Human factors examples

Outline

- DC-10
- Design problem vs. human error?
- New view vs. old view
- NWA188
- Summary

DC-10 Cargo Door

- Incident in 1972
  - AA Flight 96
  - Cargo door blew out during flight
  - Part of the floor collapsed
  - Severed all control cables and hydraulics (which ran along the floor)
  - Pilot Bryce McCormick had previously decided to train himself to fly with only the engines
  - Pilot landed successfully, nobody died
- See video
  - http://www.dailymotion.com/video/xa16vd_plane-crash-turkish-airlines-flight_shortfilms

DC-10 Cargo Door

- Various recommendations were made
  - The pilot (McCormick) recommended that every DC-10 pilot get trained to fly with engines alone
  - The NTSB recommended aircraft design changes, but could not enforce them
  - The manufacturer (McDonnell Douglas) recommended changes to baggage handler procedures
    - They were forcing the door handle closed
    - The plane was basically safe
    - Nobody had died

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DC-10: The "root" cause

- What do you think was the "root" cause?
  - One correct answer?
  - Different perspectives?
- Who should be blamed?
  - Baggage handler?
  - Pilot?
  - Technology?
  - Manufacturer?
- Suppose you blame the baggage handler
  - What changes would you make to the system?
  - What changes do you think the manufacturer made?

DC-10: Déjà vu

- Actual changes
  - Additional training for baggage handlers
  - Cargo door problems seemed to go away …

- Accident 2 years later
  - See video

  - DC-10 cargo door blew out again

  - Plane crashed

  - See video
    - http://www.dailymotion.com/video/xa16vd_plane-crash-turkish-airlines-flight_shortfilms
    - Relevant parts at 3:00–3:30 and 4:20–6:00

DC-10: The "root" cause

- What is the "root" cause? Is it the same one?

- Who do you blame this time?

 – How does this affect the corrective actions you take?

DC-10: Many causes?

- Baggage handlers believed door was closed
- No indication that door wasn't closed
- Cockpit cargo door light said it was closed
- Pilots were not aware of the risk
  - The problem was fixed 2 yrs ago, right?
- No vent to prevent floor collapse
- All hydraulic lines ran near the door, loss of control
- Pilots were not trained to use engines only
- Outward-opening cargo door

- Other causes?
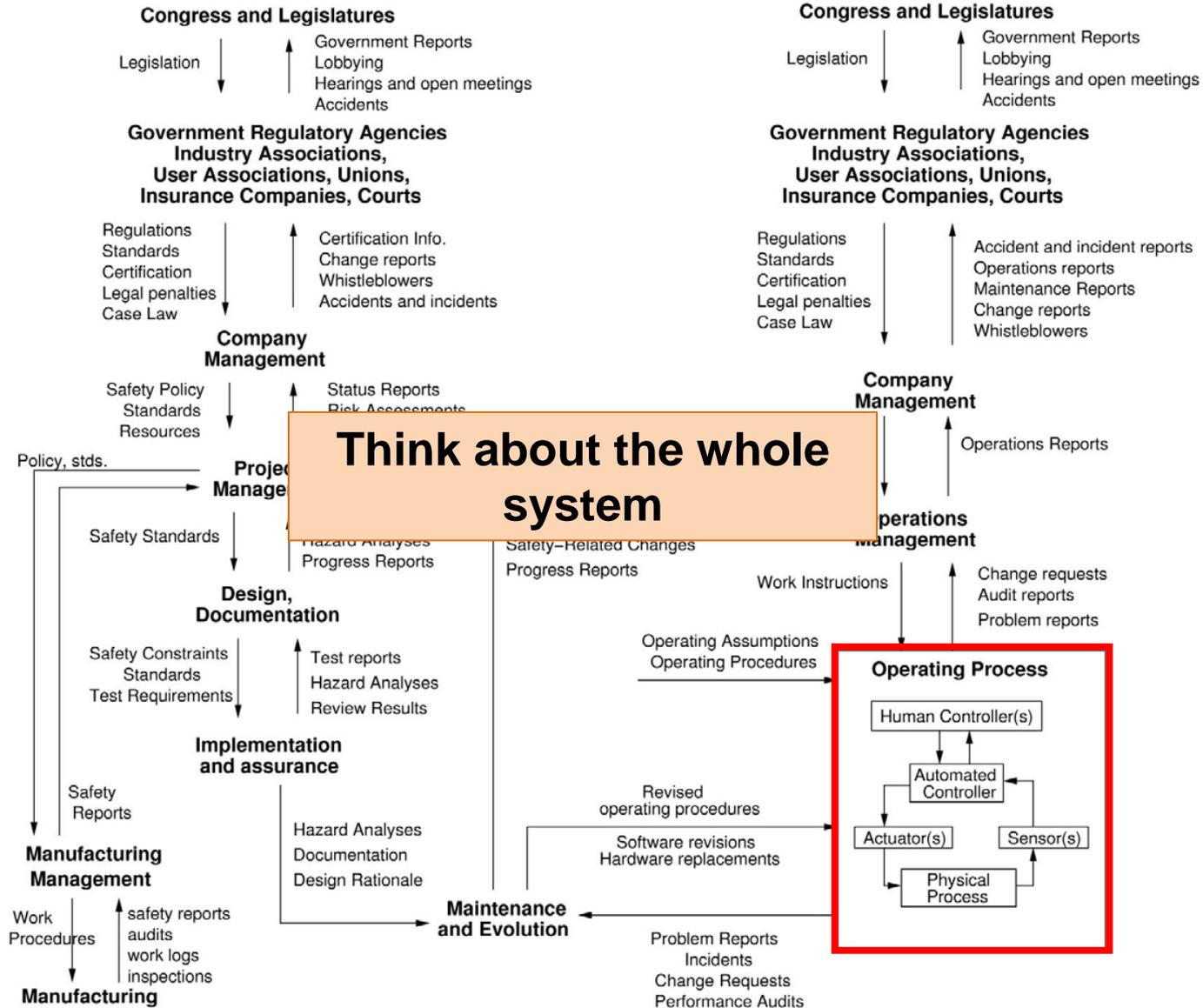
From Leveson, Nancy (2012). E*b[ ]bYYf]b[¨U¨GUZYf¨K cf`X. ¨GmghYa g¨H\]b_]b[ ¨5dd`]YX¨hc GUZYhm* MIT Press, © Massachusetts Institute of Technology. Used with permission.

