Global Aviation Information Network
ENHANCING AVIATION SAFETY THROUGH SHARING

Aviation Safety Analysis Tools *in Action*

Stories of Airline Success with New Analytical Capabilities

Methods of analysis and the computerized software that can automate them are continually raising productivity and our level of knowledge about the world, helping us to better understand patterns, trends, causes, risks, potential costs, or likely outcomes. This brochure has been prepared by GAIN Working Group B (the Analytical Methods and Tools Working Group) to share stories of how airlines have successfully applied analytical tools in flight safety management and increased their capabilities and knowledge. GAIN hopes this will encourage other airlines to consider the use of a wider range of analytical capabilities in their own safety practices.

The Risk Analysis Tool at British Airways

By Captain John Savage *September 2004*
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In 1998, British Airways Flight Operations Department sought a formal method of risk analysis. This quest was partly in response to the need to document the evaluation of risk and subsequent mitigations, and partly to ensure we were not caught out by new risks arising from changing technology. For example, while "glass" cockpits brought many improvements over the previous "clockwork" cockpits, they also introduced new, largely unforeseen, risks such as a reduction in situational awareness.

British Airways (BA) sought a method of risk analysis that could not only evaluate current risks, but could predict the future risks involved in changes to hardware, software, procedures etc. After looking at several methods, we settled on a method known as "Dependency Modelling" and the Risk Analysis Tool software.

The Risk Analysis Tool (RAT)
Arium Technology
www.arium.co.uk

RAT is based on *dependency modelling,* a "top-down" approach that first analyses a problem and then incorporates any data that are available to help quantify the problem. This is very different from the majority of risk-modelling techniques where the creation of the model is dependent upon the data.

With RAT, a high level objective is set and the dependencies that need to be achieved to meet that objective are then identified. In a complex issue there could be a whole series of dependencies that will need to be addressed in order to ensure that the high level objective will be met.

In creating this chain of dependencies step by step it becomes easier to see which areas will need to be handled in order to manage the risk or hazard. The RAT software also contains a mathematical engine which enables certain assumptions to be weighted with probabilities of failure. The mathematical model can then calculate and identify which parts of the model are the weaker links in the hazard management chain.

Resources Required to Use RAT

I believe RAT could be used by anyone after a little training. However, in practice it is best utilized in concert with a RAT experienced person who can act as a facilitator and communicate with the people who hold the knowledge and expertise in the particular field being assessed. At British Airways, we find it works best to involve at least two people thoroughly familiar with both the concept of Dependency Modelling and the use of the RAT tool.

"Failure probability rates" are needed for each of the individual risk elements in a model. These values can be derived from an aviation incident database such as BASIS or obtained from knowledgeable sources through formal methods. BA has used an approach called "Eliciting Expert Opinion," originally developed for the European Space Programme.

It is hard to generalise on how long a RAT model takes to construct and analyse, but many we have developed have required from 2 to 8 hours with two people working on them. Time spent applying the Eliciting Expert Opinion process, if needed for a particular analysis, would be additional.

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The Risk Analysis Tool at British Airways

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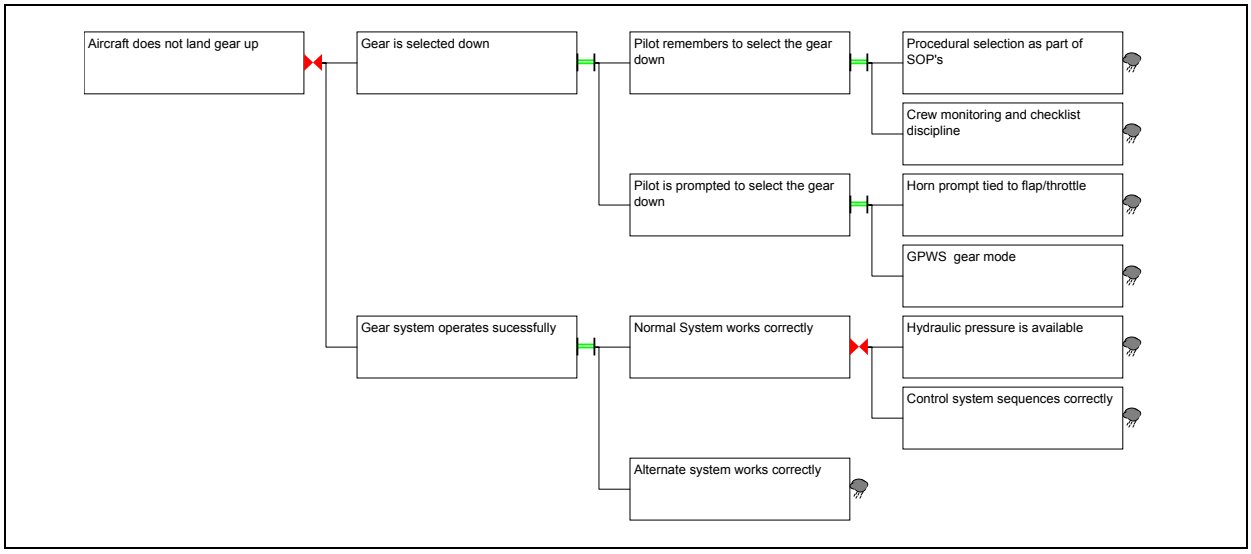

