Can Accident Investigation Tools Help Crime Scene Reconstruction?

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Abstract: The search for ways to improve present crime scene reconstruction practices is a continuing endeavor. Might the adaptation of tools used in the accident and incident investigation field be useful in that endeavor? That question was first addressed during the 2010 Association for Crime Scene Reconstruction Conference, at which some such tools were explored during an experimental demonstration. This article describes task similarities, and accident investigation concepts, principles and tools that might be adaptable to similar crime scene investigation and reconstruction tasks. Key candidates include viewing occurrences as processes, an iterative framework for investigations, and standardized input data structure.

Keywords: crime scene analysis, crime scene reconstruction, Multilinear Events Sequencing, accident investigation

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Authors' Note:

Contents of this paper were influenced by experience gained during an experimental application so some of the accident investigation tools at the 2010 Association for Crime Scene Reconstruction conference. The presentation slides, containing illustrations of some of the tools, can be viewed and downloaded online at http://www.iprr.org/presentations/ACSR-1002.pdf.

Introduction

As with most activities, crime scene investigators' and reconstruction analysts' practices are subject to continuing scrutiny for potential improvement in their efficiency and the results they produce. The purpose of this paper is to address the question raised in the title: can some insights and tools developed in the accident investigation field offer useful insights and tools to improve crime scene investigation (CSI) and crime scene reconstruction (CSR) practices? The question was suggested by Gardner's paper comparing Event Analysis for CSR with Multilinear Events Sequencing (MES) for accident investigations in this Journal. [1] This paper describes accident investigation concepts, principles, and tools that might be adapted to criminal investigation and crime scene reconstruction tasks. It focuses on the selection, capture, structuring, and documentation of data (evidence) by investigators and the organization, analysis, validation, and reporting of investigative evidence for analysts.

Historically, accident investigation practices were primarily influenced by historic judicial ideas and practices as they evolved. Traditional accident investigation vocabulary, for example, is still heavily salted with words like cause, evidence, analysis, findings, conclusions, and variations of subjective assertions like fault, blame and negligence. [2] Ever increasing complexity of systems and larger risks have motivated a growing body of accident investigation research by increasingly diverse disciplines. [3,4,5] Such research challenges much of the traditional wisdom and practices, and offers new investigation concepts, principles, and tools for the accident investigation field. [6] Those new investigation concepts, principles, and tools diverge from the judicial ideas and practices toward a more scientifically oriented view of accidents and their investigation. What are those new developments, and might they benefit criminal investigations and crime scene analysis and reconstruction?

Accident Investigation Developments

Developments involve many issues, such as accident investigation methodological improvement and assessment, [7] accident investigation scope, accident modeling, accident investigation output quality, [8] lessons learned from accident investigation, [9] and accident investigation performance metrics, [10,11] among others. Methodological tasks and tools seem most directly comparable to crime scene investigations and reconstruction, so they will be the primary focus of this analysis. Accident investigation advances have addressed accident investigation tasks and procedures like accident investigation data acquisition; data interpretation; data documentation, organization, analysis and validation; and reporting of accident investigation findings.

The challenges faced by investigators of accidents and crimes have many similarities, and some significant differences. Similarities include the fundamental questions of what data to acquire and how best to analyze the data. Both deal with historical events, have a similar goal of describing and reporting what happened accurately and persuasively, have many similar data identification and acquisition challenges, and face challenges from parties with different interests. Other similarities could be cited, like the status of privileged information and concerns about the "truth" revealed by their work.

A major difference is the use to which their respective work products will be put. CSR is used to prepare and present facts for juries or judges to weigh. Accident investigation outputs are used primarily to determine how to prevent recurrence. The main focus of this paper will be on the similar tasks and practices.

Investigation concepts

Similarities suggest that several fundamental accident investigation concepts could be relevant to CSI and CSR. They include viewing occurrences as processes, iterative framework for investigations, and standardized input data structure.

Occurrences are processes. Both accidents and crimes are best viewed as "processes." [12,13] During a process, successive actions affect other actions, and change conditions or states, to produce process outcomes. Thus actions offer a focus for investigation tasks. Traditional views, such as chain of events, do not reflect the dynamic realities of accidents or crimes observed by investigators and analysts. They must contend with multiple actions and interactions occurring in sequence and often concurrently over time.