DC-10: Many causes?

- Plane was much heavier than usual (financial pressures)
- Company wanted more room for cargo
- Outward-opening cargo door
- Incentive to only make cheapest changes (financial pressures)
- Design philosophy/principles
  - Single points of failure
  - Status light indicates handle position, not lock confirmation
- FAA/NTSB communication and authority structure
- FAA/McDonndell Douglas relationship
- What about the other DC-10 problems?
  - Common trend?

DC-10: Many causes?

- Is there a "root" cause?

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Norman

- "The Design of Everyday Things"
- Talks about designing things to minimize human error

- "If an error is possible, someone will make it. The designer must assume that all possible errors will occur and design so as to minimize the chance of the error in the first place, or its effects once it gets made. Errors should be easy to detect, they should have minimal consequences, and, if possible, their effects should be reversible."

Norman

- "The Design of Everyday Things"
- Talks about designing things to minimize human error

"Of course, people do make errors. Complex devices will always require some instruction, and someone using them without instruction should expect to make errors and to be confused. But designers should take special pains to make errors as cost-free as possible."

Human Error: Old View

- Human error is *cause* of incidents and accidents

- So do something about human involved (suspend, retrain, admonish)

- Or do something about humans in general
  - Marginalize them by putting in more automation
  - Rigidify their work by creating more rules and procedures

(Sidney Dekker, Jens Rasmussen, David Woods, etc.)

Human Error: New View

- Human error is a *symptom*, not a cause
- All behavior affected by context (system) in which occurs
- To do something about error, must look at system in which people work:
  - Design of equipment
  - Usefulness of procedures
  - Existence of goal conflicts and production pressures

(Sidney Dekker, Jens Rasmussen, David Woods, etc.)

Accidents revisited

- How did McDonnel Douglas view human error?

- What about your company?

