Example Application of Investigation Organizer

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Preface

This example application has been prepared by NASA AMES Research Center in conjunction with the Global Aviation Information Network (GAIN) Working Group B (Analytical Methods and Tools) (WGB) as one of a number of such examples of the use of analytical methods and tools described in the "*Guide to Methods & Tools for Airline Flight Safety Analysis*". The intent of these example applications is to illustrate how various tools can be applied within an airline flight safety department, and provide additional information on the use and features of the tool and the value of such analysis. GAIN WG B hopes that these example applications will help increase the awareness of available methods and tools and assist the airlines as they consider which tools to incorporate into their flight safety analysis activities.

Each example application of an analytical method or tool is posted on the GAIN website (*www.GAINweb.org*). Readers are encouraged to check the website periodically for a current list of example applications, as further examples will be added as they become available.

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Investigation Organizer (NASA Ames Research Center)

1 Introduction

1.1 OVERVIEW OF THE TOOL FUNCTIONALITY

The Investigation Organizer (IO) tool enables key elements of successful investigation through fusing accident investigation methodology with collaborative, information sharing technology:

- Gathering and sharing disparate types of information
- Identifying the relationships between pieces of information
- Understanding the significance of such relationships
- Preserving the evidential chain

The tool enables the first element through a Web-based application that can be accessed by distributed teams to store and recover any digital investigation material in a secure environment. The second is performed by making the relationships between information clear by using a semantic network—a structure that allows an investigator or team to “connect-the-dots.” The third element, the significance of the correlated information, is shown through causality and consistency tests using several different methods embedded within the tool, including fault trees, event sequences, and other accident models. Finally, the evidence gathered and structured within the tool can be directly, electronically archived to preserve the evidence and investigative reasoning.

1.2 INTRODUCTION TO THE EXAMPLE APPLICATION

With investigations like SwissAir 111 consuming 4.5 years and $40 million dollars, future investigations are likely to increase in size and complexity. Tools that can improve the effectiveness and efficiency of investigators and investigative teams are not only desirable, but vital. The Investigation Organizer fills this need and has already displayed its usefulness and significance in real and complex investigations, such as those of the Columbia accident and the CONTOUR mishap.

2 Input Data

Today, a wide variety of different media and instruments are used to record evidence about mishaps and accidents, which may be collected and stored at remote locations. This evidence can include: handwritten notes, e-mail, text documents, taped or transcribed interviews with witnesses, and multiformatted data files and images generated by software and/or by hardware. When a mishap or accident is investigated by a team that is geographically dispersed, these information management and coordination problems are particularly acute. Even more important, the management and coordination process of understanding the relevance of relationships within this evidence is the heart of the investigation process itself.

The semantic network in IO allows users to create information items of different types, such as people, evidence, systems, action items, or causal models. It allows investigators to store important metadata with each information item, such as the address of a person, or the weight of a system. Investigators can also attach nearly any file to the information items, including text documents, images, and digital audio or video files. Most importantly, the semantic network allows users to create links between these items. An example might be when an investigator collects a piece of evidence that supports a hypothesis (see Figure 1). These links allow users to share the reasoning as they conduct the investigation, "connecting the dots" from evidence, through analysis and modeling, and into findings and recommendations.

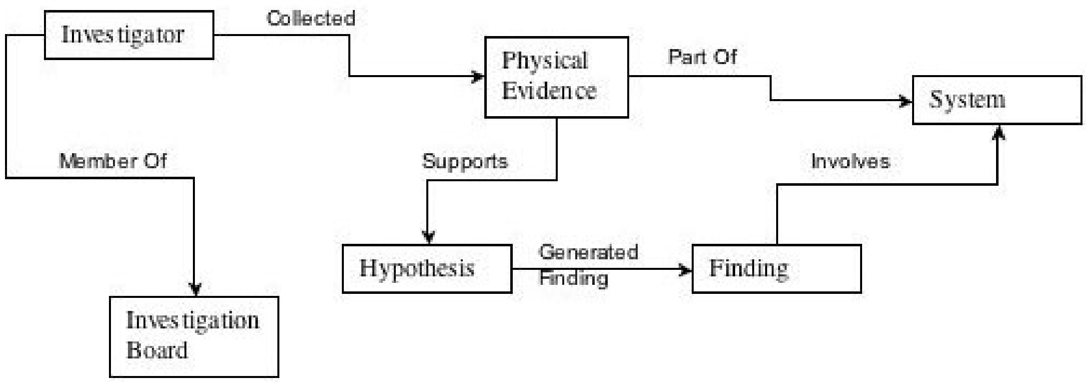

Figure 1 **Semantic Network**

Information items are entered within the IO ontology through a simple web form (see Figure 2), which allows the investigator to upload a file and include any metadata they wish. The optional nature of the fields in the form means an investigator can upload information quickly and fill in the details later. Paper documents can either be scanned to electronic form using common tools or IO can be used as an index for the paper documents stored in an investigator's office.

