

accumulate evidence over the initial phases while the more experienced groups tend to move between broad and shallow and deep and narrow search (focusing on specific frames, but, generally working with more than one frame at any one time). This suggests that traversal of the Data / Frame cycle is more effective for the experienced analysts, who were able to switch frames, than for the less experienced analysts, who might have been either unable to generate an appropriate frame (being swamped by data) or who might have stuck with a particular frame even when it is not appropriate to the current set of data. This implies that differences in sense-making of experienced and inexperienced are not simply a matter of knowledge but also relate to the manner in which evidence is selected and processed, and hypotheses and frames employed.

In both versions of the Exercise, the extracts of team discussions (tables 1-4) suggest that, even when teams focus on a frame, their attention is drawn to other data and the analysis moves between several frames in short succession. This suggests that traversal of the Data / Frame model is faster than one might expect. In other words, in this Exercise, teams seem to move through the Data / Frame cycle quickly, with consideration of several frames, rather than taking a single frame and processing this. In terms of the 'foxes' versus 'hedgehogs' distinction considered in section 1.3, all groups acted as 'foxes', shifting between sets of evidence and seeking a variety of frames, hypotheses and rules. It is interesting to note that, even with the experienced analysts in version two, the focus was not so much on the single 'rule' that would solve the puzzle as on developing and testing several hypotheses.

This implies that the Exercise resulted in an abductive approach to reasoning, in which the data were explored and resulting hypotheses developed, rather than a deductive approach in which rules

are proposed and tested. While we would not claim that this represents all forms of Intelligence Analysis, it is interesting that this cyclical approach is very different from the more rational and linear approaches implied by Pirolli and Card (2006) or Heuer (1999). What we observed in this study was that, while people operate using 'competing hypotheses', these tended to be articulated as loose, imprecise statements rather than as objectively grounded comparisons. While this is partly an artefact of the study (and is not meant to imply than Intelligence Analysis does not or should not seek objective grounding of hypotheses), it does suggest that searching for problem opportunities is as much an art as a science.

4.2 Using Representations

Representations are a way of framing sets of data. The representations either focused on the grouping of people (through link or social network diagrams) or events (through timelines), or a combination of these.

Interestingly, once the groups in version one had created a representation, they spent little time in editing the representation during the exercise. One possible explanation for this behaviour was that evidence piles and representations *were* the frames, and that discussion involved creating and working with variations on these frames. Thus, in version one it was difficult to identify points at which the groups had a 'complete' frame but it was easy to see how partial (minimal) frames would be created. This suggests that the activity was primarily a data framing exercise, in which the aim was to discover links between topics.

In contrast, groups in version two focused their attention on the creation and development of representations. Initially these were, like in Version one, a means of framing data. However, as the Exercise developed, the representations became the focus of the final presentation. This meant that, rather than creating representations to serve as aide memoire for their own discussions (as groups in version one seemed to be doing), the groups in version two were creating representations for an audience, i.e., their Commanding Officer to whom they would give their presentation. This suggests that the activity was primarily to create hypotheses for further investigation.

The difference in how experienced and inexperienced analysts use representation, however, is deeper than simply a matter of considering one's audience. As de Vries et al. (2013) point out, collaboration is often based on minimal representations. In this Exercise, there are two possible reasons for this. The first is that the data provided made it difficult to produce a complete representation of a set of data. Even when groups sought to develop maps, timelines or network diagrams, they were frustrated by the fact that they had gaps in the available information. So, the representations in this Exercise were underspecified simply as a result of limited information. Noting the comments made in section 2.2, the issue of limited information could, in real activity, be addressed either through Requests for Information or through auctioning further intelligence collection. However, the second reason (as suggested by de Vries et al., 2013) is that representations created in collaborative activity are not merely diagrams showing data; rather, they are records of the discussion and thought-processes of the groups. This means that, in order to understand the content of the representations, it is often necessary for someone from outside the group to have an explanation of the assumptions, ideas and background knowledge that inform

these representations. In other words, the role of representations is often to capture 'local' discussion rather than to create a more 'global' view.

