Two Causal Analyses of the Black Hawk Shootdown during Operation Provide Comfort

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Abstract. We perform a Why-Because Analysis (WBA) starting from the information in the Executive Summary of the U.S. DoD Aircraft Accident Investigation Board report on the shootdown of two U.S. Army Black Hawk transport helicopters by U.S.A.F. F-15 fighter aircraft over Northern Iraq on 14 April 1994, during Operation Provide Comfort. We compare with the effort of Snook to perform a similar analysis.

1 Introduction

Every so often, things go wrong with complex critical systems in such a way as to cause a loss of materiel or people. It is part of the safety-critical engineering task to analyse systems to attempt to avoid such losses. In turn, part of this task is to understand loss incidents which have happened, in order to avoid similar events happening again.

The 1994 "friendly fire" or *fratricide* incident, during which two U.S.A.F. F-15 fighter aircraft shot down two U.S. Army UH-60 Black Hawk utility helicopters, is a notable example of how things can go wrong in a complex system. It is particularly noteworthy for critical system engineers in that very little of what went wrong was purely technical - indeed the single purely technical contribution to the unfortunate event remains unexplained. However, much of what went wrong involved the human-operational use of technical systems, which were embedded in a complex command-and-control structure. For this reason, along with the existence of two preceding analyses, by Snook [Sno00] and Leveson et al. [LAS02], the incident was chosen by participants in the Bieleschweig Workshop series [Bieds] as an example on which to effect a comparison of analysis methods.

As a contribution to this task, we present the results of a Why-Because Analysis (WBA) of facts as presented in the Executive Summary of the U.S.A.F. Aircraft Accident Investigation Board report [USA94], and we compare with Snook's Causal Map [Sno00, p21], which is purported also to be the result of applying what WBA terms the *Counterfactual Test* to determine causality between phenomena. A short introduction to WBA may be found in [Lad00], and book-length introductions in [LL98,Lad01].

Since a WB-Graph and a Causal Map purport to show the same relation, through application of the Counterfactual Test to a list of facts, one would expect the results prima facie to be similar, if not identical. In this case, they are not. They are by no means close.

We suggest some reasons for this, and conclude by enumerating some of the advantages of applying a methodical approach such as WBA to the task of determining causality.

2 The Shootdown

Operation Provide Comfort (OPC) was set up after the First Gulf War in 1991 by a U.S.-led coalition of nations to provide physical protection for the people of Northern Iraq against potential aggressive acts by the then Iraqi regime. It included a complete ban on flights by Iraqi aircraft within Iraqi airspace north of the 36th parallel, the line of 36 degrees latitude. This airspace and the land underneath it was designated the Tactical Area of Responsibility, TAOR, and included in its northernmost part a Security Zone (SZ) bordering Turkey and including the town of Zakhu.

On the morning of 14 April 1994, two Black Hawk helicopters known as Eagle Flight took off from their base at Diyarbakir in Turkey, with senior members of the Operation Provide Comfort command, planning to visit Zakhu in the SZ, where the Military Command Center (MCC) of OPC was situated, and later Irbil, Salah and Din Iraq, within the TAOR but outside the SZ, for meetings with UN and Kurdish officials.

Eagle Flight flew regularly within the TAOR, mostly within the SZ, for such purposes. Generally, allied flights within the TAOR were regulated by a daily Air Tasking Order (ATO), which specified who was to do what and when in detail. The flights of Eagle Flight, however, were not specified in detail in the ATO, both because of the nature of their mission and because of more general organisational and military-cultural factors.

The TAOR was kept "clean" of Iraqi aircraft through regular U.S.A.F. fighter patrols operating

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out of Incirlik air base in Turkey. The fighters were supported by an airborne command and control station, called an AWACS aircraft, similar to a flying military control tower, with additional facilities for detection of flying aircraft. Eagle Flight had checked in with the AWACS, had landed at Zakhu, and had then taken off again en route to their further destinations. AWACS had registered intermittent radar returns from Eagle Flight after departure from Zakhu but its operators had established no further positive contact.

The first U.S.A.F. patrol of the day arrived "on station" at the TAOR at 07:20 local time. The pilots were expecting themselves to be the first allied aircraft of the day in the zone, as specified in the ATO. They received radar returns from Eagle Flight, and notified AWACS, who confirmed the returns. The F-15 pilots intercepted Eagle Flight, apparently expecting them to be Iraqi aircraft, and performed a visual identification during which they identified Eagle Flight as Hind helicopters, which the Iraqis flew, and not Black Hawks. They then shot down the helicopters with missiles.

Allied aircraft can identify each other by means of a system called Identification Friend or Foe (IFF), which consists of a radio transmitter-receiver ("transponder"), which receives radio signals from another IFF device and responds by issuing its own signal. IFF operates in a number of "modes", and coalition aircraft were supposed to display a daily code in IFF Mode I. Eagle Flight was unaware of the Mode I code of the day in the TAOR and was not displaying it. However, all coalition aircraft should have been "squawking" (transponding) in another mode, Mode IV, automatically, and no definitive Mode IV squawk was observed by the F-15s. The transponders were recovered after the shootdown and appeared to be in working order. The technical discrepancy has to date no apparent satisfactory explanation. The IFF system failed for unknown reasons.

3 Outcome of the Official Investigation

The accident was investigated in detail by an Aircraft Accident Investigation Board convened by then-US Secretary of Defence William Perry. In his memo approving the Board's report, he said that

> The accident was the result of errors, ommissions, and failures in the procedures of Operation Provide Comfort, the performance of air units involved, and the operation of equiment used

[Per94], cited in [Sno00, p68]. Secretary Perry summarised the "errors, ommissions and failures" as four bullets:

- The F-15 pilots misidentified the Black Hawks
- The AWACS crew failed to intervene
- Eagle Flight and their operations were not integrated into the Task Force
- The Identification Friend or Foe (IFF) systems failed

[Sno00, p68]. To explain the second of these points, we note that certain personnel in the AWACS aircraft had nominal command authority over the F-15 actions concerning the helicopters.

4 An Investigation by a Sociologist

Colonel Scott Snook, then a Lt. Col., undertook an extensive sociological investigation of this accident, after the manner of Perrow [Per84], Sagan [Sag93], and Vaughan [Vau96], to identify the social and technical structures involved. He identified four conceptually different levels of analysis: the individual level, the group level, the organisational level, and the technical level, and observed that Secretary Perry's four highlights spanned these levels (in the order given). He considered factors at each of the four levels in exhaustive detail. He felt that known science at the four different levels was insufficient to provide a fully satisfactory explanation, and added a "Cross-Levels Account" in which he posited a theory of *Practical Drift*.

We defer to Snook's authoritative "thin description" and "thick description" accounts of events and human factors for a more detailed and compelling description of the shootdown and its contributing factors than we can hope to give here.