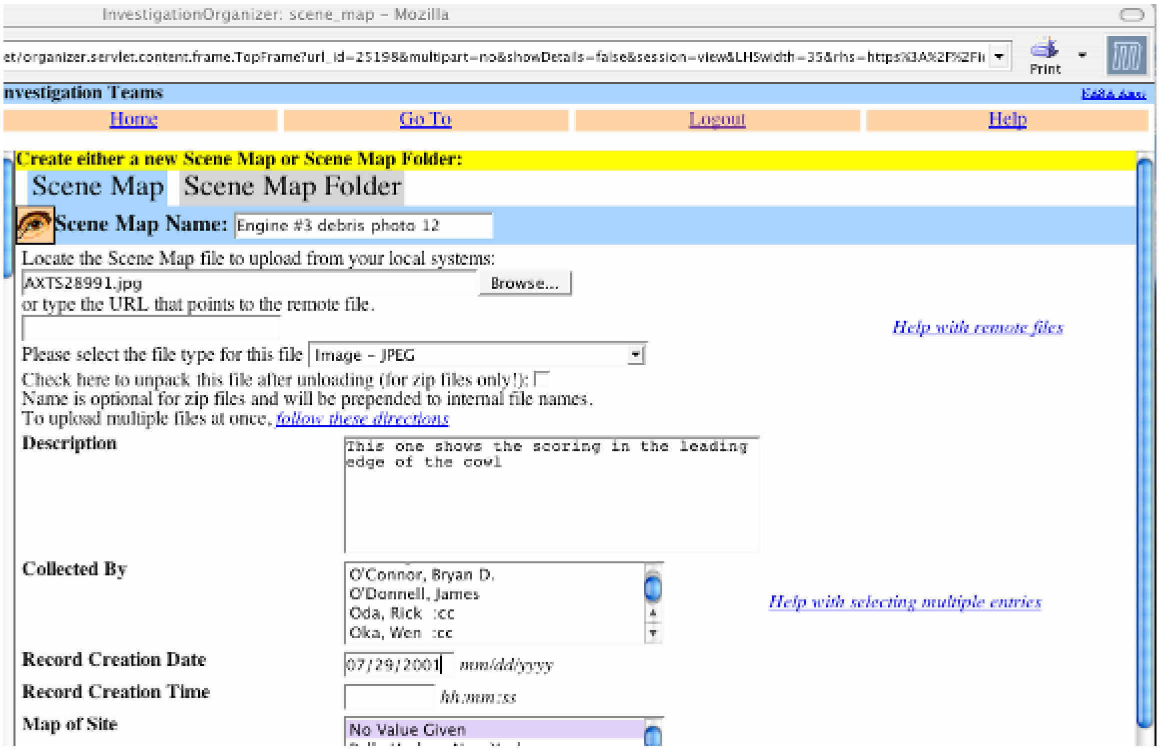

Figure 2 **Information Entry Form**

To allow even faster entry of information into IO, investigators can zip many files together to be expanded in IO, or an API can be used to import data from other applications (for example the CAFTA fault tree tool). Development is continuing, allowing investigators to e-mail files and other standard forms directly to the system for faster integration and communication.

To assess and integrate the information gathered in the investigations, investigators link items by standard link types (see Figure 3). Each link can only apply to certain types of items, and when an investigator goes to make a link, IO's search function makes it easy to find the item to link to. In addition, a built-in inference engine allows the system itself to help make basic links between information.