Outline

- DC-10
- Design problem vs. human error?
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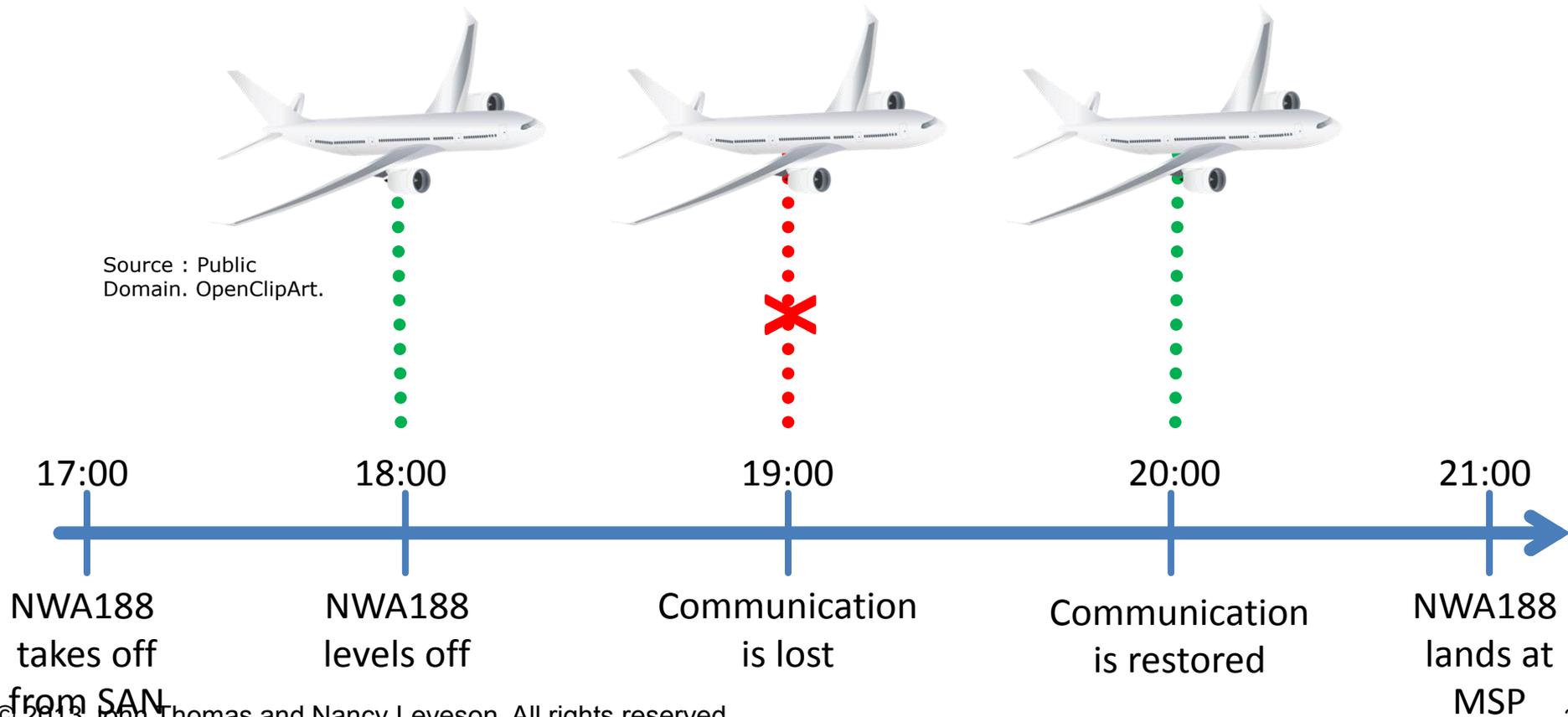- NWA188
- Summary

What has been said already?

- ## New York Times
  - "THE Northwest Airlines pilots who became so absorbed in their laptop PCs that they flew 150 miles past their destination have added to the concerns of the public"
  - "these pilots' preoccupation was so deep that situational awareness went out the window and even radio calls were tuned out."
  - "Designing an alert intrusive enough to yank crews back to reality in moments when they're not responding to conditions won't be easy and it will have to be right."

**General reaction: How could this have happened?
Pilots must have been sleeping/bored/distracted/etc.
Old view or New view?**

NWA188 Timeline

- Flight 188 from San Diego to Minneapolis
- Communication was lost for 77 of 234 minutes

Source : Public
Domain. OpenClipArt.

17:00	18:00	19:00	20:00	21:00
NWA188 takes off from SAN	NWA188 levels off	Communication is lost	Communication is restored	NWA188 lands at MSP

Actual Flight Path

Goal

- Goal is not to find someone to blame
- Goal is to understand why it made sense for the people to do what they did
- Then, as engineers, change the system to prevent future accidents

