

# The role of artefacts in Police emergency response sensemaking

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## ABSTRACT

This paper presents a study of the role of artefacts in sensemaking during emergency response. A qualitative study was conducted with two UK Police Forces, with a particular focus on the role of artefacts in the creation and modification of sensemaking frames. This research demonstrates that sensemaking is a key component of emergency response Command and Control and that this activity is distributed across the individuals within the system. Collaborative sensemaking is coordinated via social and organisational means, supported by a range of private (informal) and shared (formal) artefacts, which function as resources for action – cueing frame seeking and frame-defined data collection. The study also reveals the role of narrative in bridging the gap between these two parallel sensemaking processes and raises implications for the further digitisation of the emergency response environment, demonstrating the importance of balancing social and technical factors in the design of ICT for emergency response.

## Keywords

Command and control; communications; distributed cognition; emergency response; sensemaking.

## INTRODUCTION

### UK emergency response Command and Control

Response to emergencies involves a distributed network of individuals sharing information through a range of technologies. During the initial response phase of an incident, often very little relevant information may be available to the responding organisations, but it is imperative that the Command and Control (C2) system makes sense of the unfolding incident and identifies the most appropriate course of action (Jensen, 2009). In recent years, a combination of technological innovation, performance demands and financial pressures have led to a prolonged period of change within UK emergency services in respect of work practices, personnel levels, organisational structures and information and communication technologies (ICT). Whilst these changes represent potential opportunities to improve the way in which emergency response activity is coordinated, all too frequently new technologies are imposed upon an organisation without any appreciation of the pre-existing social and organisational characteristics (e.g., the well-known case of the London Ambulance Service computer-aided dispatch system (LASCAD) project failure reported by Beynon-Davies, 1999). In discussing technological support for C2 in large-scale disasters, Khalilbeigi, Bradler, Schewizer, Probst, and Steimle (2010) note that users retain an attachment to established work practices and low-tech artefacts, such as pen and paper. There is therefore a tension between the desires of organisations to use technology to enhance emergency response C2 and the preference of many employees for the flexibility afforded by less formal alternatives.

### Sensemaking

Sensemaking has been adopted as both a methodology and subject for research in a number of previous ISCRAM papers (c.f. Landgren, 2004; Muhren, Van Den Eede and Van de Walle, 2008; Muhren and Van De

Walle, 2009). Sensemaking is conceptualised as the ongoing process by which people identify problems, construct meaning and develop explanations (Weick, 1995). In contrast with decision-making, which addresses the question of *what shall we do*, sensemaking is a prospective processes that aims to establish *what is going on* (Landgren, 2005). Landgren (2004) describes sensemaking as the progressive clarification of a situation, which involves an iterative process of ‘committed interpretation’, where an individual’s behaviour (actions) influences further sensemaking (and further actions). In this way, sensemaking is about more than just interpretation, but is instead the study of how people “*generate what they interpret*” which is a plausible, coherent understanding, rather than an attempt at accuracy (Weick, 1995). Social interaction is a central feature of Weick’s (1995) sensemaking framework, being seen as a collective process performed by people involved in equivocal situations. The meaning and significance of elements within a situation may be open to different interpretations; consequently, the expertise and experience of those actors involved in the process of action and interpretation are seen as crucial variables in resolving uncertain situations (Weick, 1988; 1995). The vital role of communication means that researchers are able to directly observe the important elements involved in sensemaking, through the study of social interactions and the ICT in use (Landgren and Nulden, 2007).

Klein, Moon and Hoffman (2006) have developed the data/frame model of sensemaking. In this model, frames take the form of a retrospective narrative account, based on expertise and experience – and are used to organise data and anticipate future events (Pirolli and Card, 2005). For Klein et al. (2006) the process of sensemaking involves the recognition and fitting of data into an appropriate frame, which then guides further data collection and influences the filtering of data viewed as relevant to the situation. These processes of frame construction and modification, and frame-defined data collection are thought to occur in parallel (Klein et al., 2006). For Minsky (1975, cited in Klein, et al., 2006) frames primarily serve to aid recognition, by guiding attention to fill in the missing elements of the frame and to search for information that allows the frame to be tested. Pirolli and Card (2005) followed by Attfield and Blandford (2011) give complimentary accounts of intelligence analysts and legal teams creating and manipulating a range of artefacts (including maps, databases and networks), in order to make sense of and communicate their findings during investigations. Treating external representations as frames moves beyond the purely ‘in the head’ view of sensemaking and towards one in which sensemaking is a technologically mediated activity (Attfield and Blandford, 2011).