Framework for investigation. A conceptual framework for investigations drives what is done. A framework is a basic structure behind a system. In accident investigation, two structures are involved: the structure for the facts and for the analysis. Selection of the structures used by investigators and analysts is a pivotal decision: they must be mutually compatible and supportive. (See Figure 1.)

Input data structure. Investigation input data or evidence must be structured so it can be verified as true or untrue. Logic statements provide a formal common structure for documenting inputs or evidence.

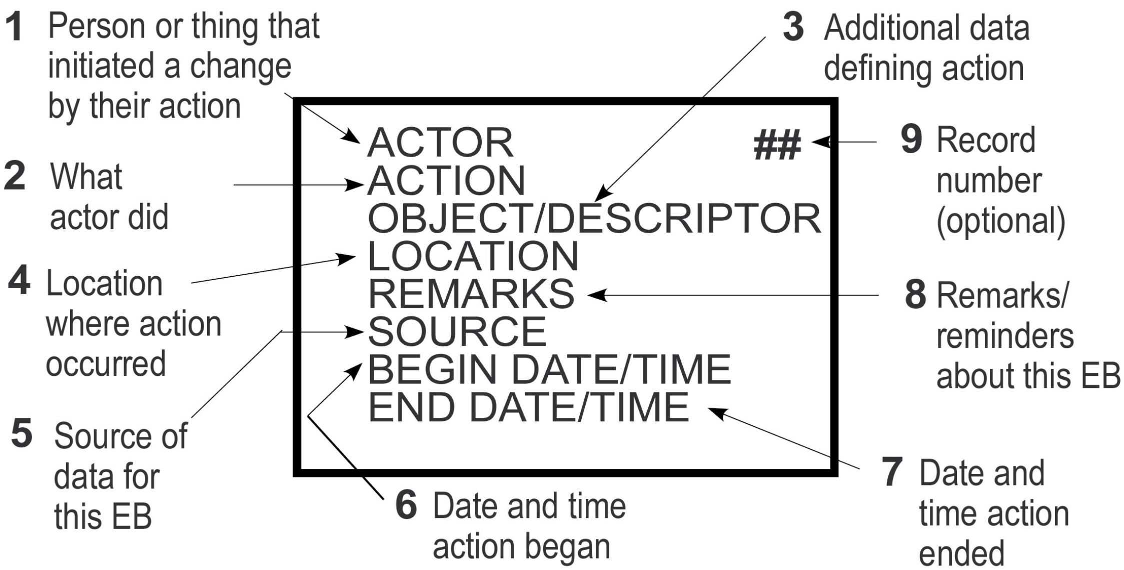


Figure 1: Investigation Building Block Structure.

For accident investigation, the main workhorse is the actor/action structure for logic statements, which produces the building blocks (BBs) for the analysis tasks. [14] Investigators and analysts can verify whether each BB is true or false from the referenced source data.

Analysis structure. A practical analysis structure for the accident investigation analysis tasks is the multilinear events sequencing (MES) worksheet, using a time/actor matrix to array the logical statement building blocks in their temporal and spatial sequence. [15] The matrix is analogous to the structure of a musical score. This structure provides a workspace that enables the analyst to enter, edit and display the order, relevance, relationship and materiality of each building block used to describe what happened. When completed and simplified, it provides a road map for readily understanding what happened. (See Figure 2.)