ATC sectors over-flown
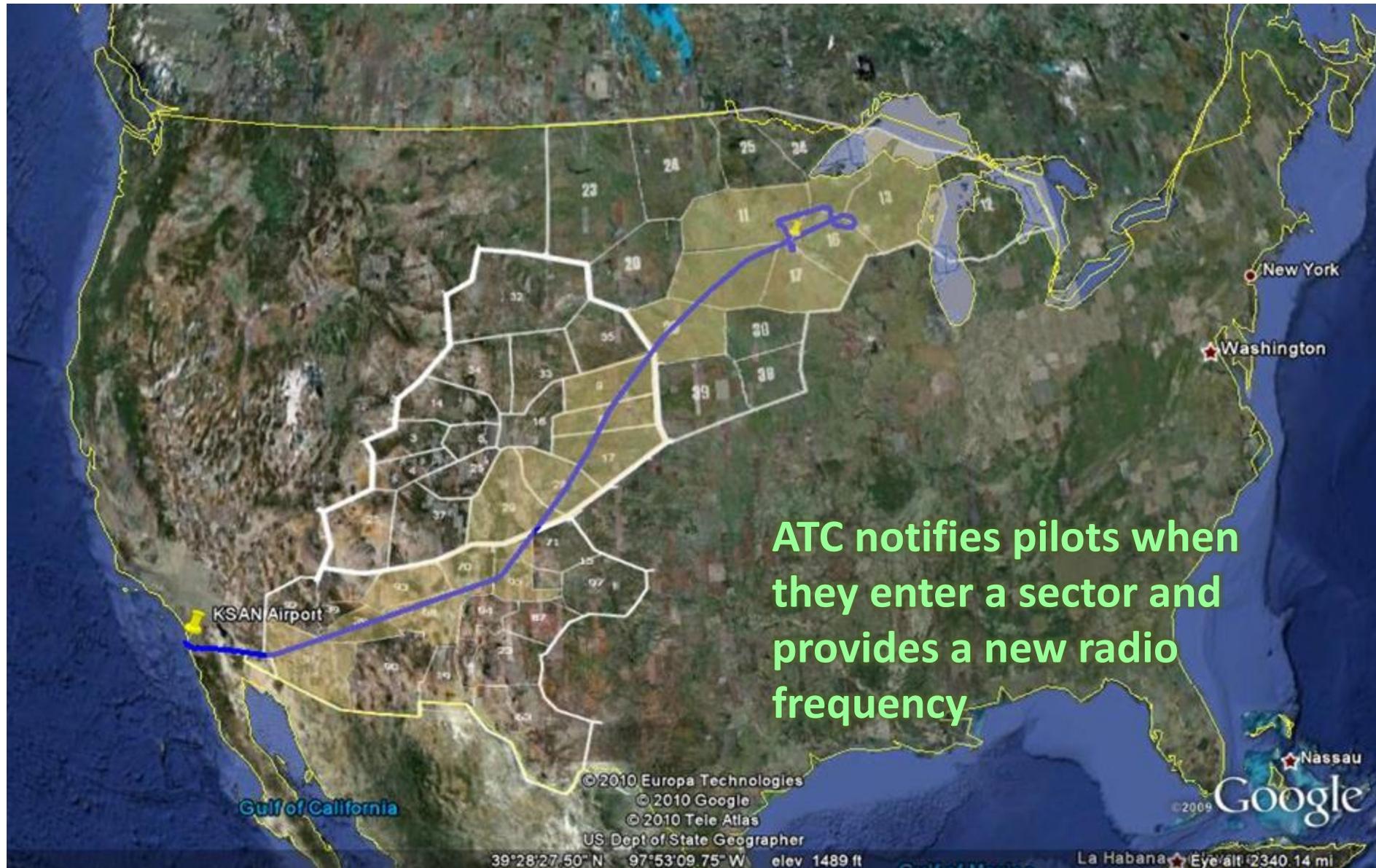
ATC notifies pilots when they enter a sector and provides a new radio frequency
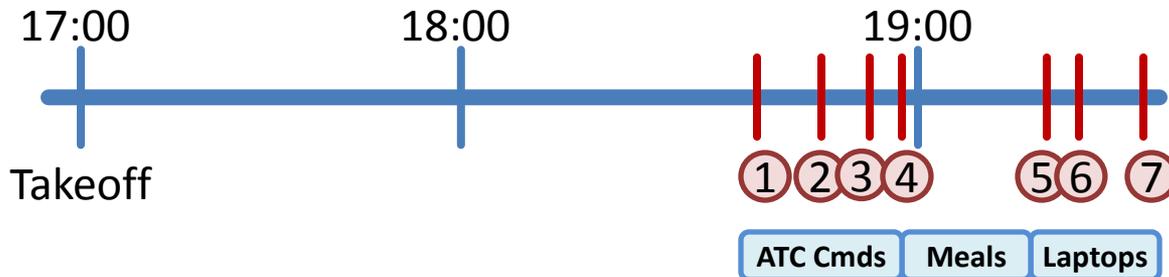
Captain's view