### Distributed cognition

Distributed cognition (DC) is the study of cognitive processes of groups of individuals and artefacts (man-made objects) engaged in the performance of a task (Artman & Garbis, 1998). DC studies cognition at the systems-level, with proponents arguing that these cognitive processes are emergent properties of the whole system and are distributed across it, rather than being contained within a single individual (Artman & Garbis, 1998). This is possible because any unit – regardless of size – that is engaged in problem solving can be defined as a cognitive entity (Perry, 2003). In the context of this research paper, ‘artefact’ refers to a cognitive artefact – i.e., any object within the environment that is designed or adapted to serve an information processing function. In order to reduce the load placed upon limited mental resources, individuals often make use of physical objects in the environment, for example instrumentation on machinery or handwritten notes. These artefacts can serve as external memory cues, reducing mental workload during complex problem solving (Norman, 1993). Unlike traditional descriptions of individual cognition, where representations of knowledge are held within the individual’s mind, within a distributed cognitive system artefacts themselves act as representations of task relevant information and the system arrives at its goal-state by performing transformations upon these representations (Perry, 2003). The transformation of representations is achieved by combining, interpreting and re-presenting information provided by both artefacts and individuals in the system (Hutchins, 1995; Artman & Garbis, 1998). Consequently, artefacts are viewed as representing the critical information within a work domain (Nemeth and Cook, 2004). Therefore, the DC approach may reveal cognitive processes that would not be found by research methods that examine individual-level processes.

The DC concept of artefacts functioning as ‘resources for action’ argues that their design, appearance or functionality may act as prompts for agents to perform certain activities, without consciously reflecting on them first (Fields, Wright & Harrison, 1996). This mirrors the sensemaking view of artefacts as schema:

*“Referred to as frames, or schemas these representations are used as aids which guide interaction with the data and influence the ways in which it is understood and accounted for.”*

(Faisal, Attfield and Blandford, 2009, page 1)

Baber, Smith, Cross, Hunter and McMaster (2006) investigated the role of artefacts in the process of Crime Scene Investigation; they made a distinction between informal artefacts (which are used to make sense of a crime scene) and formal artefacts (which form part of the final report). Baber et al. (2006) also described the development from informal sensemaking to formal reporting of the investigation as a process involving the

construction of different forms of 'narrative'. Similarly, Paul, Reddy and Abraham's (2007) investigation of collaborative sensemaking during emergency medicine differentiated between the 'structured' (i.e. formal) articulation required for ICT and the use of low-tech artefacts (pen and paper, whiteboards) for unstructured (i.e. informal) articulation. However, whilst Paul et al. (2007) allow for the possibility that artefacts facilitate sensemaking, they appear to view artefacts as merely transferring information between actors, rather than as an integral component within sensemaking. There is therefore a requirement for further work to examine the role of artefacts in real-world emergency response sensemaking from a distributed cognition perspective, specifically – to address the question of how artefacts might be involved in the processes of frame construction and modification, and frame-defined data collection.

## INVESTIGATION

The aim of the paper is to develop the current understanding of sensemaking in emergency response C2, through the application of the distributed cognition approach to examine the associated social processes and technological artefacts. In order to obtain a representative view of emergency response work, an extended period of data collection was conducted with two UK territorial Police forces between 2004 and 2010. The forces in question border each other and whilst they perform fundamentally the same emergency response activities, they are very different in terms of size, C2 structure, geographic area and populations served. Force A is one of the largest forces in the UK, covering a densely populated urban area, whilst Force B serves a larger, sparsely populated and predominantly rural area and at the same time is one of the smallest forces in the country.

### Data collection

In line with previous studies of sensemaking in emergency response (c.f. Landgren, 2004; Paul and Reddy, 2010) and in order to study both social and technical components of sensemaking within the C2 system, this work was conducted using an ethnographically informed multi-method approach. This included the use of three main data collection techniques: observations, interviews with emergency services personnel, and participant observation; these are summarised below.

A series of observation sessions were held at Force A's Communications Centre and within two of the local police stations. These sessions took place over an extended period from May 2004 to December 2008. A shorter series of observation sessions was conducted within the Control Centre of Force B between July and September 2009. Data collection methods included observation and shadowing of staff, document and incident record analysis. The purpose of these observations was to develop an in-depth understanding of the work of the various control centre staff and the role that artefacts play in their activities.

During the observation sessions, semi-structured interviews were carried out with experienced personnel from both forces. Personnel interviewed were drawn from all stages of the emergency response process, including Police Officers (Constables, Sergeants and Inspectors) and civilian staff (Call Handlers and Controllers). At least five individuals of each role were interviewed, firstly to ensure that a representative view was obtained, but also to enable an iterative approach (i.e. a cyclical process of repeated data collection, analysis and reflection) to the formulation of an understanding of the process and the role of artefacts during emergency response work.