4.1 Practical Drift

Snook suggested that organisations have two attributes, each with two limiting values, which can explain to a large extent phenomena which are left unexplained by separate theories of individual, group, and organisational behavior. Organisations can be *tightly-* or *loosely-coupled* in the sense of Perrow [Per84], and their "logics of action" can be predominantly *rule-based* or *task-based*. Rule-based action means that the interactions of organisational parts is governed predominantly by a set of explicit rules (orders, laws). A task-based action set is governed predominantly by actors performing "whatever it takes to get the job done". A task-based logic lacks the coherence of a rule-based approach but is characterised by adjustments to each other's apparent interests of actors performing repetitive interactive tasks. Snook proposed that an organisation such as OPC as *designed* is tightly-coupled and rule-based. When the design is implemented in an actual organisation, which state Snook calls *engineered*, the actual organisation operating as designed becomes in fact loosely-coupled. He claims that this is an unstable state for an organisation, because rule-based action does not match loose coupling. As "pragmatic" concerns take over, the organisation becomes task-oriented while remaining loosely-coupled; he terms this state *applied*. However, through time, pragmatic adjustments become de facto norms, and the organisation becomes once again tightly-coupled, this time without a coherent design. "*Local task-based logics don't match the global demands of a tightly-coupled situation. This is when friendly helicopters get shot down*". An organisation which is task-based and which has become tightly-coupled through task rigidities becomes *failed*. We illustrate the mechanism of Practical Drift after Snook in Figure 1.

4.2 The Importance of Snook's Investigation

Snook's detailed investigation of the social structures involved in the shootdown are compelling for three reasons. First, he has been injured himself in a friendly-fire incident and understands such incidents from a participant's perspective. Second, he demonstrates again the value to understanding the accident of investigations using "thick description" and "thin description" techniques, as well as other tools in the social-organisational theorist's portfolio. Third, his thorough inquiry highlights the apparently large explanatory gap between explanations such as his, and explanations derived from such formal and semi-formal techniques as WBA and STAMP [LAS02].

5 The Counterfactual Test

The *Counterfactual Test* to determine whether phenomenon A is a necessary causal factor (ncf) of phenomenon B was initially proposed by David Hume more than two hundred years ago. David Lewis proposed a formal semantics for causation [Lew73a] which relied upon his semantics and formal logic of counterfactual conditionals [Lew73b].

The Counterfactual Test rests on the following definition. Suppose A and B are phenomena, both of which have occurred. Then *phenomenon A is a necessary causal factor of phenomenon B* if and only if *had A not occurred, B would not have occurred either*. Since we are talking about phenomena which have occurred, the definiens refers to a phenomenon which did not happen, namely that A did not occur. Since it is a conditional expression, it is thus termed a *contrary-to-fact conditional* or a *counterfactual conditional*. Hume proposed this definition as his second definition of causality [Lew73a]. Lewis gave a formal semantics to counterfactuals using the notion of possible worlds, an established formalism for non-classical logics, and exhibited a formal logic complete for the semantics [Lew73b].

Applying the Counterfactual Test to determine if two phenomena are in the relation *ncf* turns out to be quite practical. Lewis's semantics require one to consider the *nearest possible worlds to the actual world* in which A did not occur, and to consider whether B did not occur in these situations either. The technical expression *nearest possible worlds* simply means how the world would have been had A not occurred. It turns out that in most cases interesting to incident analysts, the intuition as to whether B would have occurred in these situations appears to be strong. Such judgements appear to command some degree of general agreement in the majority of cases. The feasibility of using the Counterfactual Test in practical incident analysis rests on the general uniformity of results achieved by analysts who have practiced applying the semantics intuitively.

WBA is based on constructing a list of phenomena, called the *List of Facts*, and then using the Counterfactual Test on the List of Facts to determine the relation *necessary causal factor* amongst them. The graph of this relation is called the *WB-Graph*. The List of Facts may be constructed using traditional investigative methods, although WBA provides some guidance as to when critical facts are missing and how to handle such missing facts.

The appropriateness of the causal explanation represented by the WB-Graph can be further checked against formal criteria by using the formal verification method in WBA. This verification method is resource-intensive, as are most formal methods, and most analyses skip the verification step for that reason. Most WB-Analyses perform just the intuitive assessment to obtain the WB-Graph, and WBA has achieved success in industrial use in this form.

6 Explaining the Discrepancies

We present Snook's Causal Map as in [Sno00, p21], rerendered using our tool *ciedit*, in Figure 5. After checking the causal connections as represented by the edges using the Counterfactual Test, we rerendered the corrected Causal Map as Figure 6.

The WB-Graph derived from the List of Facts (Figures 11, 12, 13 and 14) is rendered in the hard-to-read Figure 7. We split the graph into three parts at the two "chokepoint" nodes at which the graph has width 1, and rendered the top part as Figure 8, the middle section as Figure 9, and the lower part as Figure 10 to aid readability.

We concluded through our WBA of the shootdown incident that the reasons for the discrepancies between the WB-Graph and the Causal Map are

Different Procedures for Deriving Facts: The List of Facts used in the WBA was derived procedurally directly from the AAIB Report Executive Summary, whereas the nodes appearing in the Causal Map appear to be derived ad hoc. There is no explanation of from where the nodes in the Causal Map derive (they are not identical to those we obtained from the AAIB report, neither does he indicate another source. He refers obliquely to repeatedly asking "why", and to breaking down and reorganising a "rich set of data", but these comments do not tell us from which data set he started). Some, such as *Fall of the Soviet Union* and *Changing World Order* appear to be very general social and political phenomena which appear to be outside the scope of phenomena normally identified for inclusion in a WBA. These phenomena are certainly outside those chosen for inclusion in the AAIB Report. Although the "cutoff point" of relevance for incidents is largely conventional, it is nevertheless not arbitrary, and it is hard to see the explanatory purpose in including these two nodes.

The Existence of Causal Loops: The Causal Map includes seven pairs of phenomena (states or events) between which there are arrows (directed edges) in both directions. The relation of *necessary causal factor* is asymmetric (that is, if *A is a necessary causal factor in B* is rendered *A ncf B*, then in logical terminology $(A\ ncf\ B) \Rightarrow \neg(B\ ncf\ A))$ [Lew73a]. These double arrows must be regarded as technical mistakes if the Counterfactual Test is to be taken literally.

One possible explanation for the double edges is that the phenomena so connected in the Causal Map do not represent states, events or processes as required by WBA, but rather groups of these entitities, and the relation displayed is not that of *necessary causal factor* but rather that of *contains a necessary causal factor of*, $cNCF$, between groups of entities in the relation ncf. The relation $cNCF$ which may be defined as follows in logical terminology:

$$(D\ cNCF\ E) \Leftrightarrow \exists x \in D\ \exists y \in E\ (x\ ncf\ y)$$

That is, there is an element of D which is a necessary causal factor of some element of E. The relation $cNCF$ may allow arrows both ways between sets of entities D and E, for it may be that there is an element of D that is an ncf of an element of E, and also some element of E which is an ncf of some element of E (the asymmetry of ncf entails that these cannot be the same elements in each group):

$$(D\ cNCF\ E)\ \&\ (E\ cNCF\ D)$$

$$\Leftrightarrow$$

$$(\ \exists x \in D\ \exists y \in E\ (x\ ncf\ y)\ \&\ \exists z \in E\ \exists w \in D\ (z\ ncf\ w)\ )$$

If this condition holds between two groups of entities D and E, we say that D and E satisfy the *General Factor Condition*.

This explanation emphasises the point that, if Snook's double arrows are to be taken to be correct, the relation he illustrates is other than the relation which he claims to be illustrating (namely, ncf).