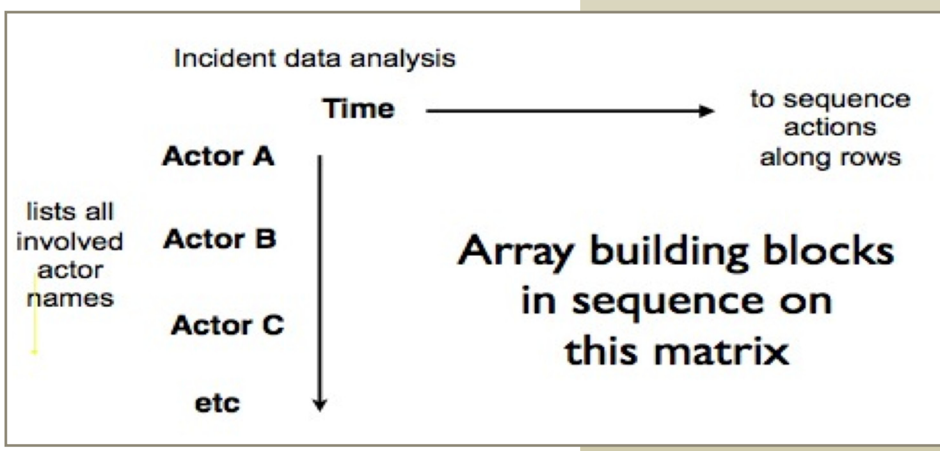
Investigation Principles

Principles are propositions that serve as a foundation for a chain of reasoning. A number of accident investigation principles seem relevant to crime scene investigation and reconstruction tasks. Accident investigation principles that might provide guidance for CSIs and CSRs include:

Think Actor/Action. This helps investigators and analysts to document and work with logic statements that can be related to each other to form a verified description of what happened. When viewing the scene or examining verbal or physical evidence, other principles are:

- Track change makers
- Transform input data into reconstruction building blocks (BBs)
- Make mental movies of actions
- Break down BBs as needed to follow actions
- Build worksheets with Time/Actor matrix to sequence BBs
- Link interdependent BBs
- Fill gaps on worksheet
- Remove extraneous BBs and links
- Draft reports from worksheets

Figure 2: MES Matrix Worksheet Structure.



Eleven detailed guides for implementing these principles [16] are publicly available. Most seem adaptable to crime scene investigation and reconstruction. These principles can be implemented manually, and they have been implemented in software to support accident investigation. An overview of what the software is and how it works is available online. [17]

Axioms. Axioms are propositions that are regarded as being established, accepted, or self-evidently true. Ten accident investigation axioms for improving investigation performance can be found at http://www.iprr.org/admin/Top10Axioms.html. Axioms like, "If you can't flow chart it, you don't understand it" or "No test plan, no test" or "Abstractions cover up poor investigations" for example, would seem applicable to criminal investigations.

Investigation Procedures

Accident investigation procedures implementing these concepts and principles seem to have the potential to help CSIs and CSRs develop relevant and material descriptions of crimes.

Crime scene analysts depend on input data from many sources, so they should be able to specify to each data provider the structure and other attributes of the input data they need. That varies from case to case. The sources could include crime scene sketches or maps and measurements, photographs, audio or video recordings, victims injuries or their observations, various kinds of objects, debris or residues, forensic reports, interrogation and interview statements, and documents, instrument recordings or historical records, for example. Each case is unique, as are the data sources that need to be pursued. Analysts can identify those sources using MES tools like the actor/action building block worksheets, placeholders, and mental movies. An essential MES BB component is the source of the data from which the BB entry is derived. (Figure 1 item 5).

Create Building Blocks. When examining the scene, identify with a unique name the people, objects, or energies involved. The name of the actor, or a placeholder, is always the first entry for any MES building block. This helps to keep investigators and analysts focused on the needed evidence structure as they gather the input data and use it. The most challenging BB entry is the description of what the actor did, to ensure that others reading it could visualize it. Using words at the lowest level of abstraction and the least ambiguous words helps to achieve this. A list of "poison words" or ambiguous words to avoid is useful because ambiguous words frustrate logic application and testing.

Use placeholders. When entering data, often some part of a BB is not known when it is first created. Use of a "?" as a placeholder in the BB identifies data to be acquired.

Once created, all BBs must be organized to show the sequence in which they occurred. With MES, this is done on a worksheet consisting of a time/actor matrix. Array BBs on the worksheet in sequence as soon as they are acquired. Any "?" indicates an open data item or uncertainty.

Make mental movies. As an MES worksheet grows, it is helpful for investigators or analysts to try to visualize what happened from the wording of the BBs, in the form of a "mental movie." That step brings to light gaps in the scenario being developed as difficulties arise with tracking an actor or action, or picturing what an actor did.

Break down BBs. If what an actor did can't be followed, it may be helpful to break down actions into smaller steps to fully describe a crime. For a simple example, "suspect fled from scene" might be broken down into suspect broke bedroom window, climbed out through the window, and so forth, to suggest places to look for more evidence. In developing circumstantial evidence, a similar technique might be useful when pursuing actions that might provide motives for a crime, such as developing a pattern of actions over time before or after a murder, and displaying the resulting BBs.