From September 2007 to September 2010, the researcher collected data whilst working as a Special Constable with Force B. The rank of Special Constable is an unpaid voluntary position, which confers all of the powers of a regular (paid) Police Officer. Special Constables wear full Police uniform and perform the same duties and activities as regular Officers. During this time, the researcher accrued over 900 hours of police activity, 637 of which were in front line operational policing duties and a further 180 hours in completing police training. The majority of front line policing hours (over 400) were spent as one-half of a two-officer 'reactive' patrol crew (partnered with a regular Police Officer) deployed on patrol in a marked police vehicle and regularly responding to emergency calls. 55 operational hours were spent on patrol with Force A, as part of a temporary secondment that was approved by the two forces to enable comparative data collection for this research.

During the participant observation phase, observations and notes were made in a similar manner to that of Borglund and Nuldén (2008) in their study of sensemaking in police work: informal conversational interviews during patrols with crewmates were conducted and observations of face-to-face and radio-based conversations between Police Officers and with Controllers were made. Notes were taken during patrols whenever possible; research notes were often made in parallel to police notes during the shift and were supplemented with reference to electronic incident logs for timings and other details. Additionally, reflective notes were compiled in a field diary after each shift. This process enabled the activities of front-line Police Officers and the wider C2 system to be experienced directly and then reflected upon, prior to the next observation session. Data collection was

initially unstructured and was intended to develop the researcher's understanding of the domain; this was later followed up by more structured data collection that focused on specific aspects of emergency response work, for example looking at the nature of radio communications and the role these play in sensemaking.

## Analysis

In a similar manner to several earlier ethnographic studies of emergency response work (Landgren, 2004; Paul, Reddy and Abraham, 2007; Muhren, et al., 2008; Borglund and Nulden, 2008) sensemaking has been adopted as a theoretical lens through which the data collected were analysed. In particular, for the purposes of this paper, we looked at artefacts in terms of their formal purpose, their role in collaborative sensemaking and their suitability to that role. Confidence in the veracity of the findings was achieved through a number of measures; firstly, collecting data with two very different Police Forces permitted comparison and gave a level of assurance that the findings were not merely due to local idiosyncrasies. Secondly, the iterative approach to data collection and analysis allowed the researcher to check their understanding with emergency services personnel at regular intervals. Finally, the multi-method approach enabled the triangulation of findings. All of the activities described were consistently observed throughout the observation period and form an integral part of the standard response process.

## FINDINGS

A number of artefacts have been purposely designed to capture and share information during the emergency response process, such as electronic incident management systems (IMs) and Airwave - the digital radio communications system. However, during sensemaking activities individuals will modify their use of these artefacts, or improvise new ones, in order to better support sensemaking activity. The focus of the research was on developing a description of the way that the C2 networks of the two forces make sense of unfolding emergency incidents; the following pages provide a description of the process routinely used when responding to 999 (emergency) calls, along with the artefacts that support sensemaking activities during this response.

### Making sense of the emergency call

999 calls are first answered by an operator who will ask the caller to specify an emergency service; once a service has been selected, the call is then passed on to a Call Handler within the geographic area where the call originated. The Call Handler's role is to gather details from the caller and establish the nature and severity of the incident. Incident details are entered into an electronic log, which is then passed to a dispatcher (generally known as Controllers, or 'Control'), who are either in the same control centre, or distributed across local control rooms, depending on the structure of the force. A number of commercial IMs are available; Force A uses DOS-based 'OASIS' (Operational and Support Information System) whilst Force B uses windows based 'STORM' (System for Tasking and Operational Resource Management).

When a call comes in, the Call Handler uses the call handling software (labelled '1' on Figure 1, below) to answer the call. Answering a 999 call causes the IM to automatically open a new log (2) and populate some of the log fields with information, such as the calling number and address (this depends on the telecommunications company handling the call). The Call Handler will greet the caller with a phrase such as "*Police Emergency?*" prompting the caller to state the reason for their call. As the caller is speaking, the Call Handler may check that a log has not already been created for the incident (3) before entering any details into the log for this call.