Mistakes Applying the Counterfactual Test

There are mistakes in the construction of the Causal Map.

Generally, one may query how carefully the Causal Map was constructed. For example, there is a node labelled *OPORD 97-1 never updated.* There is no *OPORD 97-1* that we could identify fom the sources. We consider it likely that Snook meant to refer to *OPLAN 91-7.*

While checking the relations of the nodes in the Causal Map to each other using the Counterfactual Test, we found some 69 edges that passed the Counterfactual Test, and some 25 edges that did not satisfy the Counterfactual Test. (There may be some variance in these numbers depending on whether one counts a double-headed arrow, as in the Causal Map, as one edge or as two.) That means that only some three-quarters of the edges portrayed in the Causal Map passed the Counterfactual Test, and some one-quarter did not. This one-quarter appears therefore to consist of mistakes.

Amongst the seven occurrences of double-arrows in the Causal Map, we were able to interpret three as satisfying the General Factor Condition. The other four occurences appear to be mistakes. In each of these four cases, the ncf relation holds one way between the two nodes, but not in the other direction, according to the Counterfactual Test.

We do consider that the techniques used to render the graphs play a large role in detecting and avoiding mistakes. The Causal Map attempts to show three factors: causality, "proximity" to accident, and time. To our minds, it succeeds mostly in visually obscuring the all-important relation of causality. Experience in rendering WB-Graphs dates from 1996 [GLL97], and our attempts to improve the readability of WB-Graphs led us rapidly to incorporate the *Graphviz* graph-rendering engine *dot* from AT&T Research into our tools *wb2dot*, and then *cid2dot* and *ciedit*.

The layouts presented through *dot* have enabled us in various examples to correlate groups of factors, as well as to analyse potential "key" factors using formal graph-theoretic techniques. We have found that the visual layouts presented through *dot* enable useful hypotheses concerning the structure of the graph (and therefore of the causal factors) to be formed, and we believe that these have helped us considerably in our WB-Analyses to date.

7 Drawing the Time Line

Snook considers that a time line is important, in which actors are represented along with the times of events in which they participated. This view is confirmed by the analysis of the Herald of Free

Enterprise accident undertaken by Braband et al [BEdS03], which used a similar representation called a Time-Actor Diagram.

The method used by both Snook and the Time-Actor Diagram is to represent actors on multiple parallel timelines, with the timelines running horizontally, and to show the events engaged in by each actor by means of a symbol on the corresponding actor-timeline. Since the multiple lines must be arrayed vertically, this leads to representational difficulties when actors with non-adjacent lines participate in the same event. One may take identical vertical alignment of event symbols on different actor timelines to indicate participation in the same event, but this representation can fail to discriminate between participants in two different events which occur at more or less the same time. This confusion could be resolved through use of annotations or colors within the symbol chosen to represent an event.

We consider it preferable to construct a single vertical timeline of all events, and to annotate the events with the actors participating in this event, as in Figs 2, 3, and 4. The actors are represented by thin columns lying to the right of the time line, and a mark (a cross) in a column by an event indicates that the corresponding actor participated in that event.

Use of a vertical timeline with columns for actor participation allows easily for a greater number of actors than appears visually feasible using Snook's or the Time-Actor-Diagram representations.

Different events at identical or nearly-identical times are indicated through use of one time mark (a horizontal line across the vertical timeline) and descriptions of the events on different horizontal lines adjacent to the single time mark. The actor participation is indicated on the same line as the event description.

Our chosen representation solves the two problems arising with the two other representations in a visually simple manner. We found it directly implementable using an existing tool (OpenOffice^{TM} Spreadsheet, which works similarly to Microsoft Excel^{TM}).

8 Resources Used

WBA is a method comprising some tasks, such as building the WB-Graph, which are profitably undertaken in small groups. We consider it important for industrial application of WBA to state the resources used in performing each WBA.

- Compilation of the List of Facts from the AAIB report Executive Summary took the second author around 6 person-hours
- Drawing the initial WBG using the tool *ciedit*, and modifying it up to the final version (Version 4) took the second author about 5 person-hours
- Drawing Snook's Causal Map in the tool *ciedit* took the first author about 4 person-hours. Let us call the result of this rendering the *Snook Map*
- Drawing the Timeline for the AAIB report Executive Summary took the second author around 1 person-hour
- Checking the Snook Map for incorrect edges took a group of five seminar participants about 3 hours, for a total of 15 person-hours. We estimate that this task could have been as effectively performed with three people experienced in use of the Counterfactual Test in the same length of time. We are, however, wary of performing lengthy systematic error correction tasks with fewer than three participants, because of the increased risk of failing to identify some errors. (This is not to be interpreted as suggesting that our results in this case are themselves completely error-free! Errors in informal-formal methods are a fact of working life, and only a formal verification of the result can guarantee error-freedom. However, performing a formal WBA verification, as with many formal verifications, often stretches resources well beyond their current availability.)

9 Conclusion

The most important conclusion one can draw from this exercise is the advantage in accuracy to be gained through proceeding with a causal analysis using the Counterfactual Test in a methodical manner, as in WBA. We wish to make three points here.

First, we consider construction of the List of Facts. We constructed ours directly from the AAIB report Executive Summary, and it is apparent that our list differs considerably from that of Snook. Also, we tend to avoid listing the kinds of generalised phenomena which led Snook to represent causal connections between these phenomena using loops in his causal map. Loops in a causal graph constructed according to the Counterfactual Test (a WB-Graph) must be a mistake. An inclination to draw such a loop indicates that the phenomena have been described ambiguously, or that the relation illustrated is not that which was proposed; either way, one could consider such inclinations rather as encouragement to describe the phenomena more precisely.

Second, our methodical check of the Causal Map using a small group of analysts revealed that about one-quarter of the causal connections proposed by Snook were mistaken.

Third, one may note the difference in shape between the WB-Graph we constructed and the (corrected) Causal Map. The WB-Graph is deeper, narrower in certain parts (it has width one at two points, whereas the Causal Map appears to have width at least five throughout). We suggest that the WB-Graph is thereby more easily cognitively assimilable. Further, experience of WBA in industrial use has shown that graphs of depth and low width at certain points more easily allow countermeasures to be formulated. Countermeasures are actions an organisation can take to preclude similar incidents occurring in the future. We have no proof that "well-constructed" WBAs tend to yield WB-Graphs with such cognitively amenable properties, but we have noticed what seems to be such a correlation.

One may ask whether the differences in the WB-Graph and the Causal Map indicate that the application of the Counterfactual Test can lead to radically different results when applied by different people. We believe that this phenomenon is adequately explained in the current example simply through the more orderly derivation of the List of Facts in the Why-Because Analysis. The example does help to emphasise that an orderly derivation of the List of Facts whose causal connections are to be judged is a crucial part of a satisfactory Why-Because Analysis.

Our second conclusion concerns the methodology in general. Snook contends that the Causal Map and the Timeline alone are unsatisfactory explanatory devices. His argument is compelling as it proceeds from his Causal Map and his Timeline. However, the argument is much less compelling when the WB-Graph and Timeline from the AAIB report are derived using a WBA. We see no reason prima facie why the other individual, group and organisational factors investigated by Snook, as well as the phenomena he ascribes to Practical Drift, cannot adequately be represented in an expanded WB-Graph of the incident. We intend to derive such an expanded WB-Graph and compare it with Snook's discursive analysis, as well as with Leveson's STAMP analysis [LAS02], in further work.