If this second point is a reasonable line of analysis, then it follows that groups who are able to work within a shared view of the analytical process might develop and use representations in a different manner to groups who are, in a sense, negotiating their view of the analytical process in parallel with creating the representations. Thus, while the physical appearance of the diagrams created by groups in both versions of the Exercise were quite similar, the fact that groups in version one tended to abandon their diagrams shortly after creating them suggests that the role of these representations was to support the development of an agreed analytical process (e.g., in terms of agreeing which pieces of data might link to which other pieces), rather than to provide the basis for further analysis. In contrast, the experienced analysts in version two, used the representations as the basis for their analysis. In short, groups in version one treated representations as the end (or product) of their analysis while groups in version two treated representations as the beginning of their analysis.

4.3 Investigative Process

In terms of the manner in which the exercise was approached, the graphs of activity (Figures 3 and 4) revealed interesting differences. For example, while the groups in version one (with the exception of Group C) spent the first 80 minutes or so gradually building up their collection of evidence to review, the groups in version two spent around 40 minutes accumulating evidence and then alternated between larger and smaller sets as they focused on specific suspects.

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One might expect the groups to select an hypothesis which they feel is more plausible than others and then seek to elaborate on this. While we noted that, in version one, some of the group members were keen to make this switch (e.g., in terms of identifying the prime suspect early on and then seeking to prove the guilt of this person), the nature of the group collaboration meant that this was not always pursued (e.g., either because other group members challenged this claim or, more likely, because other group members were developing other lines of enquiry). Thus, the groups in version one tended to consider multiple topics at any time (and this is illustrated by the vignettes in this paper); even when the focus was on a single suspect, the group discussions tended to introduce other people or other items of data. In version two, as noted above, the goal of creating a plausible hypothesis become more apparent as the Exercise developed.

For the experienced analysts in version two, the approach taken to the Exercise would have come from their training and prior analysis activity. It is worth noting that the nature of the Exercise (in terms of the subject matter and the nature of the puzzle to solve) and the material provided, was very different from what they usually handled. This means that they were no ready-made frames to approach the data. What they did have was a generic approach to Intelligence Analysis which focussed on creating plausible hypotheses in order to create a briefing for a critical audience (their Commanding Officer). Furthermore, one can assume that the analysts were employing Heuer's (1999) notion of Situational Logic (not least because this the approach that their Commanding Officer favoured). Heuer (1999) describes this approach as "Generation and analysis of hypotheses start with…concreate elements of the current situation…A scenario is developed hangs together as a plausible narrative." (p.32)

4.4 Conclusions

In this paper, two versions of an Exercise were reported: one version involved groups of participants at a conference who had minimal experience in Intelligence Analysis, and the other version involved serving Military Intelligence personnel. The Exercise was designed to explore the manner in which Intelligence Analysis is undertaken and to consider ways in which sense-making could be explored.

The studies in this paper support the observation that Intelligence Analysis is not a linear, orderly process (see also Elm et al., 2005; Kang and Stasko, 2011; Roth et al., 2010). Even with so simple a set of evidence, we could observe behaviour which was parallel (with several group members working on different lines of enquiry), disjointed (with group members pursuing contradictory 'frames', e.g., arrest Sarti or Pico, or Sarti or Pasquidini), and recursive (with groups dismissing a frame and then reintroducing it, e.g., dismissing the abandoned car and then considering that it was used as the drug transport vehicle). This suggests that such behaviour is likely to be a characteristic of this type of activity. From this, it is apparent that the activity is primarily one in which small sets of data are combined and explained.

From the use of representations, it is apparent that experience dictates the manner in which people construct, use and share representations. This suggests that the design of "sense-making support systems" (Weick and Meader, 1993) should not focus simply on ways to support the construction of diagrams and other forms of representation, but also needs to consider the manner in which these representations are to be used. For example, tools which support the collation of information

to help identify links between pieces of information might help with 'down-collection' of data but does not provide support for 'conflict and corroboration' or for 'hypothesis exploration'. Following Cabitza et al. (2013) we could say further that each representation is *"a physical, i.e., material but not necessarily tangible, inscribed artifact that is collaboratively created, maintained and used to support knowledge-oriented social processes..."* (p. 35). For the inexperienced groups, the knowledge-oriented social process was as much a matter of developing an agreed strategy to approach the problem as it was on working the solution to that problem. Conversely, the experienced groups already possessed an agreed strategy (which was shared by their 'audience') and their focus could be on working the solution.