The Call Handler's notepad (4) plays an important role as a private cognitive artefact, by assisting the Call Handler in initially making sense of the call. Members of the public who call the emergency services are often in a highly agitated state and rarely impart information in a logical manner, repeating themselves or giving less significant details first. It is imperative to not only handle the call efficiently, but also to verify that it is a genuine emergency and the specific nature of the incident. As the caller gives their initial account, the Call Handler is able to quickly note key details of the incident on their notepad, such as location, type of emergency and persons involved. The Call Handler will then take control of the conversation, using the information on the notepad to engage in frame seeking by i) cueing further questions to and clarification from the caller and ii) checking their understanding by verbally summarising the incident back to the caller. This is an iterative process, with the Call Handler's notes and the caller's responses cueing further questions from the Call Handler, until they are clear as to the nature and severity of the incident. The incident log also acts as a resource for action, by requiring that the Call Handler select from a defined set of incident types that may be used to classify the nature of the emergency. For example, the Call Handler would immediately recognise that caller's statement "*My boyfriend's phone has just been stolen*" fits with the 'Robbery' incident type, though more often a period

of information seeking and clarification with the caller is required. When recording the incident in the log, the Call Handler enters the minimum amount of information necessary to describe the key details of the incident, rather than typing up the full account from the caller verbatim. The language used may also change, as call details are converted from plain English into abbreviations and standardised Police jargon, for example, the description of an offender may change from “white lad” to “IC1 male”, which is the relevant UK Police National Computer Ethnicity Classification. Abbreviations and acronyms are also employed, for example “My car has been stolen” is formalised within the Police as “Theft of Motor Vehicle”, which is written as “TOMV”. In this manner, the Call Handler constructs a succinct narrative to make sense of the incident, which they use to translate details from the informal (notepad) to formal record (IMS). At the same time, the structure of the IMS and the formalised language required for incident logs serves to match the incident to a recognisable frame (i.e. incident type). Whilst the use of the notepad leads to a small amount of duplication of activity (i.e. capture of information twice), it arguably saves time overall, through the production of a clear, concise incident summary.



**Figure 1: A Call Handler's workstation from Force B**

Given the emergency nature of the incident and the fact that the call may end at any point, the important consideration is to quickly gather the fundamental information required to initiate the response – i.e. the location and an approximate description of the incident. As soon as the Call Handler has entered this information, they will send the log to the Controller and then continue to talk to the caller. The IMS automatically validates the location information entered and sends the log to the Controller for the relevant geographic area, therefore without a location the log cannot be passed on. Where the caller does not know their exact location or the call is cut-off midway, Call Handlers will instead give an approximate location. The IMS used in Force A requires a house name or number, so the Call Handler will give a house number such as “9999” (i.e. higher than would be found in the UK), which satisfies the IMS and indicates to the Controller that the exact location is not known. In Force B, Call Handlers are able to leave the house number field blank, which automatically creates the entry “Exact address not known”.

### Supporting responding units

As they make their way to the incident location, Officers begin to make sense of and plan their response to the incident. As the Conflict Management Model (Figure 2) suggests, this includes considerations of risk (threat assessment), powers and policy and tactics. Although the Officers will have received some initial details from the Controller, these are often only the bare minimum, such as an approximate location and a statement of the nature of the incident, for example “male being assaulted by two males”. The first indication of the level of risk associated with the incident (both to members of the public and the responding Officers) and consequently the appropriate response, will come from the type of incident. Officers will also use what is known to cue frame-defined data collection; this is done via a series of questions to the Controller, who in addition to the IMS has access to a range of databases and information sources not available to the response Officers. For example, if there is a specific location for the incident (such as a residential building) Officers may ask the Controller to check IMS for: previous emergency calls to that location, details of any persons associated with that location and any previous convictions or warning markers (e.g. for violence or weapons) associated with those individuals. Whilst single-crewed Officers would struggle to interrogate IT systems whilst en route to an incident, for double-crewed units and once at the scene, the lack of direct access to IMS and police databases creates a barrier to sensemaking, as these artefacts are not able to cue the Officers' frame-defined data collection directly. Controllers usually manage several ongoing incidents at once, so they have limited time to pro-actively seek out and push relevant information to the Officers.

If the Call Handler adds updates to the log (e.g. description of an offender, their direction of travel, vehicle, etc.), these will be visible to the Controller, who passes them to the Officers. On receiving further updates from the caller, the responding units may change their tactics, for example, if the offender has left the scene Officers may decide to perform a search of the area before speaking to the victim, in the hope of quickly catching the offender. If multiple units are en route, then they may either split the tasks between them, or coordinate their activity; for example, when responding to an attempted theft, unit A asked “*What direction are you coming from?... We will come round the other way.*” To which unit B replied “*We are coming from the station.*”