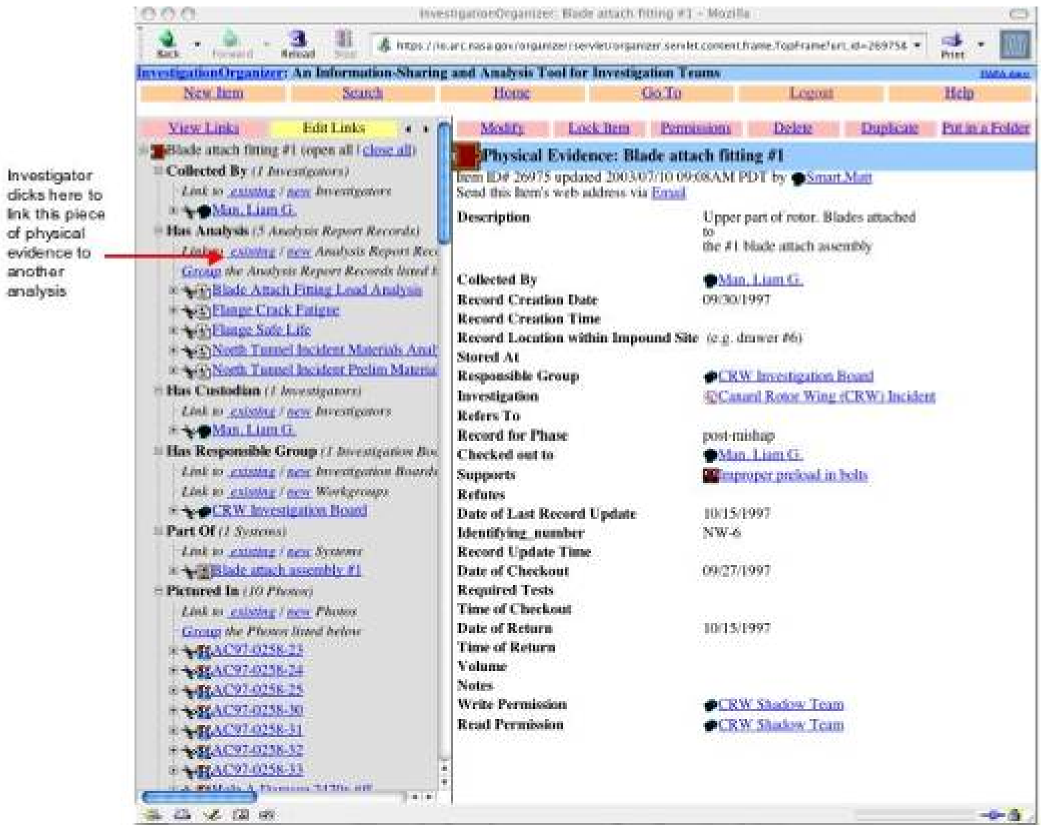

Figure 3 **Linking Data**

3 Analytical Process

Causality and consistency tests can be performed on the evidence gathered and entered into IO using several different methods embedded within the tool, including fault trees, event sequences, and other accident models. As investigators determine which evidence supports or refutes the hypothesized causes or elements of the causal model, they form clear links between them, allowing the entire investigation team to see the reasoning as it develops (see Figure 3). Investigators can also view and change event sequences based in a specialized viewer within their web browser (see Figure 4). Investigators can reorder the sequence by clicking on the "X" in the link to break it, and clicking on the handles of two boxes to link them. Investigators can also add new events and conditions to the sequence directly in the viewer.

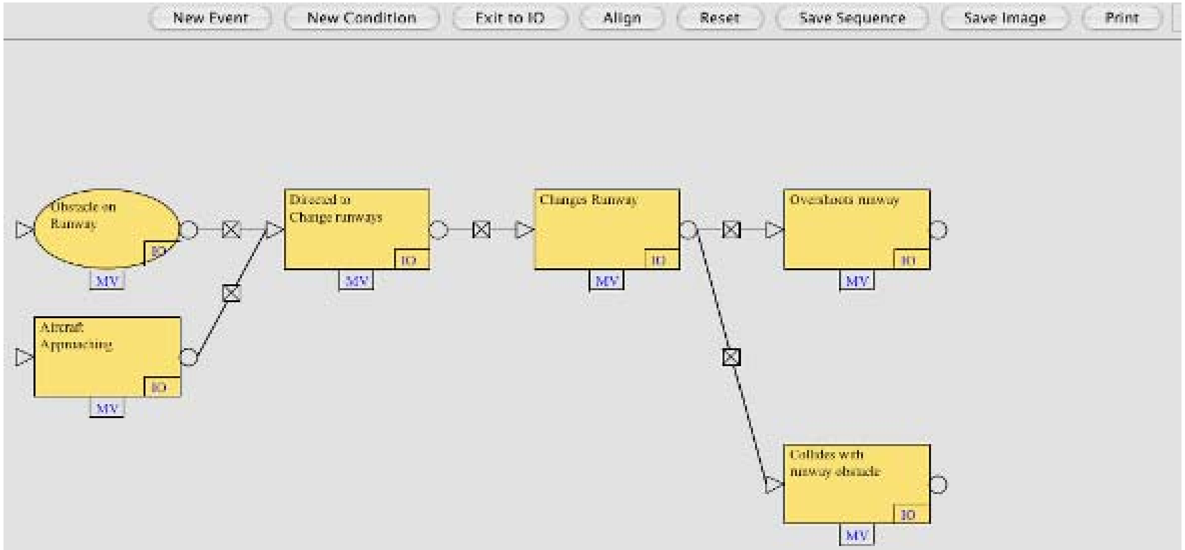

Figure 4 **Event Sequence Viewer**

Similarly, investigators can use a fault tree viewer (see Figure 5). The fault tree viewer also allows investigators to manage and track the progress of the investigation. The colors show the status of each node in the fault tree, and the numbers (e.g. 6/0 on fatigue) show the number of pieces of evidence that either supports or refutes that particular part of the fault tree. In both viewers, the "MV" tag on the boxes allows the investigators to move them around to better see what there is. The "IO" button on the boxes allows the investigator to return to the standard view (see Figure 2) at that particular node. Within the fault tree viewer, the user can also limit the view of the tree to a particular depth or a particular branch to make it easier to view, as some fault trees include hundreds of nodes.