Figure 1. Example RAT model

Example of a RAT model

The example RAT model in Figure 1 illustrates the principle of Dependency Modelling and the RAT display software. Most real-life models are much larger than this.

The objective we wish to achieve is "Aircraft does not land gear up"; this depends upon both "Gear is selected down" AND "Gear system works correctly". The red double triangle symbol represents the AND relationship. Continuing the model: "Gear is selected down" depends upon either "pilot remembers to select gear down", OR "Pilot is prompted to select gear down". The green parallel line symbol represents the OR relationship, and so on.

If failure rates of the individual risk elements on the right of the model are inserted (*e.g.* hydraulic pressure to lower the gear may not be available once per 500,000 flights, *i.e.* a failure rate of 2×10^{-6}), the RAT software will calculate the risk that the overall objective will fail. It will also indicate where efforts to improve the overall risk will be most effective.

Use of RAT models at British Airways

British Airways has produced almost two hundred RAT models on a wide variety of subjects. RAT models have been used to persuade bodies such as the CAA (the regulator), BAA (the airport authority), BALPA (the pilots' association) and other departments within British Airways of the merits of our proposals.

One large RAT model helped us break down the risks involved in the proposed Land And Hold Short Operations (LAHSO) in North America. With help from the RAT model, BA concluded that not all risks had been addressed in the LAHSO program, and therefore that BA would not participate in the scheme. We used the RAT model to demonstrate our concerns to the FAA.

In a similar vein, the risks involved in flying with a locked, bulletproof flight deck door were analysed using a RAT model. We were able to quantify the benefits of fitting such a door (as well as the benefits of other countermeasures such as sky marshalls, passenger intervention, passenger database etc.) and the disbenefits of fitting such a door: decompression, crew resource management (CRM), pilot incapacitation etc. The final result was a graph showing how the benefits/disbenefits varied as a function of the level of threat against BA.

We also used RAT to help analyse a proposed change in arrival procedures for approaching stands at London Heathrow Airport Terminal 4. The analysis predicted a savings to BA of US$0.5 million per year. While a decision has not yet been made on this proposed change, the RAT model helped all parties understand the expected costs and benefits of the change. ■

TapRooT® Root Cause Analysis Tool at Alaska Airlines

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Alaska Airlines began using the TapRooT® root cause analysis tool in spring of 2002 to fill a need for a better understanding of accident and incident root causes. Prior to this time, there was no formal process in place that ensured consistent results in the investigation process. The software was deployed on a limited scale in the Safety Division to evaluate the usefulness and results of the program. TapRooT was used to analyze several serious incidents including major aircraft ground damage and an in-flight injury.

Results of these early investigations yielded corrective action recommendations that would have gone unrecognized prior to the use of TapRooT. Continued successes prompted Alaska Airlines to expand its use of TapRooT throughout the airline.

Resources Required to Use TapRooT

Alaska Airlines has developed an in-house, one-day, training program for TapRooT and provides users with access to an employee experienced in the tool on request. The software itself is easy to work with once the concepts of the tool are understood.

However, successful use of the TapRooT process does not come free. A TapRooT analysis of even a simple event can consume considerable staff time to complete and is not usually cost effective for low-risk events. A simple trip-and-fall accident could take an entire day to analyze, depending on circumstances.

Where TapRooT really shines is in analyzing complex events that pose a serious threat to an operation. A properly conducted investigation and analysis can save time and money by combining individual department investigations into single process involving all the players, providing access to all of the pertinent information and organizing it into a standard format. Although this approach can sometimes be difficult to apply due to a natural reluctance of work groups to cooperate, it can produce truly global solutions for the organization.