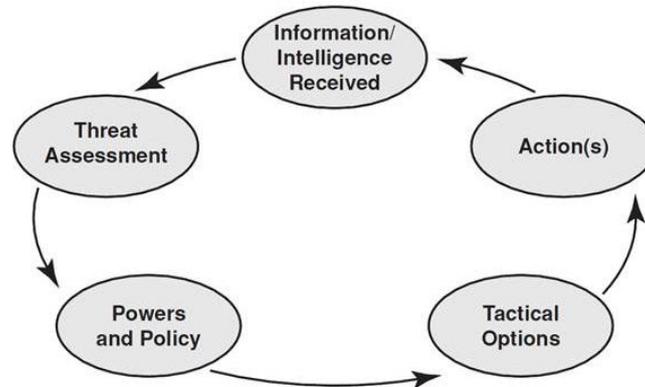


Figure 2: The Conflict Management Model (adapted from NPIA 2010, page 45)

### Sensemaking at the scene

As they arrive at the scene, responding Officers notify the Controller (who updates the incident log); the Officers may be confronted by an ongoing emergency, or they may find that the immediate threat from the incident has stopped. Either way, in order to achieve the goals of restoring order, preserving life and property and the detection of offences and offenders (HM Government, 2002), their response to the incident is concerned with two interrelated high-level tasks: i) controlling and resolving the situation and ii) performing an initial investigation of the events surrounding it. This is complicated by the fact that many of the incident details known so far may well be inaccurate, including the caller’s account of events, the names or descriptions of parties involved and very often the nature of the incident itself (i.e. the frame selected by the Call Handler during the initial call). The Pocket notebook and Airwave (the UK’s secure digital emergency services radio network) support many of the activities associated with making sense of the incident.

The pocket notebook is intended to give Officers somewhere to record information when dealing with incidents, such as witness accounts, details of evidence and the Officer’s narrative description of the incident. Whilst the pocket notebook is principally for an Officer’s own use, the information recorded here will form the basis of subsequent investigatory paperwork. It may also be referred to by the Officer when giving evidence in court (potentially years later) and therefore may be examined by lawyers or court officials. Consequently, there are strict rules governing when and how the notebook is used, in order to support the reliability and accuracy of entries. However, over the course of the participant-observation period of this research, it gradually became apparent that many Officers had modified their use of the notebook, employing the back pages to support sensemaking in a similar fashion to the Call Handler’s notepad described earlier. As details of the incident become known during an Officer’s enquiries (e.g. vehicle registrations, names, locations or descriptions of suspects), they are often recorded in the back of the notebook; these details are used to cue further information gathering from witnesses, as well as the Officer’s actions, such as searching the area and questioning individuals that match the description. With support from the Controller, Officers often use their notebooks to their advantage during their enquiries, for example if they suspect that someone has given false details in order to avoid detection (e.g. if they are wanted, have no insurance or driving licence). Details given by the individual (i.e. name, date of birth, home address) are recorded in the notebook and checked on Police databases (via the Controller over the radio). If these checks are negative, the Officer will ask the individual to repeat their details and provide further information, such as other persons living at an address (who will be listed on the electoral register). Through this process, the deception becomes clear and Officer’s will then take appropriate action. In this manner, the notebook supports both frame-defined data collection and reframing of the incident.

Airwave replaced analogue channels with talk groups that enable all units within a functional group to hear one another’s broadcasts. Although audible to all users, the vast majority of radio traffic in the talk group is either to or from the Controller, though Officers wear earpieces and monitor the talk group constantly during their shift, to keep track of the activities of their colleagues. Depending on the type of incident (e.g. those involving

violence, weapons or several offenders) the level of risk to the public and responding Officers may be greatly increased. Controller periodically hail Officers attending higher risk incidents for a 'welfare check'; in such situations, welfare checks are frequently prompted by other Officers, demonstrating that they are monitoring each other's activities via the radio, in the event that support is required. As the incident develops and further details become apparent, other units monitoring the incident may pro-actively state their intention to attend the incident, to increase the number of Officers and decrease the level of risk. For example, where checks on a driver that has been stopped reveal that they have warning markers for violence towards Officers, another unit will frequently volunteer to drive by and 'fly the flag' (i.e. make a show of strength).

All incident updates radioed to the Controller are recorded in the incident log, providing a record of actions taken as part of the incident response and enabling supervisors and other Officers to monitor events at the scene. Airwave also supports collaborative sensemaking at the scene, by enabling discussion between officers that have split up to deal with an incident (e.g. to talk to different witnesses or to conduct searches). This is often done using direct radio-radio transmissions (known as point-to-point); this frees up airtime on the Talk Group (which is shared across all ongoing incidents) and means that Officers are able to discuss the incident in greater detail. However, these discussions cannot be heard by other agents, thus limiting their ability to monitor developments and intervene, either with information or to attend the scene.