① **18:39** ATC asks NWA188 to switch to radio frequency 135.4, copilot acknowledges
② **18:45** ATC asks NWA188 to switch to radio frequency 134.12, copilot acknowledges
③ **18:56** ATC asks NWA188 to switch to radio frequency 132.17, copilot acknowledges
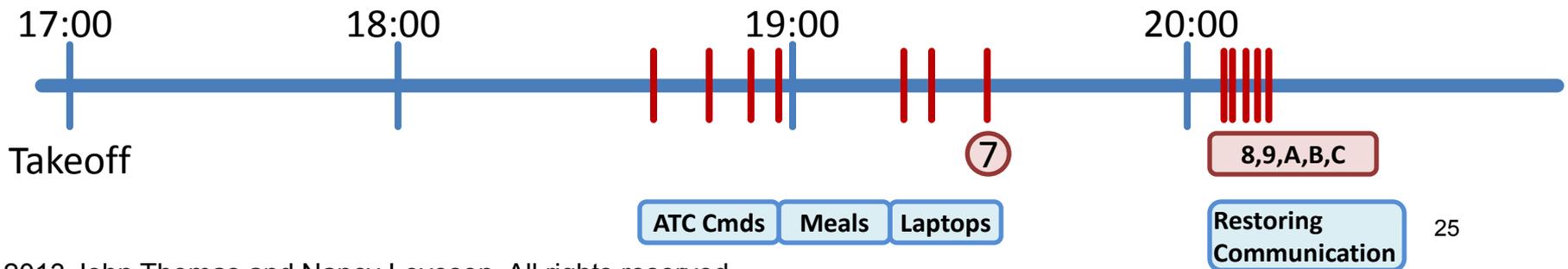④ **18:59** Flight Attendant offers meals to the pilots, and the captain takes a lavatory break

⑤ **19:20** Captain asks F/O about company schedules, pulls out laptop
⑥ **19:25** F/O pulls out laptop to explain something, Captain puts his laptop away
⑦ **19:35** F/O finishes explaining, puts his laptop away

<u>Note</u>: The radio continues to be monitored through cockpit speakers. The Pilots hear normal ATC radio chatter, indicating they are still in contact with ATC.
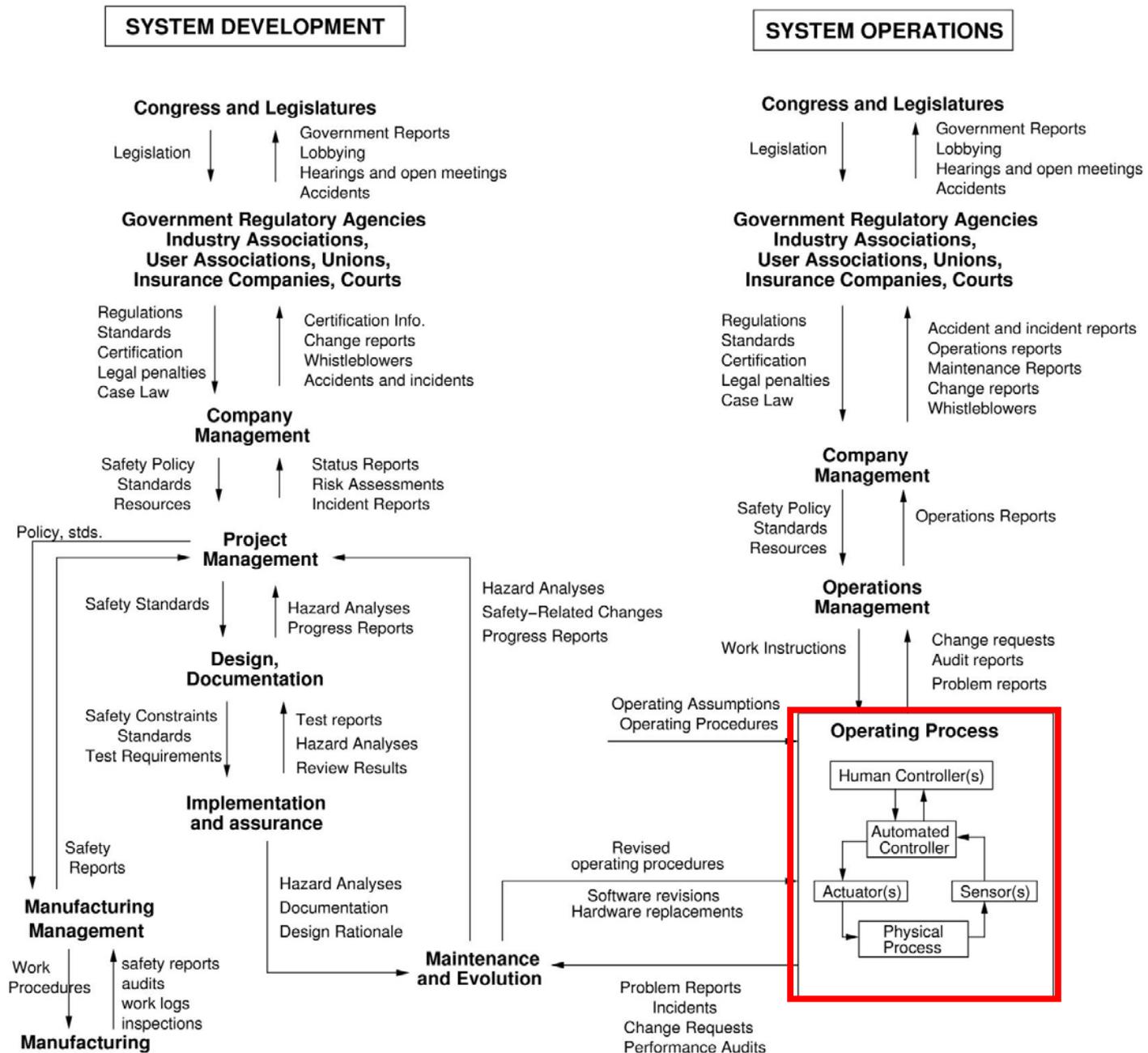
17:00   18:00   19:00