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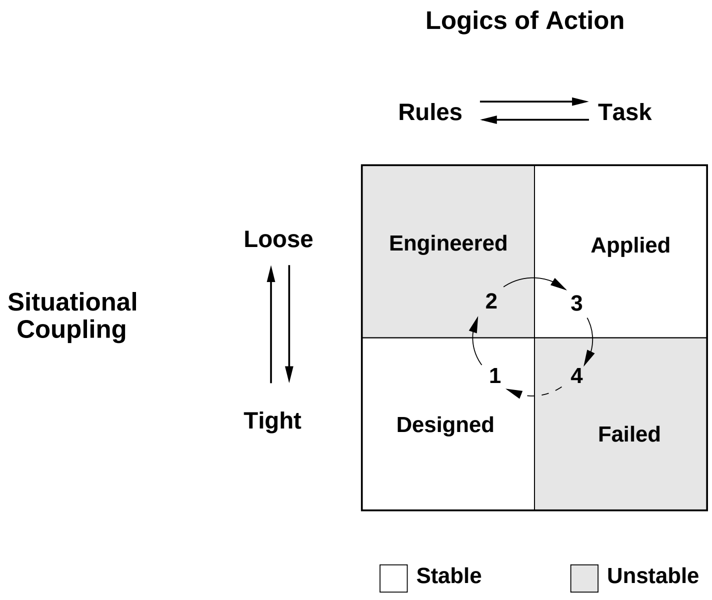

Fig. 1. Practical Drift (after [Sno00, p186])

Sheet1

		AWACS	BlHwks	F15
Depart Incirlik	07:36	X		
Depart Dyabirkir	08:22		X	
On Station	08:45	X		
“H” Placed	09:14	X		
Check-in w' AWACS	09:21	X	X	
“EE01” placed	09:21	X		
IFF returns fade	09:24	X	X	
Enter TAOR	09:35		X	
Depart Incirlik	09:35			X
Land @ Zakhu	09:41		X	
Depart Zakhu	09:54		X	
“H” Displayed	09:54	X		
Enter Valley	10:11		X	
IFF returns fade	10:11	X	X	
Attn Arrow placed	10:13	X		
“Negative Words”	10:15	R		X
Enter TAOR	10:20			X
HELO Symbology dropped	10:21	X		
“Clean there”	10:22	X		R
Initial contact report	10:22	R		X
Intermittent IFF RTNS	10:23	X	X	
“Hits there”	10:25	X		R
Second contact report	10:25	R		X
Visual pass “Hind”	10:27			X
AC destroyed	10:30		X	X

Page 1

Fig. 2. The Time Line of Significant Events (after Snook)

Event	***Time (Zulu)***	***F15s (Tiger)***	***Black Hawks (Eagle)***	***AWACS (Cougar)***
Departure Incirlik AB	0436			X
Departure Diyarbakir	0522		X	
On Station	0545			X
„H“ displayed on SD radar scope	0612			X
Radio transmission at „Gate“	0621		X	R
Eagle Track annotated „EE01“				X
Eagle land at Zakhu	~0624		X	
Eagle IFF and Radar fade			X	X
Departure Incirlik AB	0635	X		
Tiger IFF Mode IV interogated	0636	X		X
Onroute from Zakhu to Irbil	0654			X
Radio call received			X	R
„EE01“ reinitiated				X
„H“ regularly displayed	0655		X	X
Check In	0705	X		R
„H“ ceases to be displayed	0711		X	X
Eagle enter mountainous terrain	0712			X
*Eagle*radar and IFF fade			X	X
Symbology continues at last known speed and direction				X
ASO places SD scope in vincinity of *Eagle* last known position	0713			X
Check In with ACE	~0715	X		R
ACE replies „... negative words“		R		X
Radar adjusted to low-velocity detection				X
Enter TAOR	0720	X		
Radio transmission at „Gate“		X		R
„EE01“ symbology dropped	0721			X
Report of radar contacts at 40nm	0722	X		R
Reply „clean there“		R		X
IFF response in vicinity of *Tiger's* radar contact	0723		X	X
„H“ symbol reappears	0724		X	X
IFF response more frequent	0725		X	X
Radio „Contact“		X		R
Radio „Hits There“		R		X
Enroute controller initiates „Unknown, Pending, Unevaluated“ symbol in vicinity of *Eagle* IFF/radar returns	0727			X
Enroute controller attempts IFF interrogation				X
Visual Identification with helicopter at 5 NM	~0728	X	X	
*Eagle*IFF and Radar fade		?	X	?

Fig. 3. The AAIB Timeline (Part 1)

Event	***Time (Zulu)***	***F15s (Tiger)***	***Black Hawks (Eagle)***	***AWACS (Cougar)***
Tiger Lead conducts VID pass	~0728	X	X	
Tiger Lead calls „... Tally 2 Hinds ...“		X		R
Cougar calls „Copy Hinds“		R		X
Tiger Wing conducts VID pass	~0728.30	X	X	
*Tiger Wing*calls „Tally 2“		X		R
Tiger Lead instructs *Wing* to „Arm hot“ and gives instruction for independent targeting	~0729	X/R		
*Tiger Lead*fires AIM120 at *Eagle Trail*	~0730	X	R	
Tiger Wing fires AIM9 at *Eagle Lead*		X	R	
*Tiger Lead*calls „Splash 2 Hinds“	>0730	X		R

Fig. 4. The AAIB Timeline (Part 2)