Once the incident has been resolved, the Officer will radio the Controller with a final update that summarises their assessment of the incident and the actions taken. This narrative could be as short as "*One under arrest for drunk and disorderly – transporting to Custody*", but may be more lengthy for complex incidents. The Controller will add this final update to the incident log, which is then closed. As soon as is practicable – which may be several hours later, if an arrest has been made – the Officer will update the front of their pocket notebook with a more detailed account. Now that the incident has been resolved, the Officer is able to formulate their impressions regarding the events and can re-order the fragments of information from the back of their notebook into a narrative of the incident that coherently relates what they saw, the decisions and actions they took and the outcome. Their entry in the front of their notebook is therefore not merely the relaying of a series of events, but also involves a retrospective interpretation of the meaning of those events, i.e. sensemaking. The re-presentation of incident information from the back of the notebook to the front should not cause concerns regarding evidential accuracy, as no information has been lost; however, it does reveal that the notebook serves an additional sensemaking function, beyond merely being a personal record of events. The bridge between the disjointed 'raw' information (captured informally in the back of the notebook) and the formal record of events in the front is the Officer's retrospective narrative of the incident. In this way, Officers' pocket notebooks perform a similar role to the Call Handler's notepad and IMS. However, the pocket notebook has a much lower potential to support collaborative sensemaking during the incident, as unlike the IMS their contents are not readily accessible by other agents. Much of the contents of pocket notebook entries may already have been captured within the IMS (such as locations, incident timings and names of individuals involved) and any paperwork resulting from the incident is likely to require any additional information to be copied from the notebook into another form, thus increasing the amount of work to be undertaken.

During their response to an incident, Officers may work through the Conflict Management Model a number of times, as they define and redefine the incident in light of new information. This process bears some similarity to Pirolli and Card's (2005) model of sensemaking for intelligence analysis; the back of the pocket notebook functions in a similar manner to their 'shoebox' and 'evidence file' for information capture and organization, whilst the front of the notebook captures the post hoc final evaluation (which will be presented in subsequent crime file paperwork). This lends credence to the suggestion that emergency response sensemaking activity is mediated by artefacts, both through formal procedures and informal practices. The use of the term 'Action(s)' in Figure 2 is somewhat misleading; 'Action(s)' refers to the formative response to the incident (e.g. locate and arrest suspects; seize evidence), rather than the summative sensemaking actions that are carried out by Officers throughout the incident, as they act upon and receive feedback from their environment.

### Improvised artefacts

Officers occasionally find themselves in situations where no suitable artefact exists, in which case they will improvise new ones. When an arrest is made, the prisoner is transported to the station, where the arresting Officer will need to give an account to the Custody Sergeant, who will decide whether to approve the prisoner's detention. This account needs to include certain details, such as the time and location of the arrest, as well as the time of arrival at the police station. However, during busy periods (and particularly in large rural forces), it can often be over an hour from the time of arrest to speaking to the Sergeant, during which there may be limited opportunity to make a pocket notebook entry. Officers regularly wear disposable gloves during searches and

arrests, and in a similar manner to emergency medical practitioners (O'Connor, 2010), they will often write on the back of the glove in situations where it is not practicable to make an entry in their pocket notebook.

A second example is shown in Figure 3 – a Traffic Officer has used a china graph pencil to convert their Police motorbike petrol tank into an artefact. The Officer has recorded a summary of various pieces of information required for their intercept role during a large traffic operation, including geographic locations (motorway junctions), individuals and roles (names and call signs) and communications (Airwave talk groups). This operation involved a high level of coordination between Traffic Officers, as vehicles of interest to the Police were identified and stopped. The notation on the fuel tank means that by glancing down, the Officer is able to remind themselves of any of these details whilst riding on the motorway, without having to pull over to check their pocket notebooks or radio the Controller.

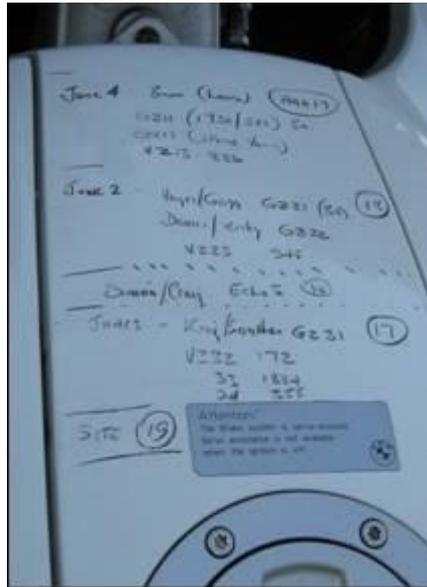


Figure 3: Notes made on a police motorbike fuel tank during an traffic operation

## DISCUSSION

The use of artefacts to store and represent information, to support reflection and reinterpretation, to cue activity and the communication of findings, provides a mechanism by which sensemaking may be carried out amongst distributed groups working on a common task. Shared artefacts are used to facilitate information capture, storage and transformation within emergency response C2 networks, which supports the assertion that these shared representations of information are acting as the frames for emergency response sensemaking. The roles of these artefacts are summarised in Table 1.