Takeoff

① ② ③ ④   ⑤ ⑥   ⑦

| ATC Cmds | Meals | Laptops |

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Captain's view

⑦ **19:35** Conversation about company schedules ends

⑧ **20:10** F/A calls the cockpit to ask about the arrival time. A pilot answers right away, says 21:00 CDT.

⑨ **20:11** Captain looks down at MCDU for flight plan info, but it's not there. Pilots cannot see lights of Minneapolis below. Captain switches the NAV mode. The MCDU now shows Deluth and Eau Claire, but MSP is missing as well as ETA information.

Ⓐ **20:11** F/O sees ACARS light, attempts to retrieve messages but inadvertently deletes them.

Ⓑ **20:12** Pilot tries to contact ATC on frequency 132.125. ATC advises they are on the wrong frequency, and to try 133.45 or 123.72.

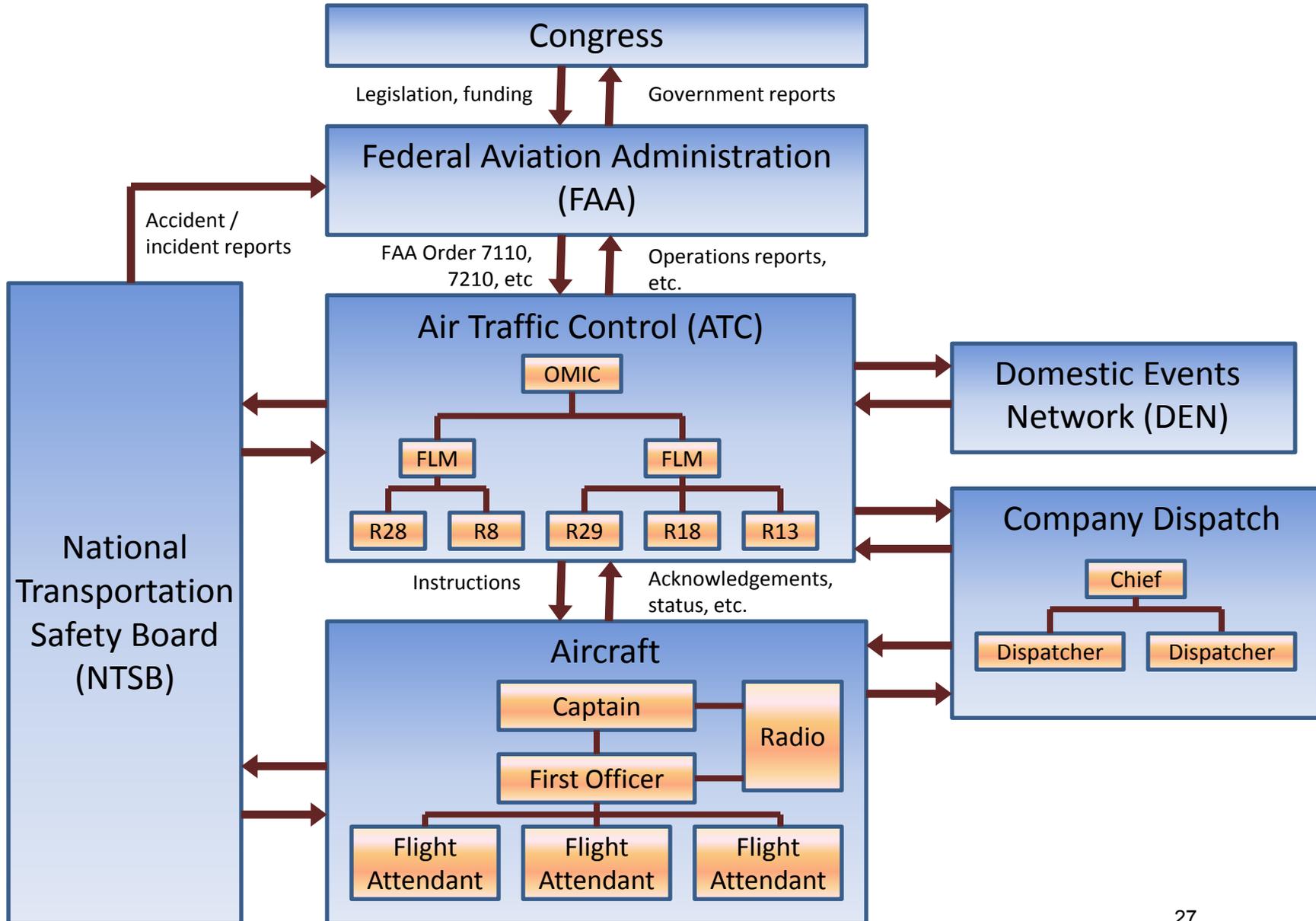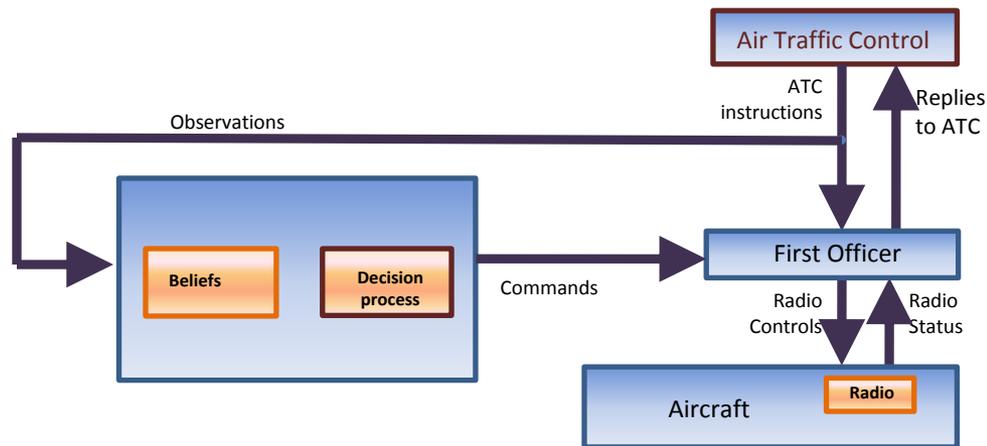Ⓒ **20:14** Pilot contacts ATC on 123.72, reports "we've overflown MSP".

17:00   18:00   19:00   20:00

Takeoff

⑦

8,9,A,B,C

ATC Cmds | Meals | Laptops

Restoring Communication

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Example Control Structure

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NW188 Operational Control Structure