Build worksheets. MES matrix worksheets provide the workspace to organize the sequence and relationships among the BBs as they are created. The time and actor coordinates provide for the positioning or repositioning of each BB relative to all others on the worksheet as it is created, streamlining, and expediting the investigation and reconstruction tasks. See Figure 3 for an example of how a worksheet being developed during an investigation might look. Figure 3 used support software ("Investigation Catalyst" for Macintosh); worksheets can be prepared manually. Color codes can indicate BB attributes. Sequence or durations can be changed as new data become available. Contents of each BB, including sources, can be viewed in detail when needed. Earlier building blocks for actions identifying motives or premeditation would be entered ahead of the actions shown.

Link BBs. For accident investigations, the scenario is described and explained by the flow of all the interactions from the beginning until the outcome of interest occurs. A few links are shown in Figure 3 to indicate relationships that have been tentatively established thus far.

Crime scene analyses would likely evolve as actions provided by forensic examinations are entered along with the actions derived from observed evidence, so the linking of all actions by first on-scene officers might not be as essential to meet Crime Scene Analysts' (CSA) objectives.

After all available BBs are entered, extraneous BBs can be removed from the worksheet, leaving only those necessary to satisfy the analyst's need to describe the perpetrator(s) and victim(s) actions. Thus the number of rows required to display actions for CSA purposes could be less than needed for accident investigation purposes.

Fill gaps on worksheets. During accident investigations, the arraying of BBs often shows gaps in the flow of interactions by showing a BB that either logically or intuitively influenced other actions, but cannot be linked directly to those actions because something else had to happen between them. Structuring speculations or hypotheses into an "MES Tree" [12] which is a logic tree structure bounded on both ends by the known BBs, provides CSAs a way to bridge these gaps.

Mark uncertainties. MES tools help ensure analysis credibility. The most important is arraying known data so it tells a persuasive story of what happened. The BB structuring, arraying, and linking tools help do this, as do the "?" placeholders. It is preferable for investigators or analysts to identify uncertainties with a ? in BBs or unconfirmed links and explain them, rather that have adversaries undermine their entire work by pointing out one or two minor gaps or uncertainties.

Review Worksheet. MES worksheets provide a relatively objective way to assure the quality of an investigation or analysis. By using the BB structure criteria and BB linking and sourcing criteria, reviewers can review the quality of the output.

Timing of individual actions may not be as critical for CSA as it is for accident investigation, but all the BBs shown on the worksheet would have to accommodate or fit between any time "anchors" defined before, during or after the crime.

Print BBs for reports. Sequenced BBs can provide a useful outline of what happened for the preparation of investigators' and analysts' written reports. Either the completed graphic worksheet displays or tabular printouts of the sequenced BBs can be used for that purpose when computer support is used. This helps ensure that the written report presents the results in a readily assimilable sequence and form for lay users.