The IMS in particular plays a crucial role during sensemaking, enabling information sharing between the actors involved (either directly or indirectly) and representing the ongoing ‘working hypothesis’ for the incident, which is revisited and reviewed repeatedly during the response. The IMS fulfils multiple roles, acting as a central record of activity (for audit purposes), a resource for action, a shared narrative of the incident (described in a shared language) and a system for allocating ownership of incidents. Whilst the contents of an incident log may be submitted as evidence in a court of law, entries made whilst the incident is ongoing are considerably ‘rougher’ than the more polished narrative summaries provided elsewhere, as the primary concern at this stage is the pooling of information about an ongoing and highly uncertain sequence of events. The current emergency response organisation faces some challenges to collaborative sensemaking, notably the information ‘bottleneck’ that occurs between the control room-based activities (Call Handling and Controlling) and the response on the ground. Officers responding to an emergency have limited (and indirect) access to electronic information sources, whilst Controllers frequently do not have current information on locations and status of officers. This creates difficulties for the parallel activities of making sense of a specific emergency and making sense of the wider task of managing the combined response to all open incidents.

These findings share similarities with Baber et al. (2006) and Paul et al.’s (2007) views of artefacts supporting parallel processes during collaborative sensemaking. Firstly, there is a formal (procedural) process by which the current understanding of the situation is captured (in a frame) and shared using Police terminology via the IMS and the radio; this forms the basis of an official record of the incident response. There is also an informal

process by which private artefacts (notepad and back of notebook) are used to capture unstructured notes and thereby support individuals as they make sense of events (frame seeking). Agents involved in emergency response construct narratives in order to move details between these two processes and to fit the incident data into a frame that will be recognised across the network of incident responders.

Artefact	Formal Purpose	Sensemaking role	Evaluation for sensemaking
Call Handler's Notepad	A temporary record of call details	A private resource for action, cueing of frame seeking activities	Pro: Supports unstructured data capture Con: Required to re-enter information
IMS incident log	The sharing of emergency incident details A permanent record of actions taken	A shared resource for action, prompting frame-defined data collection Capture and sharing of the formalised incident narrative	Pro: Enables rapid sharing of key incident information Con: Lack of access for response Officers can create an information bottleneck
Force databases	The review of information relating to the incident	A shared resource for action, cueing frame seeking	Pro: Enables rapid retrieval of key incident information Con: Lack of access for response Officers can create an information bottleneck
Airwave	Enable incident response communications	Supports collaborative sensemaking	Pro: Enables mutual monitoring within talk group Con: Use of point-to-point excludes other users and limits information exchange
Pocket Notebook	An Officer's formal record of the incident	A private resource, cueing frame-defined data collection and reframing of the incident. Capture of formalised retrospective incident narrative.	Pro: Supports unstructured data capture Con: Required to re-enter information Con: Duplication of existing information (within IMS log and databases)

**Table 1: The main artefacts involved in Police emergency response sensemaking**

The IMS could be viewed as an electronic, collaborative version of the pocket notebook, in that they both serve a number of similar functions as formal records of the events of the incident. The Airwave radio network supports the transmission of data and trials of in-car data terminals and PDA use by response Officers have begun in some UK forces. There may therefore be a temptation to replace the Pocket Notebook with an electronic equivalent, or instead to have Officers access and update the IMS directly. Whilst this may bring benefits in terms of improved information sharing with and between patrolling Officers, fully digitising the work environment may result in the loss of private artefacts and thereby negatively impact sensemaking, if information is not recorded or if the response process becomes overly formalised. Additionally, the tendency of individuals to improvise artefacts where no suitable one exists further warns against any attempt to redesign the emergency response process without providing private artefacts.

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## REFERENCES

1. Artman, H. and Garbis, C. (1998) Situation awareness as distributed cognition, in T.R.G. Green, L. Bannon, C.P. Warren and J. Buckley. (eds.) *ECCE 9: Proceedings of the Ninth European Conference on Cognitive Ergonomics*, 151-156. European Association of Cognitive Ergonomics (EACE), Le Chesnay, France.
2. Attfield, S. and Blandford, A. (2011) Making sense of digital footprints in team-based legal investigations: the acquisition of focus, *Human Computer Interaction*, 26, 1-2, 38-71.

