Why-Because Analysis (WBA)

An accident investigation attempts to determine the network of events and circumstances which causally resulted in the accident. In most investigations, the causal findings are asserted but the causal reasoning is hidden. Rigorous causal reasoning is tricky, and mistakes are often made.

Why-Because Analysis (WBA) makes explicit the causal reasoning behind a series of events and circumstances leading to an accident, and supplies rigorous, objective tests that the reasoning is correct. WBA applies the **Counterfactual Test (CT)** to determine rigorously whether event A is a necessary causal factor in the occurrence of event B. CT was formulated to the rigorous semantic standards of modern formal logic by the eminent logician David Lewis in 1973, formalising a criterion proposed in the 1770s by the great analyst of causality David Hume. WBA has adapted CT for practical reasoning. A **Why-Because Graph (WBG)** is drawn, showing the causal connections established by applying CT. A WBG typically has 60-90 nodes and a similar number of edges. It provides an objective, graphical representation clearly showing root causes, and highlighting opportunities for intervention with countermeasures to avoid a recurrence.

A Hierarchical Task Analysis of WBA has been performed, and a procedural guide is available as a series of **flowcharts**. WBA supports the construction of WBGs through the **combined software-hardware WB-Toolset.** WBA provides, optionally, a formal method for checking the correctness and explanatory completeness of a WBG based on the logic **EL**. Like most formal methods, logical checks using EL are resource-intensive, but provide an objective evaluation which other, less rigorous, methods lack.

Application of WBA to well-known accidents has shown inter alia

- that the communication between ATC and flight crew was a causal factor in the Cali CFIT accident (1995; not identified as such in the report, but identified in the NTSB letter)
- that the earth bank at the end of the runway was a causal factor in the landing accident to a Lufthansa A320 in Warsaw (1993, not identified as a causal factor in the report)
- that the use of TCAS was a causal factor in the Überlingen mid-air collision (2002; not identified as a causal factor in the report)
- that the causal factors in the Ladbroke Grove rail collision in England fell into nine distinct technical areas, in each of which countermeasures could be undertaken (1999; the Cullen Commission made only limited technical recommendations)

WBA has been adopted as a company-wide required procedure for the analysis of product defects by Siemens Transportation Systems Rail Automation division (STS RA), the world market-leader in railway signalling systems. It has recently been adopted also by STS Mass Transit division (STS MT), a major manufacturer of urban rail vehicles (trams). WBA has been used in successful litigation in Japan, Indonesia and New Zealand. WBA is also used by two railway systems engineering research institutes in Germany, at the Technical Universities of Brunswick (Braunschweig) and Dresden.

The **WBA Home Page** may be found at www.rvs.uni-bielefeld.de **→Why-Because Analysis**