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Appendix 1: Activity Sampling Pro-forma used for Observations

Figure titles

Figure 1: Data Frame Model of Sensemaking [Robert Hoffman, private communication]

Figure 2: Materials used in the "North x Southwest" Exercise

Figure 3: Numbers of topics discussed by each group in version one

Figure 4: Numbers of topics discussed by each group in version two

Figure 5: Link diagram constructed by group 2B (note the reference to 'American connection – David X?' at the bottom of the diagram)

Figure 6: Link diagram constructed by group 2C at the start of the exercise (note how PASQUIDINI is in the centre of the diagram)

Figure 7: Link diagram produced by group 2C as they refocused their discussion (note how SARTI features in the top right of this diagram)

Collaborative Sense-making during simulated Intelligence Analysis Exercises

Highlights

- **Comparison of groups experienced and inexperienced Intelligence Analysts conducting a bespoke simulated exercise**

- **Description of the "North by South West" Intelligence Analysis exercise**

- **Critical application of the Data / Frame model of sense-making to Intelligence Analysis**

Table 1

Participant	Participant Statement
1AAi	Has anyone come across Calabrese?
1ADi	Maybe I can give some information about that. Calabrese was in jail for 9 years, the taxi [driver], he was suspected of getting involved, then *Cobo has some relationship with this guy.*
1ABi	Who is Cobo?
1ACi	Cobo is Denise's boyfriend who is 19 years old
1AAii	That is actually David?
1ADii	David is the first name, Cobo is the surname
1ABii	No it is Pico
1AAiii	It could be his fake name?
1ACii	So who is Cobo?
1ADiii	*In November he was arrested in Denver, because he was a suspect in some drug thing. He also has a close relationship with her.* Let me explain using the timeline. *This guy escaped from the prison. Calabrese has a lot of experience in drug trafficking. He contacted Cobo.* Cobo is only 19 years old.
1ABiii	Are you sure that Cobo is David? That's my question.
1ADiv	I'm not sure. David Cobo, so this was November 2011 and August 2012 they have broken in to get a briefcase. Ajachinsky and Cobo get the briefcase.
1ACiii	Where did you find that?
1ADv	These two statements. They were caught by the police, as when they broke the window to get the briefcase in St Luke's College. There is a Pico, that is 19th August and this is 20th.
1ABiv	So it is possible that Pico is Cobo?
1ACiv	So let's put that in.

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Table 2

Participant	Participant Statement
1BAi	Has anyone come across Condiere? *He is married to Martina*, and he owns the boat.
1BBi	Now that's important
1BAii	He owns the boat called Sunny Jim. *The boat owner's wife is Martina.* If we look at the boat records, it leaves on the 18th, it says there were two boats that came in. I am going to put Sunny Jim in.
1BBii	Martina is the assistant manager of the Marina,
1BAiii	We know this happened in June. Do we know of any other drug delivery?
1BBiii	There was some drug delivery 12th December 2011 at Angel Warehouse – it must be in Leeds as the station is Leeds.
1BAiv	Oh no, no, that's when it is recorded. It doesn't say when it happened.
1BBiv	Can we find out?
1BAv	This is when the interview happened, but it doesn't say when the drug delivery happened. We have a delivery on 18th June 2011.
1BDi	So that's evidence.
1BAvi	A boat arrived, a van moved. We have name around that. That's the only drug delivery we have evidence for. That's the boat that came to Exmouth Harbour. What I am asking for is has anyone else found other evidence of drug delivery anywhere else?

Table 3

Participant	Participant Statement
2CBi	Is there anything on Pierre the anonymous Frenchman?
2CDi	He's been calling all over the joint.
2CAi	Go for the guy in France. Get Interpol involved.
2CBii	Who are we going for?
2CCi	Sarti
2CAii	Oh, I disagree.
2CBiii	Calabrese was a chauffeur. The new driver lives next door to Sarti. She is well connected.
2CAii	We need to take out the source in France to bring down the whole network.
2CCii	Taking her out wouldn't bring it all down.
2CAiii	Pasquidini is connected. Bring him out. He has links.
2CBiv	All we have is the phone records. He lives in the same place as the drugs come from. So what is the evidence against him?
2CAiii	It's the number of contacts on the phone records and he's on the Ricord books.