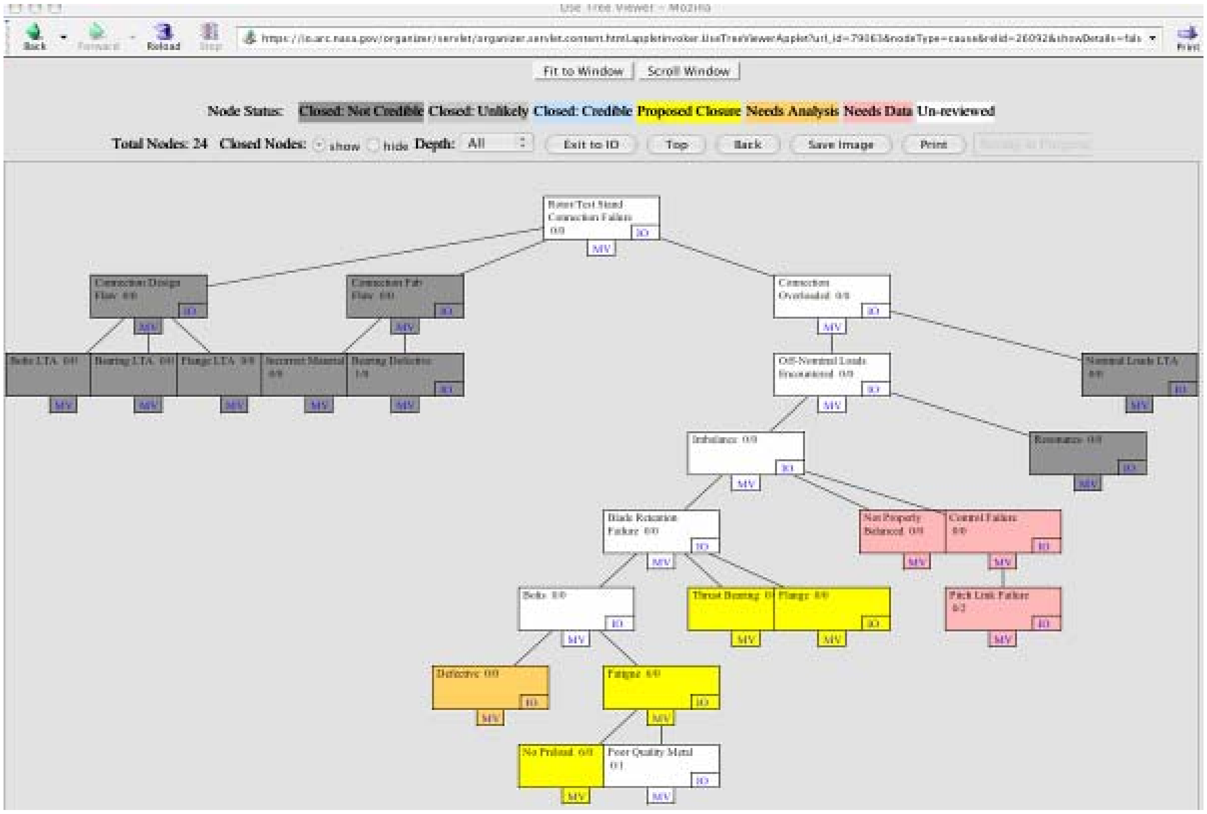

Figure 5 **Fault Tree Viewer**

4 Tool's Output

The results of the analysis process in IO is integrating information, causality and consistency checks, and preserving the evidential chain and investigative reasoning. Further, work flow and logistical information is managed within IO for the investigation team. Finally, recommendations and corrective actions stemming from the investigation can be tracked and related to the specific findings they address.

5 Application of the Results of the Analysis

At the end of the investigation, the investigators have preserved the evidence, findings and recommendations produced in the investigation. These can then be implemented by various aircraft manufacturers and operators to prevent this incident from occurring again. Preserving the chain of evidence within IO allows those teams implementing the recommendations to trace them back to the source records so they can fully understand the history and extent of the changes. This may also allow those teams to realize the recommendations should be more broadly applied. Finally, this full amount of information can allow safety review teams to review the changes made to the system and the full information behind the recommendations to ensure that nothing was overlooked. As more investigations occur, the history built up in IO will allow safety teams to begin to find larger trends in the problems that are being faced with a particular system or operator. This can then help in improving system-wide safety.