Analysing the Brazilian Mid-Air

“News-Based” Analysis of the Mid-Air Collision over the Amazon Jungle on Sep. 29, 2006

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The Accident (1)

- GOL Flight 1907 reported missing on Sep. 29, 2006
  - Boeing B737-800 operated by Brazilian carrier GOL
  - Radar contact lost at 16:57 BST (Brazil Standard Time)
  - Flight from Manaus to Brasilia
  - Flight 1907 departed Manaus at 15:36 BST
  - Rumour said, Boeing could have collided in air with smaller aircraft
The Accident (2)

- Embraer Legacy 600 operated by ExcelAire Inc.
  - Maidenflight from Sao Jose dos Campos via Manaus to U.S.
  - Emergency landing after colliding with „shadow“
  - Legacy damaged at wing and tail
  - Legacy landed at Cachimbo Air Force Base
  - Cachimbo in vicinity (130 miles) of last known position of GOL Flight 1907
The Accident (3)

- To forestall analysis:
  - Mid-Air collision between Boeing B737 and Legacy took place

- Area of collision lies at the border between
  - ATC Brasília and
  - ATC Manaus

- Radar coverage at its limits
  - Radio contact notoriously weak
The Analysis

- Information-Base used:
  - collection of newspaper clippings

- Reports analysed in chronological order
  - using information from prior reports

- Uncertain factors and rumour as factors in the analysis allowed
  - leads to graph with increased complexity
  - revision necessary, when central rumour
    - becomes valid or invalid or
    - has to be redrafted
Why „News Based“?

- I am not involved in ongoing investigation
  - Information can only be gathered through newspapers and public statements
  - Fairly easy because of large media interest in the accident

- Accident of Interest because
  - Mid-Air collision between two modern aircraft in controlled airspace
    - Boeing B737-800 was delivered 3 weeks before accident
    - Embraer Legacy 600 was on delivery flight
  - Second mid-air collision in controlled airspace in 6 years
What „News“ were used in Analysis?

- Reports from
  - International Herald Tribune
    - online sources
    - mostly reports by agencies like Reuters or Associated Press
  - New York Times
    - online sources (TimesSelect)

- from Sep. 30, 2006 up to May 05, 2007

- Further sources for greater detail in information
  - clippings from „Flight International“ and „Aviation Week“
  - NTSB Advisory and recommendation
**Very limited Information**

**IHT Sep. 30, 2006**

- Uncertain, if mid-air collision has occurred
  - uncertain, if Legacy emergency and Boeing crash are related

- Directions of further investigation:
  - What caused damage on Legacy?
  - Why did Boeing crash?
  - Did Legacy and Boeing collide?
More Details come Public

- Mid-Air collision „possible“
- Information on Legacy flight
- Statements from Legacy crew

IHT Oct. 2, 2006

- Boeing 737 wreckage found
- Boeing 737 crashes in Mato Grosso area
- Unlikelihood of survivors
- Boeing 737 strikes ground at more than 300 mph
- Legacy stabilizes after collision
- Legacy makes emergency landing at Cachimbo air force base
- Legacy loses part of a wing
- Legacy tail damaged
- Legacy flies stable northwest at FL370
- Legacy purchased by Excel Air
- Flight 3907 from Manaus to Brasilia
- Radar contact lost during flight
- Legacy does not see Boeing 737
- Legacy on route from Sao Jose dos Campos to US
- Legacy 737-800 operated by GOL
- (14) Legacy on flight
Speculation on the Causes

NYT Oct. 4, 2006

- Was the Legacy crew demonstrating aircraft potentials?
- Did the Boeing break up in air?
- Did parts of Boeing hit Legacy?
Radio-Contact and Transponder

- Assumed Mid-Air collision between Legacy and Boeing B737
- Legacy transponder was not working
- Intermittent radio contact between Legacy and ATC
- TCAS is based on operational transponder

NYT Oct. 9, 2006
Clearances and Flight Plans

- ATC cleared both aircraft for FL370 on the same airway
  - Boeing submitted flight plan requesting FL370 as cruise altitude
  - Legacy submitted flight plan
    - FL370 up to Brasilia
    - FL360 up to TERES
    - FL380 after TERES
  - Legacy was cleared by ATC for FL370

NYT Nov. 21, 2006
System Failures (1)

- TCAS error messages presented
  - Newspapers IHT and NYT only distributed the information that the Legacy's crew has missed the TCAS failure message
  - NTSB Safety Recommendation provided very detailed information
    - Failure notice displayed as static text
    - using inconspicuous colouring
    - no aural signal used to alert the crew
Graph resulting from IHT and NYT Information

- Graph includes a possible but unverified explanation for transponder malfunction:
  - ExcelAire sent report quoting that there have been problems with on-board radio systems
  - Embraer had sent the devices to Honeywell for verification
  - Devices were integrated in delivered aircraft
Expanding Information-Base and Graph

- Flight International provided detailed additional information
  - Events after collision
  - Flight Routes and Plans
  - ATC related Information
    - ATC assignment of aircraft
    - ATC interna (shift-change)
    - Details on ATC software characteristics

- NTSB recommendation
  - TCAS failure seems to have been overlooked
System Failures (2)

- ATC software „updated“ assigned altitude automatically
  - The Brazilian ATC software switches the assigned altitude for an aircraft to the altitude requested by the flightplan
  - It is not verified that aircraft is cleared for this altitude
The Resulting Graph
Apparent causes of the Collision

- Collision took place after failure to handover Legacy from ATC Brasilia to ATC Manaus
  - Radio coverage not 100%
  - Radar coverage at its limits
- Transponder on-board Legacy not operating
  - Legacy crew did not notice transponder failure
- ATC Manaus did not advise Boeing to change altitude
  - Radar software displayed assumed altitude
  - Software automatically sets the displayed altitude to planned altitude after waypoint is passed
Apparent Causes of the Collision

- Legacy crew did not recognise TCAS failure
  - Failure signal could be overheard
- Legacy wing-tip could inflict severe damage on Boeing
- TCAS does not operate without transponder info
- ATC unable to judge altitude correctly
- ATC software automatically changes displayed information without prior verification
Questions Raised:

- Had Legacy crew experience with Brasilian airtraffic conditions?
- What information was available to ATC
  - ATC Manaus received 3 minutes after the collision transponder signals from the Legacy
- Was ATC Manaus informed by Brasilia on status of Legacy?
  - Why has Manaus not intervened?
- Why was the Transponder inactive?
- Why have neither Boeing nor Legacy seen each other?
Lessons Learned - Analysis Method

- WBA can be used for analysing incidents with
  - ongoing investigation
  - uncertain information base
  - incomplete information
- WBA can point out
  - directions for further investigation
  - problematic argumentation
  - unclear information
- Assumptions have to be questioned and removed when enough detailed information is available
Lessons Learned - Ongoing Investigations

- Audit trail for changes in factors could support analysis report
- Possibility to connect investigation directions to analysis could be helpful
- Substitution of factor type „assumption“ with more detailed classification, e.g.
  - assumed event,
  - assumed un-event, or
  - assumed state
Lessons Learned - Information Sources

• Higher level of detail by use of specialised newspapers (at least in this case)

• Newspapers tend to contradict with each other
  • target audience is different
  • quoted sources present different view on incident
The End

Thanks for listening!