Table 4

Participant	Participant Statement
2CAi	What's the boat called?
2CCi	Sunny Jim. Condiere is the owner.
2CBi	Sarti can't be the driver because Calabrese was arrested. He took the van to Exeter.
2CEi	Why £26k to Ricord? A bit excessive. Money to Sarti.
2CAii	I don't think she's important enough to go after.
2CBii	There's not enough evidence.
2CCii	What evidence have you got? There's statements and phone records.
2CDi	You could go after Pico.
2CCiii	Is there anything to link him to the drugs?
2CDii	He will take you to her. She's the one linked to everyone.
2CCiv	She lives next door to Pico, who is a chauffeur. They paid his bail so they don't want him talking.
2CBiii	*He obviously knows her.*
2CCv	Sarti's paid by Grosby who also pays Ricord who pays the chauffeurs.

Table 5

	Version One	Version Two
Suspects	Sarti (4/5); Denise Ajachinksy (4/5); Grosby (3/5); Condiere (3/5); Pico / Cobo (3/5)	Sarti (3/3); Pasquidini (3/3); Pico / Cobo (2/3); Calabrese (2/3)
Evidence	Accounts (4/5); Phone records (4/5); Harbour logs (3/5)	Harbour logs (3/3); Accounts (3/3); Phone records (2/3)
Location	Leeds (3/5)	Leeds (2/3)

Figure

Figure1: Data Frame Model of Sensemaking [Robert Hoffman, private communication]

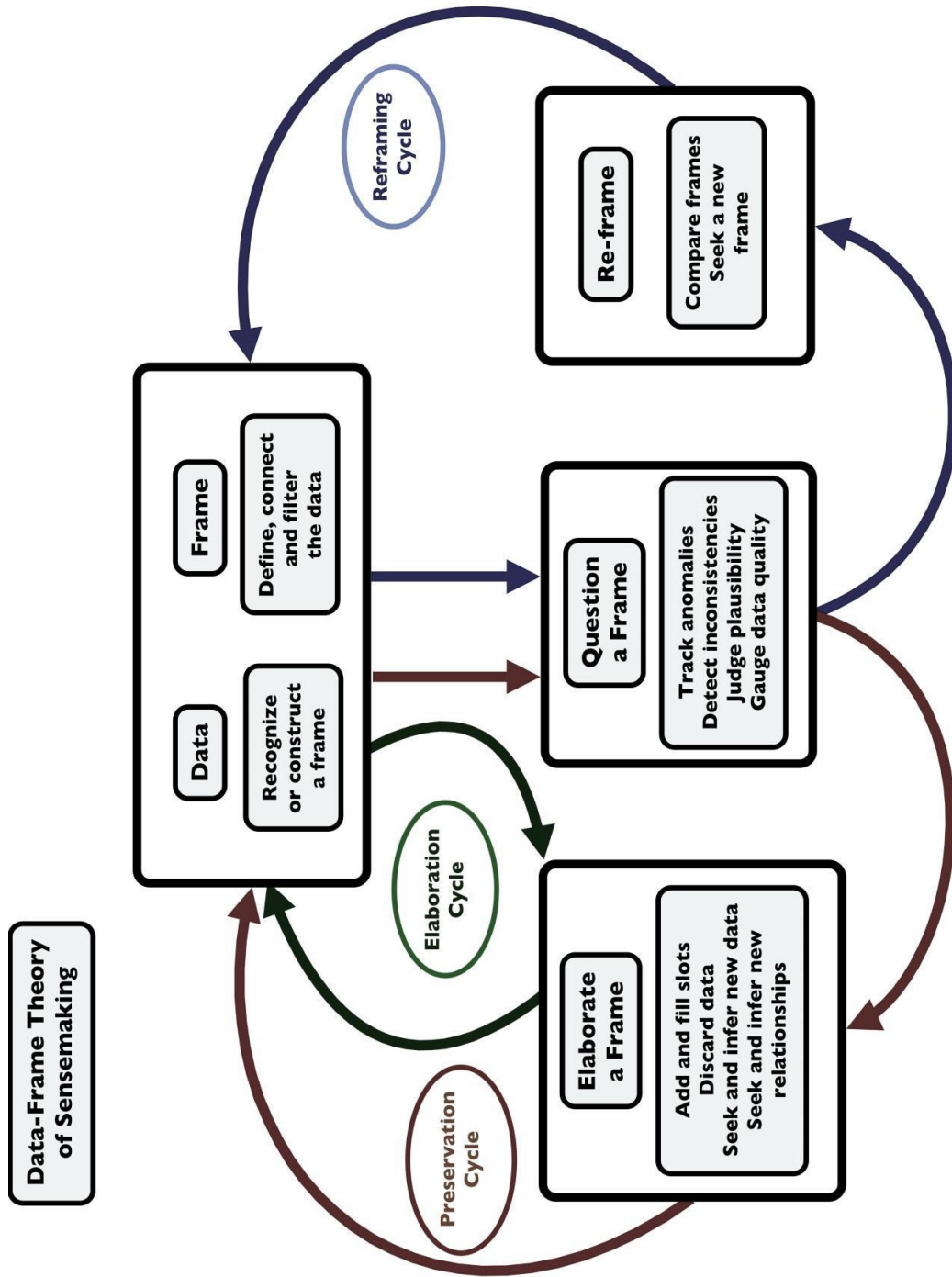Figure 2: Materials used in the North x Southwest Exercise

