A Paradigmatic Framework
for Flight Safety

by

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A THESIS
submitted to
Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed April 26, 1991

Commencement June 1991
An Abstract of the Thesis of

Title: A Paradigmatic Framework for Flight Safety

Abstract approved: [Signature]
Kenneth H. Funk II

Statistically, travel by air is one of the safest forms of transportation. Yet we continue to experience aviation tragedies. Do we fully understand flight safety or is there another way of looking at the problem? In this work a new way of approaching the question of flight safety is developed, justified and illustrated. Traditional methods are shown to be insufficient for a full understanding of flight safety. They do not provide an adequate explanation of the context of aviation safety.

The issue is approached from a new perspective with a methodology based on a philosophical understanding of explanation. For the examination of the context of aviation safety traditional modes of scientific explanation are rejected in favor of a paradigmatic explanation. A framework for explaining the context of accidents and safety, in general, is synthesized from four broad paradigms which characterize its patterned nature: the cognitive paradigm, the paradigm of normal accidents, the paradigm of technology, and the paradigm of organizational complexes. The development of the framework is supported by a wide diversity of literature from philosophers, psychologists, social scientists and engineers. It is explicated with numerous examples throughout. The framework is then compared with the traditional mode of explanation through an extensive pedagogical case-study of a specific accident.

The new framework is complementary to traditional approaches and new insights are pointed up. Finally, some broad recommendations are made for the community of professionals concerned with improving aviation safety.
A Paradigmatic Framework for Flight Safety

Chapter 1

Introduction

2246:001 Seattle Center, MAC 4-0-6-4-1 is passing three-two thousand for one-five thousand2

2246:05 MAC 406413, Seattle Center, ident; fly heading one-five-zero vectors to McChord runway one-six in use, expect a P-A-R approach4

2248:52 MAC 40641 maintain one-seven thousand; expect lower in 30 miles

2248:59 Okay; stop at seventeen

2250:43 2-8-3-2-3 is level two-two-zero5

2250:49 28323, Seattle Center, ident6; expect a P-A-R approach on runway one-three

2252:18 Seattle, 641 is level seventeen

1 Pacific Daylight Time in 24-hour designation (hhmm:ss).

2 These are transcribed quotes of actual radio communications between the aircraft and Air Traffic Control (ATC) controllers. Such communications are focused, brief and often cryptic. The identifier of the agency being called is stated first [Seattle Center]; the caller states his identifier next [MAC 40641]; and the message (information or request) follows. MAC 40641 is the identifier of a C141 Starlifter, a large four engine jet transport in the United States Air Force's Military Airlift Command (MAC); 40641 is the "tail number" or aircraft serial number of this specific airplane. In radio communications involving numbers, the numbers are (should be) spoken digit-by-digit; e.g. 40641 is spoken four-zero-six-four-one.

3 This particular airplane is returning to its home base, McChord Air Force Base (AFB) near Tacoma, Washington, from Yokota Air Base near Tokyo, Japan.

4 Precision approach.

5 V 28323 is a Navy A-6 heading north enroute to Whidbey Island Naval Air Station (NAS). During this period the air "traffic" load was very light; the only other traffic for this controller's section included two commercial flights (radio communications not included here). Also note that the radio communications in the above transcript are picked up "in progress".

6 "Ident" means for the pilot to press a button on his transponder or "squawk box" (already set to a specified code) which will cause the coded aircraft blip on the ATC controller's radar screen to become bright for a moment, thus enabling positive identification of the airplane and its position.
MAC 641, roger; now cleared to one-zero thousand and uh left to one-five-zero
One-zero thousand; left to one-five-zero; four-one
Navy 28323 fly heading three-one-zero vector for uh runway one-three
Three-two-three; three-one-zero
And Navy 323 is cleared to one-zero thousand, descend at your discretion
Roger we’re out of two-two-zero for one-zero thousand at this time
And Seattle, 40641 is level at ten
40641 maintain five thousand
Five thousand; 40641 is out of ten

This routine series of air-traffic-control transmissions [1] on March 20, 1975, resulted in the following press release from the Federal Aviation Administration (FAA) on March 24, 1975:

"The crash of an Air Force C-141 jet transport on March 20, appears to have been caused by human error by an air traffic controller who inadvertently radioed descend instructions to the Air Force airplane instead of a Navy aircraft he was also controlling. ...Both aircraft were at 10,000 feet about 60 miles apart, with the Air Force airplane heading South and the Navy heading North. The controller identified the Navy A-6 on his radar scope and wanted to instruct it to descend to 5,000 feet, but instead of calling "Navy 8323" he radioed "MAC 0641". Then, soon after, the controller realized the error, but the C-141 had already disappeared from the radar scope and had crashed in the Olympic Mountains, where the terrain raises as high as 7,900 feet." ...The FAA operates 20 Air Route Traffic Control Centers in the continental U.S. and in 1974 they handled more than 23 million aircraft operations." [2]

In the midst of clouds and dark night, the C-141 hit the 7150 ft level of a 7300 ft ridge in the rugged Olympic Mountains of Washington, instantly killing all ten crew members and the six passengers. The impact occurred at about 2258 PDT, approximately one and a half minutes after their last transmission cited above. We pick up the next transmission made by the Navy plane.

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7 "Roger" means "transmission received and understood."
8 In acknowledgements, after radio contact has been well established, communication tends to become very cryptic. Although not without its problems, in this light traffic case the identity is always clear from the rapid sequential response and (cryptic) identifier in the transmission.
9 The implied command is to "[descend and] maintain five thousand."
2258:35  Seattle Center, 28323 level ten thousand
2258:40  28323 level at five?
2258:43  Negative; level one-zero thousand
2258:46  28323 cleared to five thousand
2259:29  Whidbey Approach, Sector 3 handoff
2259:34  Go ahead
2259:35  Navy 28323 descending to five thousand, uh bearing zero-two-zero at uh twenty miles
2259:41  Radar contact; he released?
2259:43  And he is released, descending to five
2259:55  28323 contact Whidbey Approach Control two-seven-two point eight [Seattle D3 releasing the Navy flight]
2300:01  2-7-2-8, thank you
2300:03  Go ahead [D3 in response to a call from D2]
2300:04  Yeh, this is two, where is MAC 40641?
2300:08  Ah shoot, I forgot to ship him to you; standby
2300:10  Where is he though?
2300:13  MAC 40641, Seattle
2300:19  MAC 40641, Seattle
2300:23  Good question, I saw him uh one fifty heading down by Bremerton
2300:31  MAC 40641, Seattle
2300:48  MAC 40641, Seattle

10 Radio communications transcribed here also include controller-to-controller communication. The controller referred to above by the pilots as "Seattle Center" is the Seattle Sector D3 controller. He is contacting the Whidbey Approach (Navy) controller; Seattle Sector D2 controller, covering the sector immediately south of D3, comes in shortly.

11 At this point other Sectors and civilian aircraft in the area were also trying to raise 40641 on the designated communication frequency that D3 was using. In the next transmission, "guard" frequency is the emergency frequency always in monitor mode on every radio. Also, at this time the assistant chief on duty was notified.
2300:54 MAC 40641, Seattle Center on guard

2301:25 That big area precipitation just southeast of Lofall, south-southeast [Seattle Departure (SEA TWR) at the SEA-TAC airport also trying to help find him]

2301:28 MAC 40641, Seattle

2301:36 I see somebody about uh 20 north of Lofall, ten seven [17,000] descending [SEA TWR with a radar sighting]

2301:38 MAC 40641, Seattle

2301:54 MAC 40641, Seattle

2301:59 MAC 40641, Seattle

2302:54 Departure where is that Saturn? [D3 talking to SEA TWR]

2302:57 Saturn is uh 20 make it 18 miles north-northwest of Seattle; will be above the traffic that's 10 north of Lofall

2303:05 That's the MAC coming to nine; is he going to be above him alright? [D3 is confused by a Northwest Airlines flight]

2303:07 Yes

2303:32 Radar contact on the MAC; you said he was above the Northwest? [SEA TWR]

2303:34 Saturn 10 is east of uh Lofall and he'll be heading to intercept above [SEA TWR]

2303:37 Thank you

2304:30 MAC 40641, Seattle...

At this point, aircraft accident preliminary notification procedures were initiated by the assistant chief. Contrary to the FAA release quoted above, it wasn't until about an hour later, after reviewing the taped transmissions, that it was realized that a wrong clearance was given. [3] The controller never knew he made the mental slip until then.