Alaska Airlines' Experience with TapRooT

Alaska Airlines has been successful using the TapRooT root cause analysis tool in a wide variety of situations including:

- Ground damage accidents and incidents
- Maintenance errors
- Flight operation errors
- Process improvements
- In-flight cabin events
- Process coordination

A notable example is the investigation of a recent event that involved flight operations, engineering, maintenance and maintenance operations. This

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TapRooT®
System Improvements, Inc.
www.taproot.com

TapRooT is systematic method of organizing the facts of an event into a chronological order, identifying causal factors and determining root causes to those causal factors. It is an easy-to-use software program but the real value is in the process.

The first step requires the identification of an undesired event. Usually this is an accident or incident but in some cases can be a particular process that may not be performing well. The choice of an undesired event may vary from the obvious depending on the views or responsibilities of the investigator. For example in a ground damage incident one investigator may be interested in why an aircraft wingtip struck a pole while another may be interested in why the pole fell onto the airplane after breaking.

After determining an undesired event, the facts are arranged in chronological order, from the first relevant action to the undesired event, using a graphical representation known as a SnapCharT®. The SnapCharT consists of actions, something you can observe happening, and conditions, things that modify or explain an action. Once completed, the SnapCharT provides a valuable visual display of the event and helps ensure that all the pertinent information has been collected.

Once the SnapCharT is completed, each action and condition is subjected to the question, "If the problem or condition were corrected, could that have prevented the event from occurring or significantly reduced the event's consequences?" Any items with "yes" answers are considered causal factors to the undesired event. Each one of these causal factors is analyzed using a root cause tree, which asks 15 yes-or-no questions. Depending on the answer to these questions, basic cause categories and eventually root causes are assigned to the causal factors.

The software also offers assistance in developing corrective actions.

TapRooT® Root Cause Analysis Tool at Alaska Airlines

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investigation yielded corrective actions for all of the work groups that included adding a placard to a valve, communications training, clarifying special procedures and a risk assessment of certain minimum equipment lists (MELs). Historically, these types of investigations have deteriorated into finger pointing sessions with little productive output.

TapRooT has helped Alaska Airlines by providing an objective, repeatable process that identifies of all the causal factors to an undesired event, all of the "holes in the swiss cheese" if you will, and a standardized language regarding root cause analysis that we can communicate with. The easy-to-understand graphic format of the SnapCharT (such as the example shown in Figure 2) is an excellent presentation tool. It provides senior management with a quick understanding of the event. Overall, TapRooT has been a valuable addition to the safety analysis process at Alaska Airlines. ■

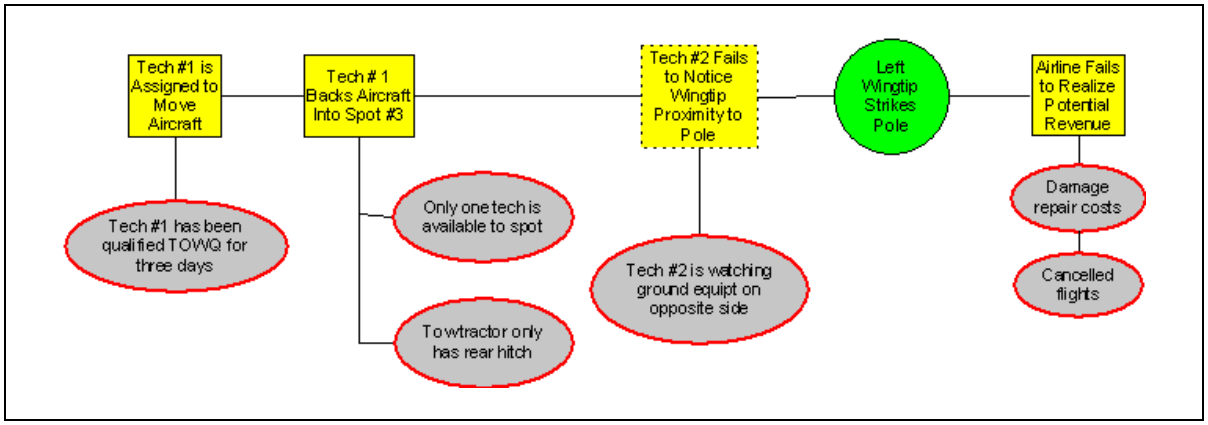

Figure 2. Example of a Simple TapRooT SnapCharT

The Global Aviation Information Network (GAIN) is an industry-led international coalition of airlines, manufacturers, employee groups, governments and other aviation organizations formed to promote and facilitate the voluntary collection and sharing of safety information by and among users in the international aviation community to improve aviation safety. Note: GAIN makes no claims for, or endorsements of, the products described in this brochure.

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as GAIN owes its success to the dedication of volunteers.

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