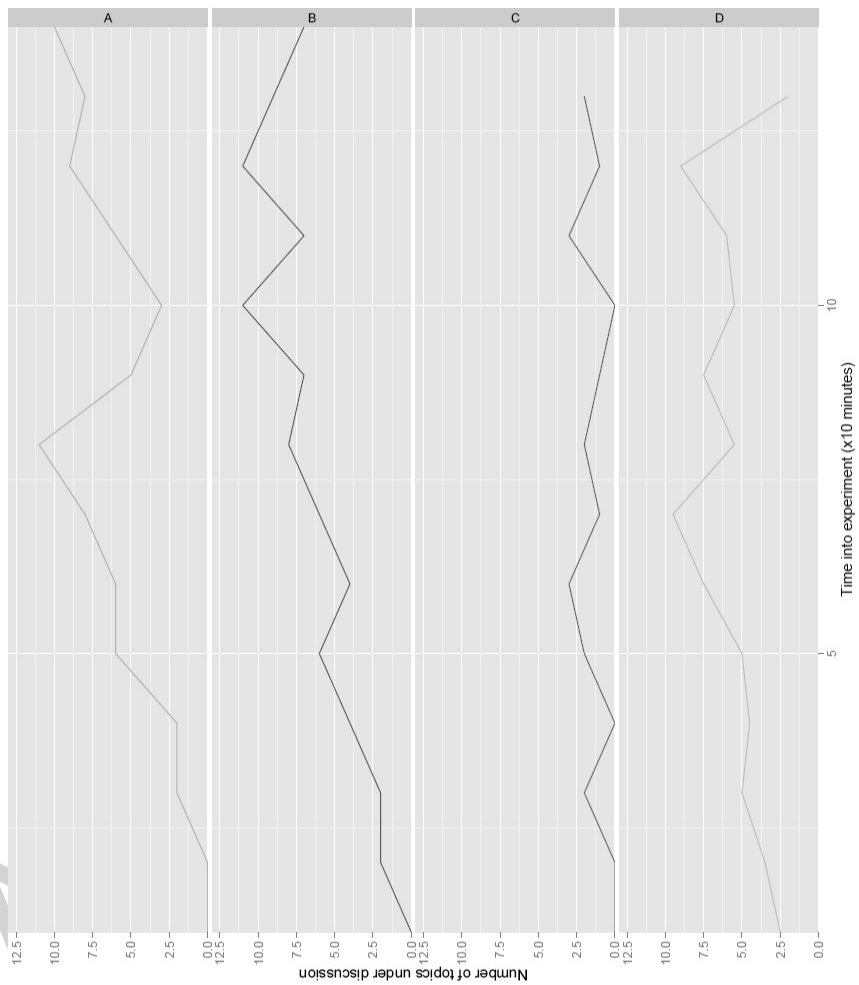Figure 3: Numbers of topics discussed by each group in version one