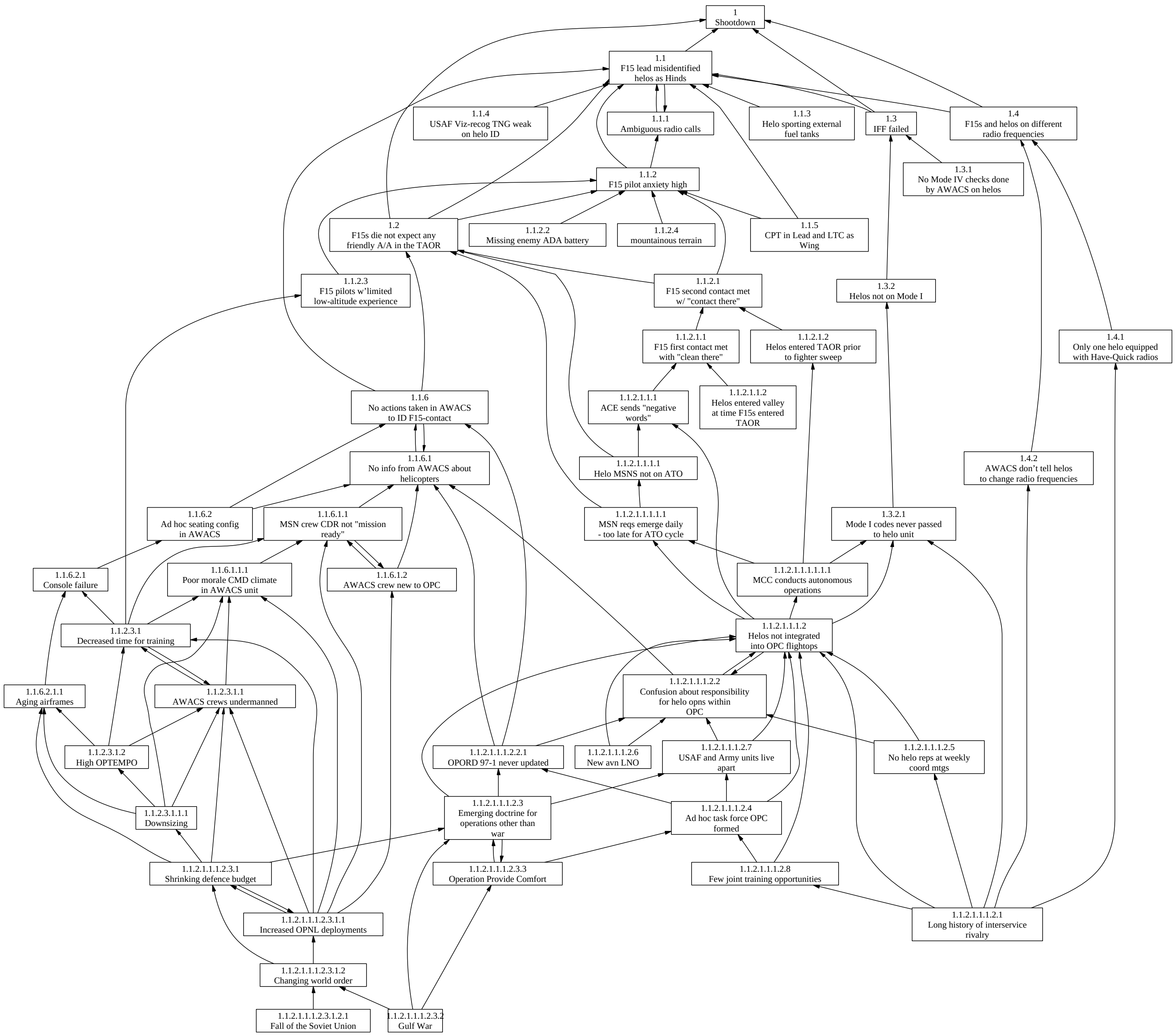

Fig. 5. Snook's Causal Map (after Snook [Sno00])

