System Resilience Case Studies

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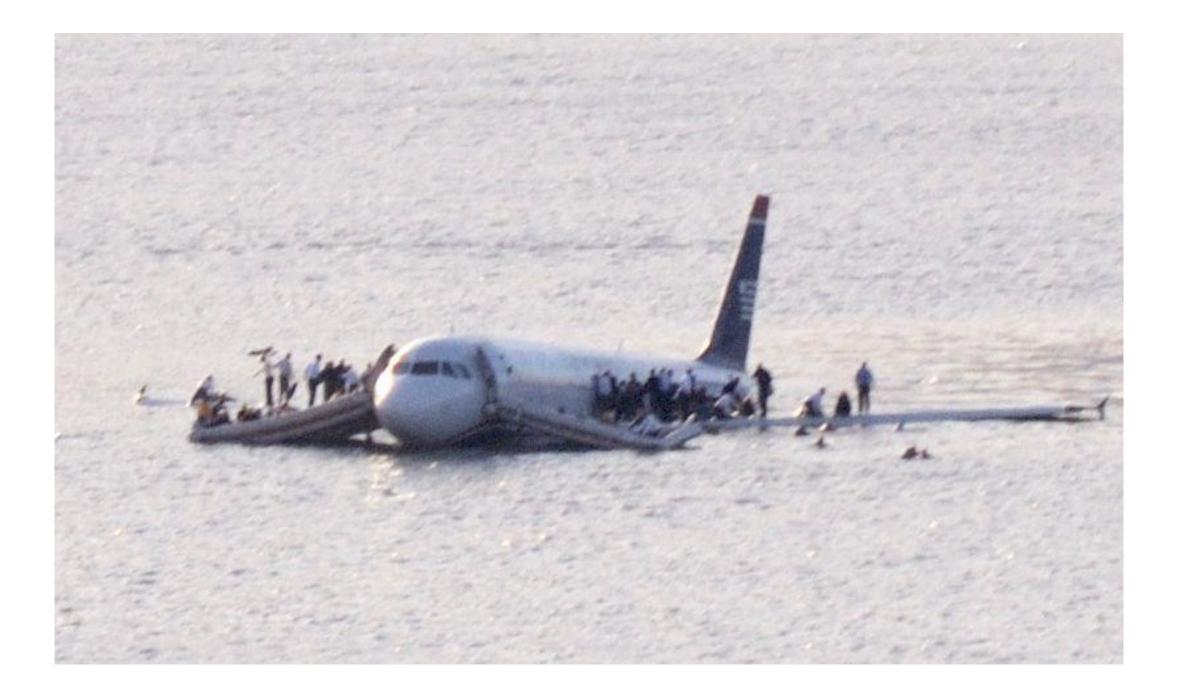jackson@burnhamsystems.net

Case Studies Overview

- Case Name
- 21 Cases (1 case per slide)
  - Only showing perhaps 5
- Technique (potential or actual)
- Situation
- What happens
- Outcome

Case 1 – New York Power Restoration (2001)

- Situation – 9/11 attacks resulted in loss of power throughout island of Manhattan

- Technique (potential or actual) – *restructuring* (actual)

- What happens – deployment of a physical [power] network, resulting in a new design for the distribution systems (i.e., on using three larger networks instead of eight smaller ones."

- Outcome – restoration of power in five hours

Case 2 – US Airways Flight 1549

- Situation – bird strike on takeoff at LaGuardia

- Technique (potential or actual) functional redundancy and human involvement (defense in depth)

- What happens – plane ditches in Hudson due to pilot control and ram air turbine (RAT)

- Outcome – All 155 occupants survive

Case 3 – Icelandic Volcano

- Situation – Volcano erupts over Iceland with ash in air

- Technique (potential or actual) – Drift correction (potential)

- What happens – AVOID device detects ash and determines damage potential (case of proactive resilience)

- Outcome – Pilot avoids damaging ash

Case 4 – Apollo 13 (1970)

- Situation – Loss of electricity in command module

- Technique (potential or actual) – *restructuring* (actual)