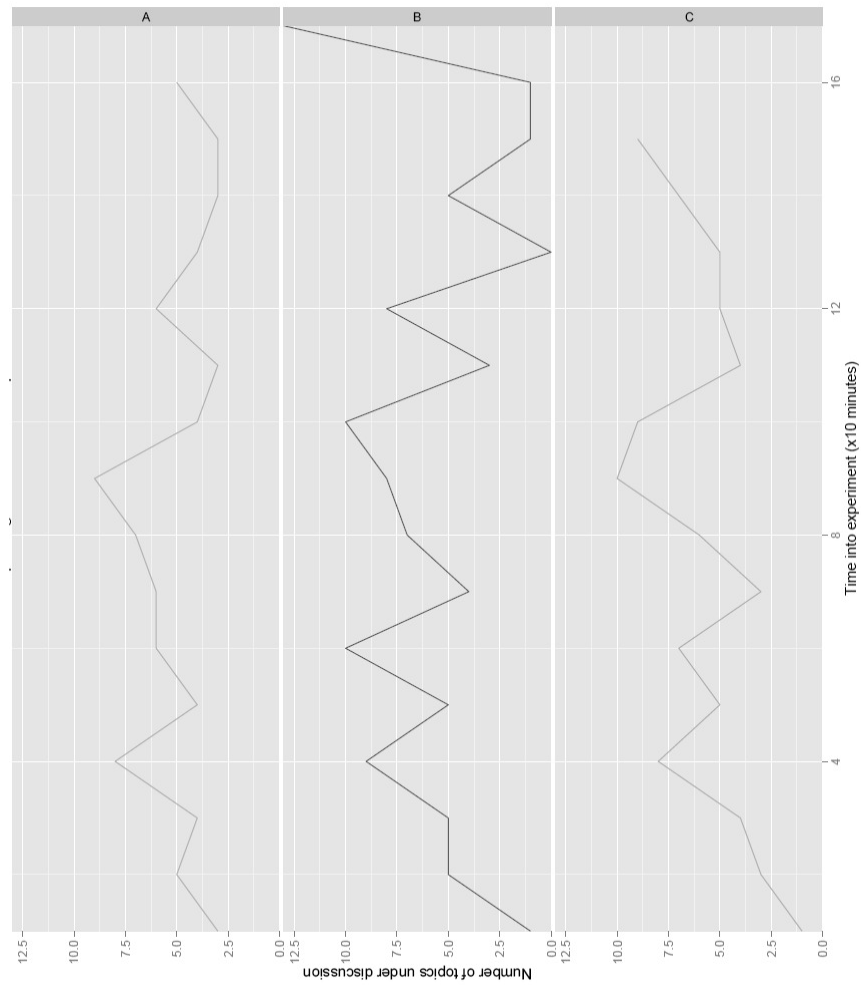Figure 4: Numbers of topics discussed by each group in version two

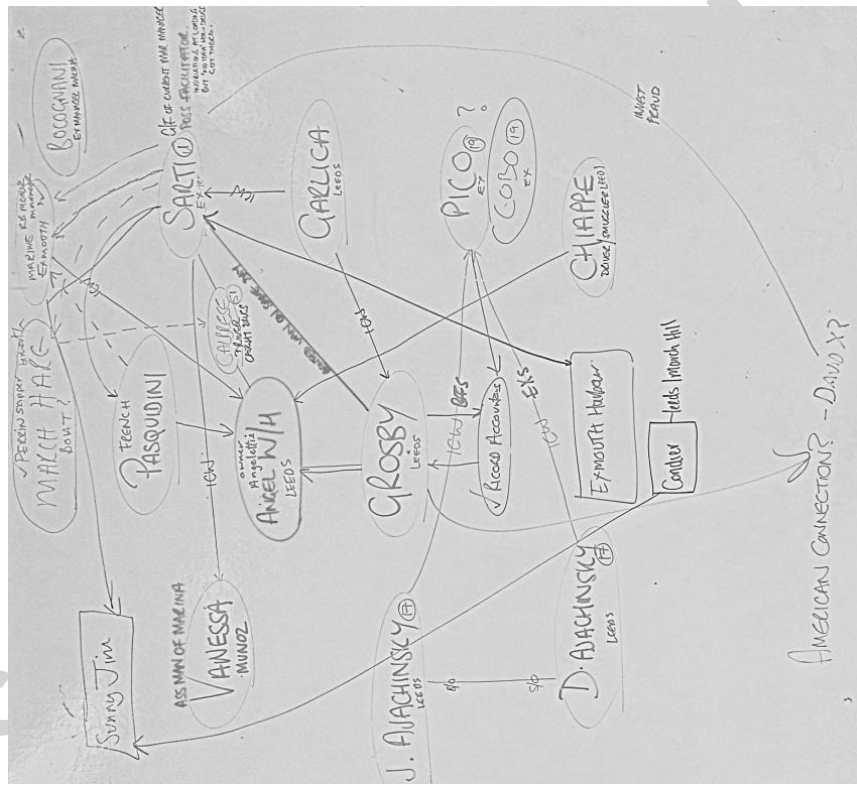Figure 5: Link diagram constructed by group 2B