Zoomed Control Structure
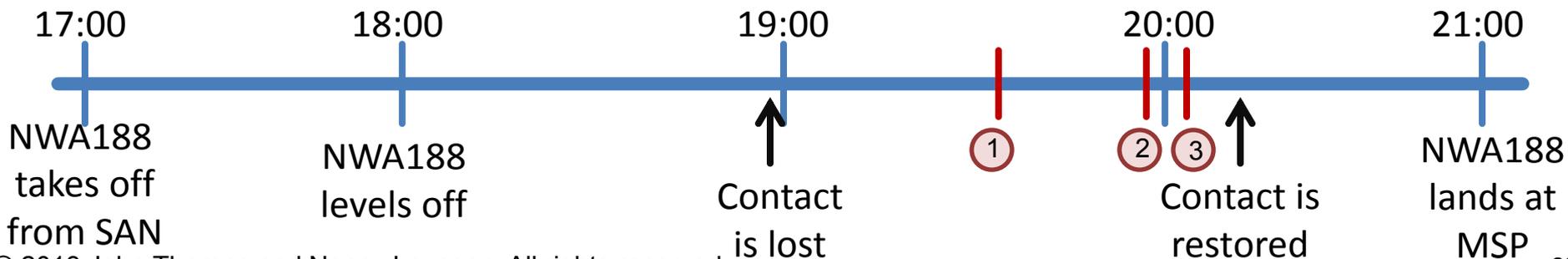

How pilots normally operate

Responsibility	Interpretation	Control Algorithm
Must detect when communication is lost	Must monitor the amount of radio chatter to make sure we are still in contact with ATC	If I cannot hear a normal amount of chatter, then I will contact ATC on the emergency frequency
	Must listen for our callsign on the emergency frequency	If I hear our callsign on the emergency frequency, I will respond

What actually happened

Observation	Beliefs	Action
Normal amount of ATC radio chatter	Still in contact with ATC	No action necessary
NWA188 callsign is not received	No emergency, still in the sector	Do not change frequencies

Indications of trouble

① At 19:32, "ACARS MSG" text appears in memo area

  – Accompanying audible chime had not been enabled by NWA

② At 19:56, the ATC broadcasted on emergency frequency 121.5

  – Another controller recalled interference on that frequency

③ At 20:01, the FMA on pilots' PFD indicates a lateral mode degradation from NAV mode to HDG mode.

  – Flight Plan page shows "PPOS" followed by a "F-PLN DISCONTINUITY"
  – Visual indication only

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17:00          18:00          19:00              20:00          21:00
  |              |              |               | || |           |
  ↑              ↑              ↑          ①    ②  ③  ↑          ↑
NWA188        NWA188         Contact               Contact is   NWA188
takes off     levels off     is lost               restored     lands at
from SAN                                                         MSP
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Pilots' view

Master warning & caution lights

Primary Flight Display

Engine/Warning Display

(ECAM messages

Primary failure

Secondary failures

Navigation Display

System/Status Display

Why doesn't this happen more often?

ATC didn't notice the lost communication either

Takeoff (SAN)

Communication restored

Destination (MSP)

Communication lost

KSAN Airport

Gulf of California

© 2010 Europa Technologies
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© 2010 Tele Atlas
US Dept of State Geographer
39°28'27.50" N   97°53'09.75" W   elev 1489 ft

New York

Nassau

La Habana   Eye alt 2340.14 mi

Google

NWA flight path image © Google maps and unknown. All rights reserved. This content is excluded
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Software issues

- Airbus offered audible chime as optional feature

- Northwest opted not to get the audible chime
  - May not have seen it as a safety feature

- ATC migration from paper flight strips to electronic
  - Marking flights

One-time event?

- NORDO's happen all the time
  - "I saw this 3 times in the last hour"
  - "Typically happens 12-15 times per shift"
- MSP visit

Norman: people blame themselves for errors

- "During my family's stay in England, we rented a house while the owners were away. One day, our landlady returned to the house to get some personal papers. She walked over to her filing cabinet and attempted to open the top drawer. It wouldn't open. She pushed it forward and backward, right and left, up and down, without success. I offered to help. I wiggled the drawer. Then I twisted the front panel, pushed down hard, and banged the front with the palm of one hand. The cabinet drawer slid open. "Oh," she said, "I'm sorry. I am so bad at mechanical things."

- "I have studied people making errors – sometimes serious ones – with mechanical devices, light switches and fuses, computer operating systems and word processors, even airplanes and nuclear power plants. Invariably people feel guilty and either try to hide the error or blame themselves for "stupidity" or "clumsiness." I often have difficulty getting permission to watch: nobody likes to be observed performing badly. I point out that the design is faulty and that others make the same errors. Still, if the task *appears* simple or trivial, then people blame themselves. It is as if they take perverse pride in thinking of themselves as … incompetent."

Cognitive Biases

- ## Fundamental attribution error
  - For outcomes involving other people, we tend to over-estimate the contribution of internal factors and underestimate external factors
  - Example:
    - A customer sees a waitress acting sloppy. The customer automatically attributes this behavior to a lack of care about her customers or a lack of intelligence.
    - The customer doesn't realize that the waitress is quite intelligent and does care; she was filling in for 2 other waitresses who didn't show up. In addition, the restaurant policy prevents her from writing anything down and she was distracted because someone just left without paying.

**We tend to automatically explain
others' behavior using internal factors**

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