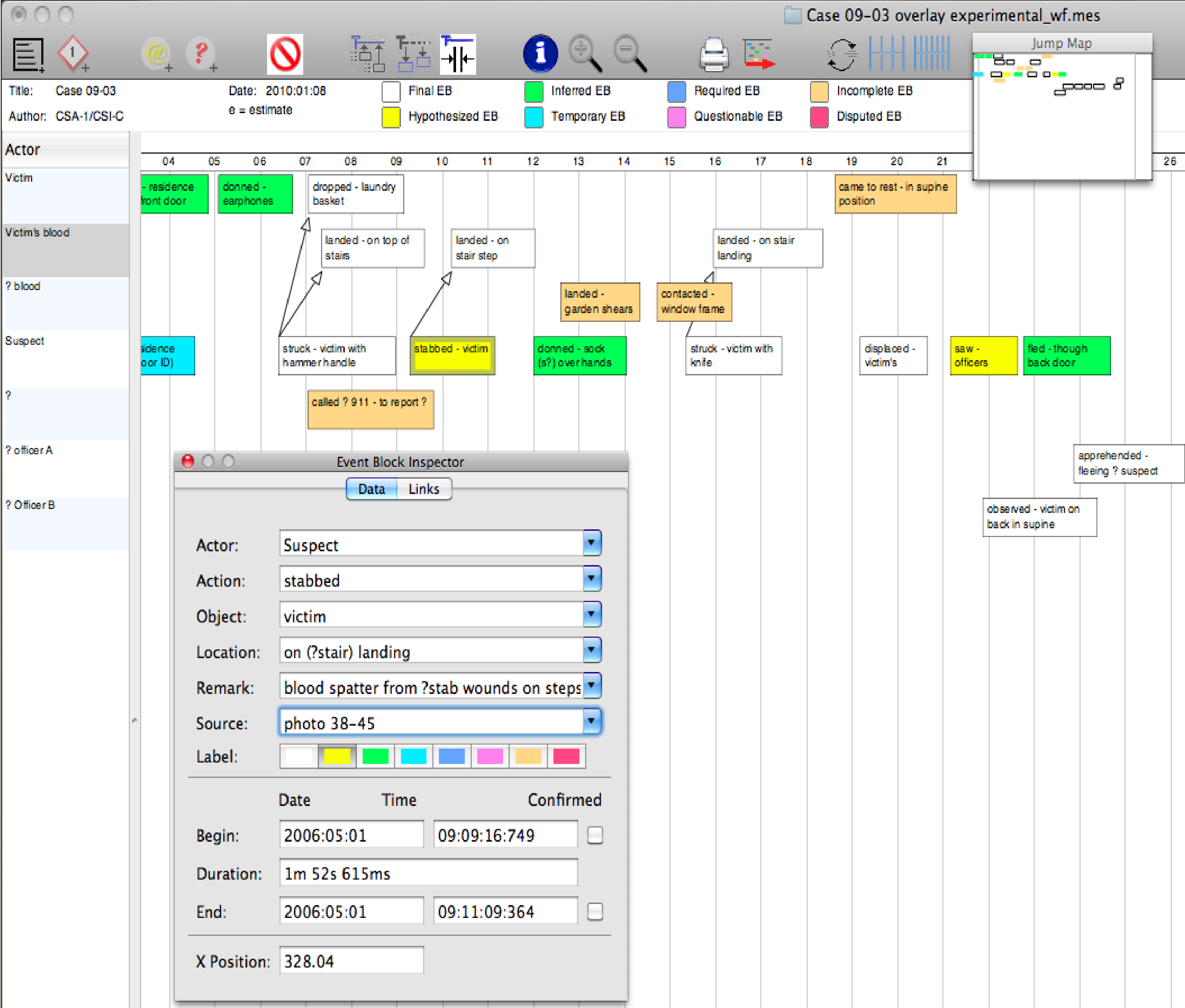


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Figure 3: Worksheet view during investigation in progress.

This opportunity is not readily available when worksheets are prepared manually.

Investigation Logic Tools

Three kinds of logic tools are used in investigations. The first kind is, or should be, logic statements which are statements that can be determined to be true or false. Each statement used on the final worksheet should be found true, based on the source evidence from which it is derived. The data structure in Figure 1 satisfies this tool.

The second kind is logical reasoning tools for creating, sequencing, and linking building blocks.

1. Deductive reasoning, used to create BBs from knowledge about how to interpret data from evidence such as debris, observations, interviews, recordings, etc. (evidence or facts).

2. Sequential reasoning, used to create MES worksheets by positioning BBs on the matrix according to their temporal and spatial sequences.

3. Input-output or cause-effect reasoning, used to find and link individual actions that were parts of action

pairs or sets, defining interactions or "behavioral sets" on MES worksheets.

4. Necessary and sufficient reasoning, used to test individual BBs and arrays of BBs and links on an MES worksheet for completeness and validity.

Logic fallacies are a third kind of logic tool used by investigators to error check their building block contents. [18] Common logic fallacies, like amphibolies, neglected aspect, or poisoning of the wells, with illustrative examples, can be accessed online.

Summary

From the above, it appears that criminal investigations and crime scene analysis and reconstruction tasks could benefit by considering crimes to be processes and by adapting selected accident investigation tools for the timely and rigorously structured documentation and ordering of actors and actions derived from evidence created during or relevant to the crime. References are provided for further exploration of that possibility by crime scene investigators and reconstruction analysts.

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