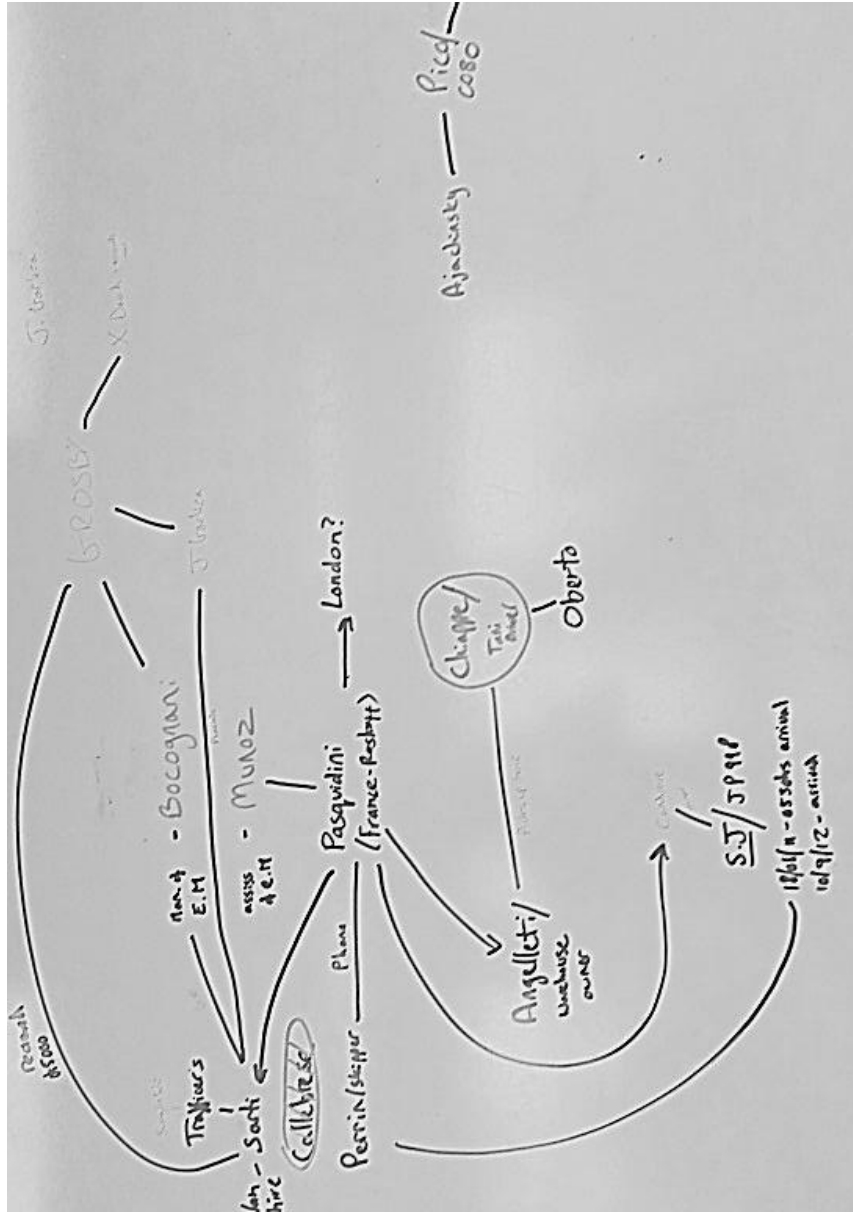Figure 6: Link diagram constructed by group 2C at the start of the exercise

Figure 7: Link diagram produced by group 2C as they refocused their discussion (note how SARTI features in the top right of this diagram)