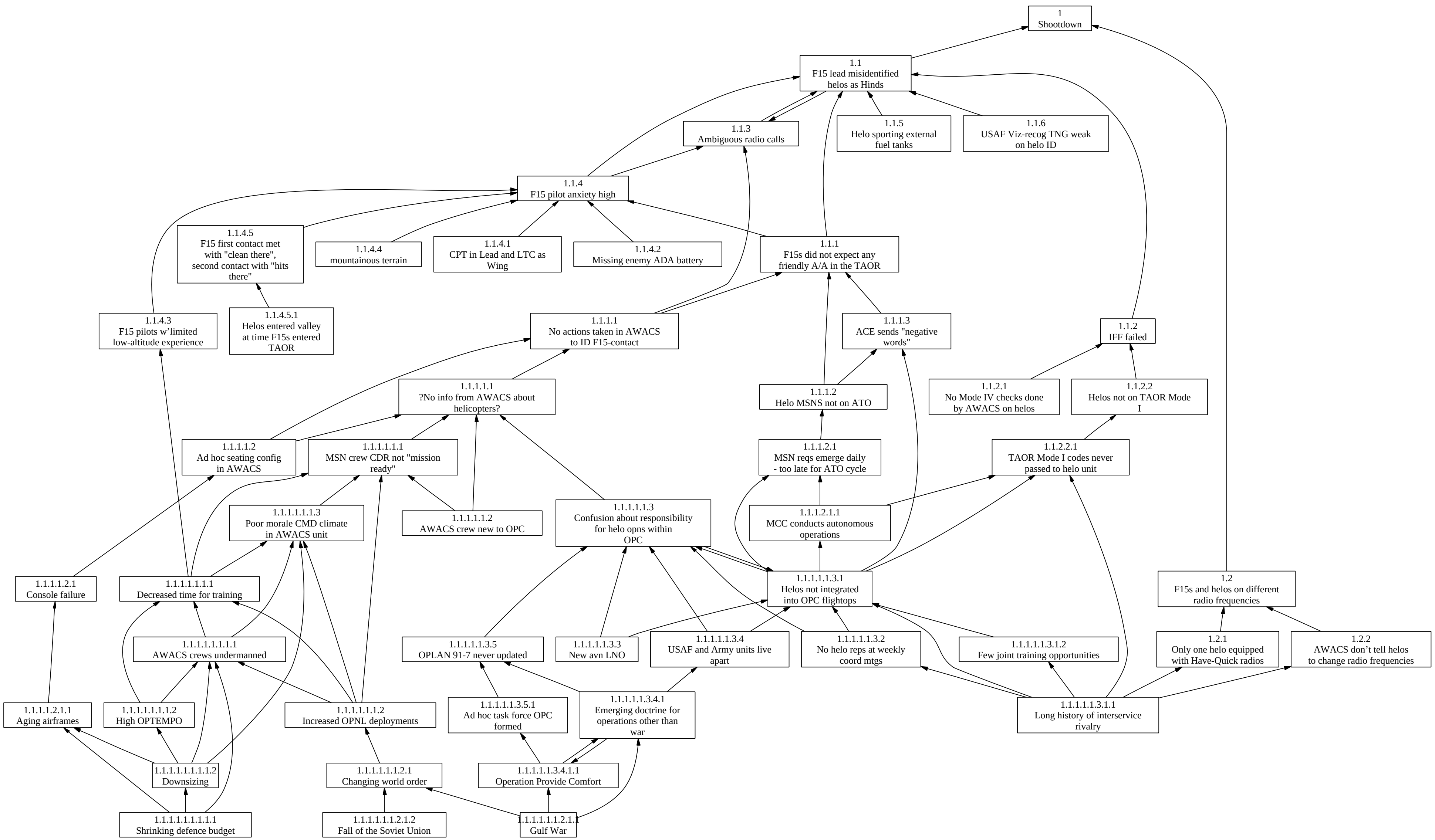

Fig. 6. The Corrected Causal Map

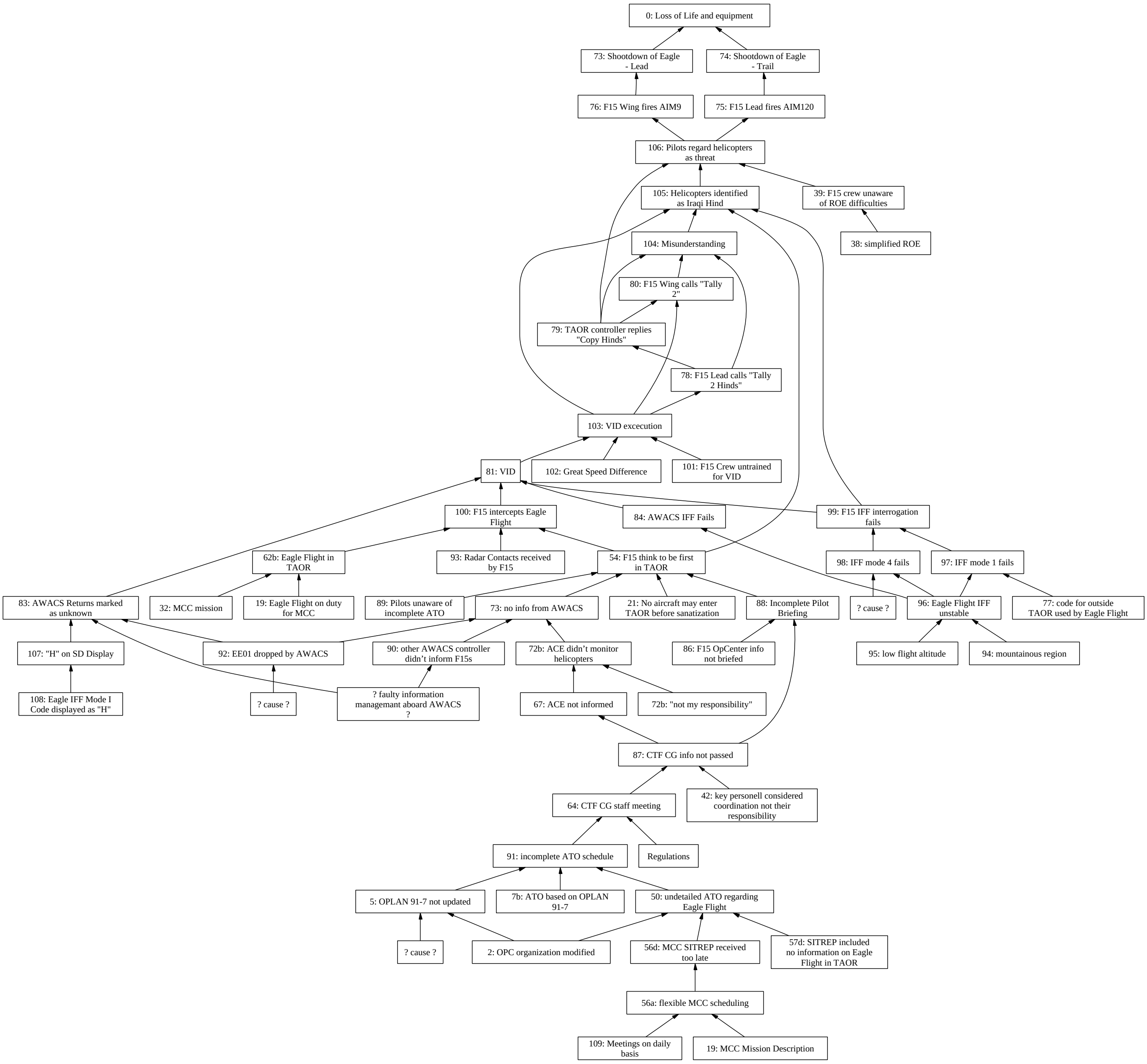

Fig. 7. The Why-Because Graph from the AAIB report

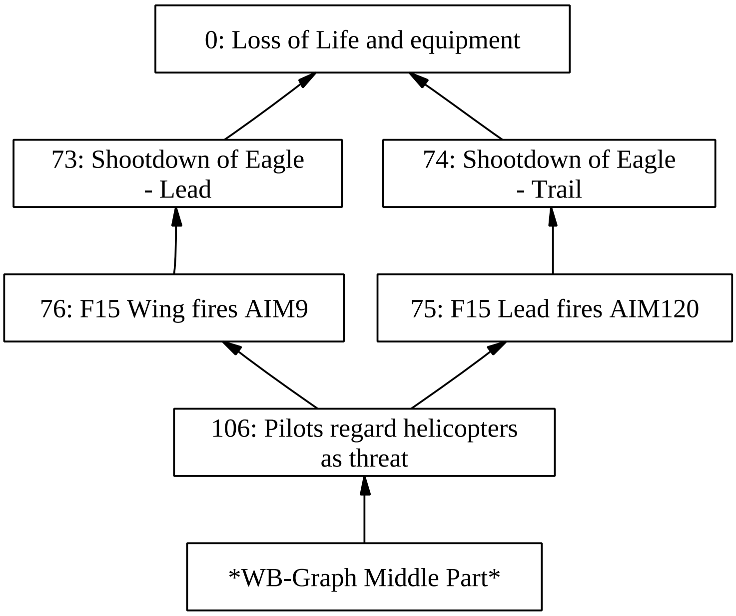

Fig. 8. The AAIB WB-Graph, Top Part

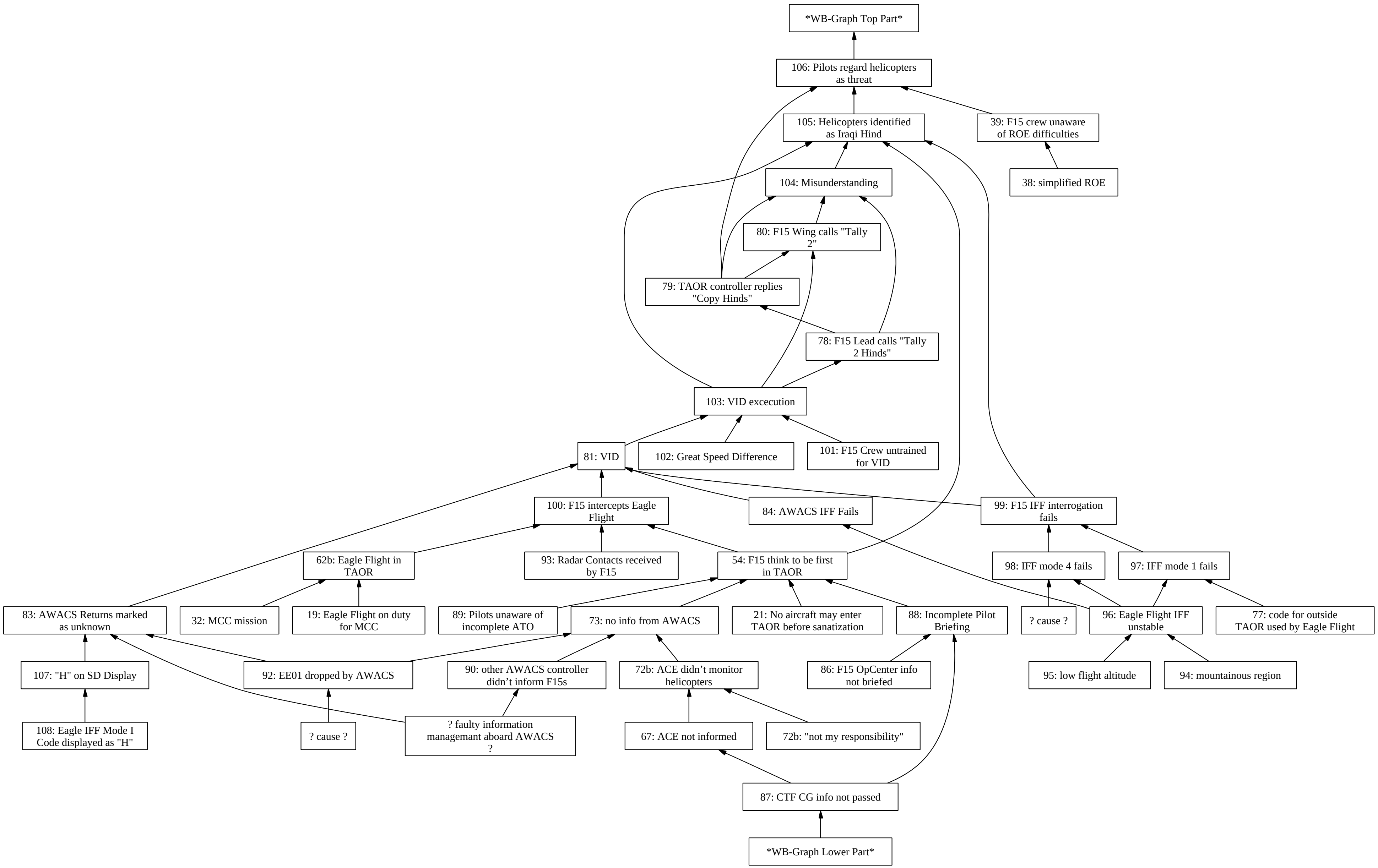

Fig. 9. The AAIB WB-Graph, Middle Part

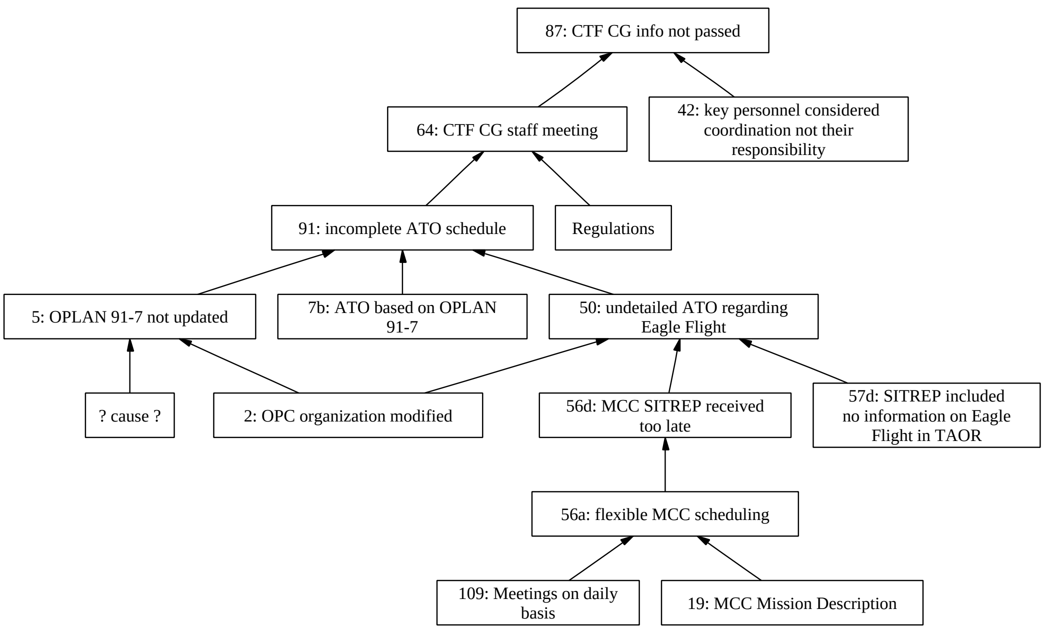

Fig. 10. The AAIB WB-Graph, Lower Part

List-of-Facts

0. Loss of 2 Black Hawk Helicopters & 26 people *(not directely stated in AAIB)*
1. Operation Provide Comfort
   a) directed in April 1991 by US National Command Authority
   b) Tactical Area of Responsibility north of 36 degrees latitude, Iraq
2. OPORD 004 (14. Sept. 1991)
   a) Withdrawal of OPC Battalion Task Force
   b) Increase size of CTF air forces
   c) retention of the JSOTF at Incirlik AB
3. OPLAN 91-7 provided comprehensive guidance for OPC as existed in July 1991
4. Redeployment of Battalion TaskForce in Sept. 1991 (2a)
5. OPLAN 91-7 not updated
6. Update of OPLAN 91-7 required by OPLAN 004
7. CFAC DO publishes
   a) Airspace Control Order (ACO)
   b) misson-related Special Instructions (SPINS)
   c) Daily Air Tasking Order (ATO)
8. Airspace Control Order (ACO)
   a) provides general guidance regarding the conduct of OPC missions
   b) is directive for all OPC aircrews
9. Daily Air Tasking Order ATO
   a) published by CFAC DO (Deputy Commander of Combined Force Air Component)
   b) lists
      - Radio frequencies
      - IFF (Identifaction Friend or Foe) codes
      - other information pertinent to each day' s mission
10. CFGround Component Commander coordinate rotary wing sorties in Iraq (OPLAN 91-7)
11. After Sept. 1991 no coordination of rotary wing sorties