- What happens – Crew moved from command module to lunar module then back again to command module

- Outcome – No fatalities

Case 5 – Apollo 11 (1969)

- Situation – Computer overload, Astronaut takes control

- Technique (potential or actual) – *human involvement*

- What happens – Astronaut lands on moon

- Outcome – Successful mission

Case 6 – San Francisco (1906) water supply

- Situation – 1906 earthquake

- Technique (potential or actual) physical redundancy

- What happens – triple redundancy (high pressure, low pressure, cisterns)

- Outcome – water supply survives

Case 7 – New Zealand Earthquake

- Situation – Train derailed

- Technique (potential or actual) - *absorption*

- What happens – Building designers use innovative techniques

- Outcome – Buildings survive

Case 8 – New Zealand Earthquake (bridges and railways)

- Situation – T rain derailment

- Technique (potential or actual) - *absorption*

- What happens – substantial damage to bridges and railways

- Outcome – Damage

Case 8 – *Columbia* (2003)

- Situation – Space shuttle failed due to lack of external imaging

- Technique (potential or actual) *drift correction* (proactive resilience)

- What happens – NASA unable to make corrections

- Outcome – Mission failure; CAIR condemns NASA culture

Case 10 – 9/11 Event (buildings)

- Situation – 9/11 terrorist attacks

- Technique (potential or actual) *absorption* (potential)

- What happens – buildings fail

- Outcome – approximately 3000 fatalities

Case 11 – Metrolink (LA)

- Situation – 2 trains collide near LA

- Technique (potential or actual) – drift correction (potential)

- What happens – train would be able to stop with positive train control (PTC), example of proactive resilience

- Outcome – collision could have been avoided

Case 12 – *Columbia* (2003) and Nimrod (2006)

- Situation – "latent faults)" failures that may occur at aime

- Technique (potential or actual) *independent review* (potential)

- What happens – Mission failure

- Outcome – "failure of management and leadership"

Case 13 – Sioux City DC-10 (1989)

- Situation – Uncontrolled failure in engine

- Technique (potential or actual) – *restructuring* (actual)

- What happens – propulsion control used to land aircraft

- Outcome – Most occupants survived

Case 14 – Minneapolis Bridge (2007)

- Situation – fatigued pins in bridge failed

- Technique (potential or actual) *drift correction* (potential), *independent review* (potential), *defense in depth* (potential)

- What happens – bridge fails

- Outcome – 13 fatalities

Case 15 – Katrina (2005)

- Situation – Hurricane strikes New Orleans

- Technique (potential or actual) *drift correction* (potential)

- What happens – Bad weather data distribution ("obsolete software," "confusing templates," "lost radar data," and "lost communications links."

- Outcome – Severe hurricane damage

Case 16 – Hubble (1999)

- Situation – Flaw in space telescope Hubble

- Technique (potential or actual) – repairability and human involvement (defense in depth)

- What happens – Telescope repaired with humab

- Outcome – Telescope repaired to full functionality

Case 17 – USS Cole (2002)

- Situation – Ship damaged by terrorist attack

- Technique (potential or actual) - repairability

- What happens – Ship repaired

- Outcome – Ship returned to full functionality

Case 18 - US Airways Flight 1549 (2010)

- Situation – Birds (geese) strike airplane, disabling engines

- Technique (potential or actual) – *Functional redundancy*

- What happens – Pilot takes control using RAT (ram air turbine)

- Outcome – All 155 occupants survive

Case 19 – New York Power Restoration

- Situation – Manhattan loses power following 9/11 attack

- Technique (potential or actual) – *Context spanning* (actual)

- What happens – Generators are deployed throughout Manhattan

- Outcome – Power restored in five hours

Case 20 – New Zealand Earthquake (1968)

- Situation – People injured

- Technique (potential or actual) – repairability (actual)

- What happens – clothing and other supplies provided to people

- Outcome – People provided with supplies

Case 21 – London Bombings (2006)

- Situation – Terrorist attack (5 bombs)

- Technique (potential or actual) – repairability (actual)

- What happens – multiple wounded people

- Outcome – treatment of the "walking wounded"