3. Baber, C., Smith, P., Cross, J., Hunter, J. and McMaster, R. (2006) Crime scene investigation as distributed cognition, *Pragmatics and Cognition*, 14, 2, 357-385.
4. Beynon-Davies, P. (1999) Human error and information systems failure: The case of the London Ambulance Service Computer-Aided Despatch system project, *Interacting with Computers*, 11, 6, 699-720.
5. Borglund, E. A. m. and Nuldén, U. (2008) Making sense in proactive police work, in proceedings of *IRIS31 - The 31st Information Systems Research Seminar in Scandinavia*, 10-13 August, 2008.
6. Faisal, S., Attfield, S. and Blandford, A. (2009) A classification of sensemaking representations, in *CHI 2009 workshop on sensemaking*.
7. Fields, B., Wright, P. and Harrison, M. (1996) "Designing human system interaction using the resource model", in L. Yong, L. Herman, Y. Leung and J. Moyes, (eds) *Proceedings of the APCHI'96 conference*, pp. 181—191, Information Technology Institute, Singapore.
8. HM Government (2002) Police Reform Act, 2002, The Stationary Office, London.
9. Hutchins, E. (1995) "How a cockpit remembers its speeds", *Cognitive Science*, 19, 3, 265-288.
10. Jensen, E. (2009) Sensemaking in military planning: a methodological study of command teams, *Cognition, Technology and Work*, 11, 103-118.
11. Khalilbeigi, M., Bradler, D., Schewizer, I., Probst, F. and Steimle, J. (2010) Towards computer support of paper workflows in emergency management, *Proceedings of the 7<sup>th</sup> International ISCRAM Conference*, Seattle, USA, May 2010.
12. Klein, G. Moon, B. and Hoffman, R. R. (2006) Making sense of sensemaking 2: A macrocognitive model, *IEEE Intelligent Systems*, 21, 5, 88-92.
13. Landgren J. (2004) Fire crew enroute sensemaking in emergency response, *Proceedings of the 1<sup>st</sup> International ISCRAM Conference*, Brussels, May 3-4, 2004.
14. Landgren, J. (2005) Shared use of information technology in emergency response work: results from a field experiment, *Proceedings of the 2<sup>nd</sup> International ISCRAM Conference*, Brussels, Belgium, 2005.
15. Landgren, J. and Nulden, U. (2007) A study of emergency response work: Patterns of mobile phone interaction, in *proceedings of CHI 2007*, April 28-May 3, San Jose, California, USA.
16. Muhren, W., Van Den Eede, G. and Van de Walle, B. (2008) Sensemaking as a methodology for ISCRAM research: information processing in an ongoing crisis, *Proceedings of the 5<sup>th</sup> international ISCRAM conference*, Washington, DC, USA, May 2008.
17. Muhren, W. J. and Van De Walle, B. (2009) Sensemaking and information management in humanitarian disaster response: observations from the TRIPLEX exercise, *Proceedings of the 6<sup>th</sup> international ISCRAM conference*, Gothenburg, Sweden, May 2009.
18. Nemeth, C. and Cook, R. (2004) 'Discovering and supporting temporal cognition in complex environments' in *Proceedings of the National Conference of the Cognitive Science Society*, August. Chicago, IL.
19. NPIA (2010) Manual of guidance on keeping the peace, NPIA, Bedfordshire.
20. Norman, D. A. (1993) Things that Make Us Smart. Addison-Wesley, Menlo Park, California.
21. O'Connor, L. (2010) Workarounds in Accident and Emergency and intensive therapy departments: resilience, creation and consequences, MSc thesis, University College London.
22. Paul, S. A., Reddy, M. and Abraham, J. (2007) Collaborative sensemaking during emergency crisis response: how do ICTs help? In *proceedings of GROUP'07*, Nov 4-7, Sanibel Island, Florida, USA.
23. Paul, S. A. and Reddy, M. C. (2010) Understanding together: sensemaking in collaborative information seeking, in *Proceedings of CSCW 2010*, February 6-10, Savannah, Georgia, USA.
24. Perry M., (2003) "Distributed cognition", in J. M. Carroll (ed.) *HCI Models, Theories and Frameworks. Towards a Multidisciplinary Science*. Morgan Kaufmann, London.
25. Pirolli, P. and Card, S. (2005) The sensemaking process and leverage points for analyst technology as identified through cognitive task analysis, In *Proceedings of the International Conference on Intelligence Analysis*, 2-4 May, 2005.
26. Weick, K. E. (1988) Enacted sensemaking in crisis situations, *Journal of Management Studies*, 25, 4, 305-317.
27. Weick, K. E. (1995) Sensemaking in organisations, Sage, London.