12. CTF C3 (operations, planning) focal point for coordination of rotary wing flights (OPLAN 91-7)
13. Joint Operations and Intellignece Center (JOIC) responsible to C3
    a) provides 24 hour point of contact for communications within CTF
    b) receives, delivers and transmits communications (when tasked) within CFG control structure
14. Army Liaison Officer availble between MCC helicopter detachment and parent unit.
    a) Not assigned to the JOIC
    b) provides liaision between MCC helicopter detachment and CTF staff (on request)
15. OPC tactical objectives
    a) flight operations scheduled as misson packages
    b) package consists of wide variety of aircraft with speficic mission capabilities
16. AWACS provides
    a) flight following to and from TAOR
    b) threat warning within TAOR
    c) fighter control within TAOR
    d) surveillance, detection and identification of unknown aircraft
17. Air Refueling aircraft provide in flight refueling for AWACS and fighter aircraft
18. Fighter aircraft provide
    a) visual and sensor reconnaissance of military targets
    b) defensive counter air (DCA) capability
    c) suppression of enemy air defense (SEAD) capability
    d) on-call precision-guided munitions (PGM) capability
19. MCC Black Hawk helicopters
    a) maintain visible presence in the security zone by
       - patrols
       - visits to Kurdish villages
    b) conduct transport
    c) conduct search and rescue missions (SAR)
20. Fighters may not cross border into Iraq without AWACS coverage
21. No aircraft may enter TAOR until TAOR searched with AI capable fighters „sanatized“
22. OPC aircraft on station 6-8 hours daily (flying „window“)
23. Fighters with AI capability leave TAOR last to protect package

Fig. 11. The List of Facts from the AAIB Report (Part 1)

24. Weapons Director (WD) in AWACS acts as enroute controller
25. Enroute Controler conducts IFF and radio checks on all OPC aircraft
26. TAOR Controler in AWACS provides threat warning and tactical control for all OPC aircraft
27. Air Surveillance Office (ASO) responsible for detection, tracking and identificaton of non-OPC aircraft
28. OPLAN 91-7: ACE (airborn command element) on AWACS has primary responsibility for mission outside 50NM of Incirlik
29. CFACC testimony: ACE onboard AWACS (14.4.94) had no decision-making authority
30. 2 F-15C departed Incirlik AB at 0635Z to conduct DCA combat air patrol in TAOR
31. MCC HQ in Zakhu, Iraq
32. 14.4.94: BlackHawks missions:
    a) tranport personal and cargo from Incirlik to Zakhu
    b) tranport MCC co-commanders and staff-officers to Irbil and Salah Ad Din, Iraq
    c) return
33. prior to accident CFAC DO provided ROE briefings
34. Individual replacement pilots were not centrally briefed in ROE
35. Briefings were left as individual sqadron responsibility
36. F-15 pilots read ARF
37. F-15 pilots received a squadron briefing on ROE
38. original ROE (by USEUCOM) were reduced to a simplified form
39. crew members not aware of specific considerations prior engagement
    a) as identifaction difficulties
    b) as need to give defectors safe conduct
    c) as possibility of aircraft in distress and crew unaware of position
40. ACO dated 12.12.93, reflect guidance of OPC OperationOrders and OPLAN 91-7
41. key personnel at 14.4.94 were unaware of existence of OPLAN 91-7 or thought it outdated
42. key personnel CFAC and CTF considered MCC helicopter coordination not their responsibility
43. last staff member that coordinated MCC activities left in Jan 1994
44. no MCC representative assigned to CFAC for coordination
45. since Dez 1993 no MCC helicopter representative had attended CFAC weekly DETCO schedule meetings
46. Army Liaision Officer new on station
47. Army Liaision Officer not fully aware of the relationship between MCC and OPC
48. Scheduling flow sheet principal planning tool for OPC air crews
49. helicopter flight information not included in daily ATO
50. ACE knowledge of MCC activity based on radar, IFF and radio contacts
51. UH-60 flight in TAOR require AWACS coverage (CTF CG policy letter. Sep 93)
52. UH-60 routinely flow in TAOR without AWACS or fighter coverage
53. CTF personnal was aware of 53.
54. F-15 pilots thought that no OPC aircraft was allowed in TAOR prior to fighter sweep as in ACO
55. MCCs mission requirements varied on events of previous day
    a) flexibility in scheduling supporting helicopter flights
    b) weekly flight schedule was developed
    c) flight schedule provided to CTF C3
    d) firm itinerary not available until after next day's ATO
    e) information not detailed enough for effective coordination and scheduling
56. MCC privided SITREP to JOIC
    a) SITREP included flights for next day
    b) SITREP used general informations
    c) SITREP included in ATO
    d) SITREP from 14.4.94 gave no info on flight within TAOR
    e) times were given as A/R (as required)
    f) ATO line was „activated“ by phone call from MCC to JOIC
    g) „activation“ included time info
    h) time info was given from JOIC to Turkish C3 for approval
    i) Info was not provided from JOIC to CFAC
57. CTF C2 representative obtained MCC helicopter info from JOIC
    a) info included MCC weekly schedule and daily MCC SITREP
    b) C2 passed info to individual units at Incirlik AB by mail pickup
58. 8.4.94 MCC provided weekly schedule to CTF C3

Fig. 12. The List of Facts from the AAIB Report (Part 2)

a) included „administrativ flight“ on 14.4.94

59. 12.4.94 MCC Commander requested approval for a flight on 14.4.94
    a) flight was to proceed from Zakhu to Irbil and Salah an Din
    b) 13.4.94 CTF CG approved request
    c) JOIC transmitted approval to MCC
60. 13.4.94 MCC SITREP listed flight as „mission support“ but no details
61. 13.4.94 JOIC receives MCC weekly schedule update including SITREP
    a) destinations for 14.4.94 flight given in update
    b) update not passed to CFAC
62. 13.4.94 1538Z MCC contacted JOIC and activated ATO line for mission
    a) 0520Z mission takeoff from Diyarbakir
    b) 0635Z gate time
    c) no takeoff time, route or flight info beyond Zakhu specified
63. 13.4.94 SITREP, weekly schedule update and line-activation received too late for 13.4.94 C3 and CTF CG staff meetings
64. no info passed to CFAC scheduling shop
65. no info passed to ground based mission director
66. no info passed to ACE on AWACS
67. MCC schedule with info on MCC helicopter flight received in Incirlik AB through C2 channels
68. info posted on intelligence briefing
69. info not briefed to air crews
70. 0635Z 14.4.94 F-15s depart Incirlik AB
    a) F15s unaware of MCC helicopters operation in TAOR
71. 14.4.94 0720Z F15 arrived in TAOR
    a) no info that BlackHawks were already in TAOR was given from AWACS to F15s
    b) ACE didn't consider it his responsibility to monitor the helicopters
72. ACE and AWACS controllers gabe any direction to
    a) helicopters and
    b) fighters

    throughout intercept and engagement
73. Shootdown of Eagle Lead *(AAIB Timeline)*
74. Shootdown of Eagle Trail *(AAIB Timeline)*
75. F15 lead fires AIM120 at Eagle Trail *(AAIB Timeline)*
76. F15 wing fires AIM9 at Eagle Lead *(AAIB Timeline)*
77. Eagle Flight used code for outside TAOR *(AAIB ExSum Vol1)*
78. 0728Z – F15 Lead: „Tally 2 Hinds“ *(Timeline)*
79. 0728Z – AWACS: „Copy Hinds“ *(Timeline)*
80. 0728.30Z – F15 Wing: „Tally 2“ *(Timeline)*
81. 0728Z – F15 lead „visual“ with helicopter *(Timeline)*
82. 0721Z – EE01 symbology dropped by AWACS (*Timeline)*
83. 0727Z – EC initiates „unknown, pending, unevaluated“ symbology (*Timeline)*
84. 0727Z – EC attempts IFF interrogation
85. MCC schedule was posted at F15 squadron briefing board
86. briefing board info not briefed to crews
87. CTF CG info not passed
88. Pilot briefing incomplete (conclusion by 87, 86)
89. Pilots unaware of incomplete briefing (conclusion by 88, 54)
90. other AWACS controllers didn't inform F15s *(AAIB summary of events – control)*
91. incomplete ATO schedule (conclusion by 50)
92. 0721Z – EE01 dropped by AWACS (*Timeline)*
93. 0725Z – F15 lead calls „contact“ (*Timeline)*
94. 0712Z – Black Hawks enter mountainous terrain (*Timeline)*
95. Black Hawks at low altitude *(AAIB ExSum Vol1)*
96. ~0728Z – Black Hawk IFF+Radar fade (*Timeline)*
97. F15s did not receive Mode I response *(AAIB ExSum Vol1)*
98. no Mode IV response received on 2 subsequent attempts *(AAIB ExSum Vol1)*
99. F15s IFF interrogation fails (conclusion by 97,98)
100. F15 intercept Eagle Flight (conclusion by 81)
101. Neither F15 pilot had received recent, adequate visual recognition training *(AAIB ExSum Vol1)*
102. identifaction passes at speeds, altitudes and distances where it would be unlikely ... to detect the Black Hawks

Fig. 13. The List of Facts from the AAIB Report (Part 3)

markings *(AAIB ExSum Vol1)*

103. VID excecution
104. Misunderstanding
105. Helicopters identified as Iraqi Hind
106. Pilots regard Helicopters as threat
107. 0724Z – „H“symbol on SD scope (*Timeline)*
108. 0655Z – „H“regularly displayed on SD radar scope (IFF Mode I, Code 42) (*Timeline)*
109. MCC mission requirements based on events of previous day *(AAIB ExSum Vol1)*

Fig. 14. The List of Facts from the AAIB Report (Part 4)