Tired of getting sick on planes?

- A group of friends has documented twenty times that they took a herbal product before taking a plane trip and then did not get sick on the plane.
- So the herbal product must work, right?

What about the ones that did get sick?

- There were two such cases.
- Of those trips when the person took the product ahead of time, there were 20 cases of not getting sick (reported on the previous slide), and just 2 cases of getting sick.
- So, if you take the product, you are ten times more likely to stay well than you are to get sick.
- That means it works, right?

### Signal Detection Problem

<table>
<thead>
<tr>
<th>Condition Present</th>
<th>Indication of Condition Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hit</td>
<td>False alarm</td>
<td>Correct rejection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Took the Product Present</th>
<th>Stayed Well Present</th>
<th>Got Sick Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hit</td>
<td>20</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Took the Product Absent</th>
<th>Stayed Well Absent</th>
<th>Got Sick Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>False alarm</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

Testimonials
**Team Work**

With a special focus on the problem of interpretation formation.

What situation is this?

<table>
<thead>
<tr>
<th>Distribution of cognitive labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Distribution of knowledge</td>
</tr>
<tr>
<td>– Specialization of knowledge.</td>
</tr>
<tr>
<td>• Coordinating the distributed parts, interactions among specialists</td>
</tr>
<tr>
<td>• Producing and reproducing expertise</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advantage of distribution: Graceful degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Redundant knowledge and skills</td>
</tr>
<tr>
<td>• Intersubjectively shared understanding of the task and filling in for other agents.</td>
</tr>
<tr>
<td>• Robust adaptation or gradual reduction in capacity rather than catastrophic failure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs of distributing cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Filtering effects (hard to diagnose causes of failures)</td>
</tr>
<tr>
<td>• The need for coordination</td>
</tr>
<tr>
<td>• Design of coordination can be difficult</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Necessary Conditions for Detecting Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access</td>
</tr>
<tr>
<td>• Knowledge or expectation</td>
</tr>
<tr>
<td>• Attention</td>
</tr>
<tr>
<td>• Perspective</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>• One must be able to sense the behavior that is in error.</td>
</tr>
<tr>
<td>• Affected by a person’s location in the system and by what information goes where, when, in what form.</td>
</tr>
<tr>
<td>– Open interactions</td>
</tr>
<tr>
<td>– Open tools</td>
</tr>
</tbody>
</table>
Knowledge

- One must have knowledge or expectation about the correct outcome. **Error detection requires a comparison between two representations of the same thing.**
  
  What is the distribution of knowledge in the system? How is that distribution produced and maintained?

Attention

- One must attend to the sensed information in terms of the knowledge or expectation.
  - This may be affected by
    - the nature of the activity
    - arousal state
    - competing cognitive tasks
  - High workload can lead to increased error production and decreased error detection

Perspective

- One’s place in the system or one’s job may make certain kinds of errors easier to detect.
- Monitoring and performing are different activities with different perspectives.

Jury Decision Making

Groups can have cognitive properties that are different from the properties of the individuals in the group

How groups differ from individuals

- Confirmation bias
- Group think
- Institutions create group-level cognitive effects
  - Legal system
  - Elections
  - Teams (surgical, process control, airline, management, software authoring, scientific research, ...)
- A fundamental cognitive tradeoff (explore/exploit in the space of interpretations).

Some factors that affect team interactions

- Communication patterns / affordances, constraints, representational formats.
- Location of information (access and shareability)
- Consequential actions
- Social status and role
- What information goes where, when, in what form?
Some Hard Lessons Learned in Commercial Aviation

Eastern Airlines, Miami, Dec. 1972
PanAm and KLM, Tenerife, Canary Islands, March 1977

Eastern Airlines

- Lockheed L1011 (new autoflight system)

Causes of Accidents

L-1011 flight deck

Three crew flight deck
Alternate nose gear check
Altitude deviation chime, but warning light is inhibited.

Accident Sequence

- Final approach to Miami International
- “Gear Down”
- No green light on nose gear
- Missed approach – climb to 2000’
- Trouble shooting away from airport
- Autopilot engaged
- Autopilot inadvertently “tripped”.
- Autopilot mode changes to CWS
- Airplane descends gradually while crew tries to get the light to come on or to verify that the gear is down.
- Airplane crashes into everglades.
- Out of 176 persons on board, 99 are killed.

Eastern Airlines Path
Eastern Airlines CVR

Error detection too late

Why?
- What information goes where when?
- Division of labor. Who is flying the airplane?
- The 4 “-ates”: aviate, navigate, operate, communicate.
- Feedback from autoflight system.
- Monitoring by controller.
- Missed opportunities to break the accident chain.

NTSB recommendations
- Therefore the Safety Board recommends that the Federal Aviation Administration:
  1. Require the installation of a switch for the L-1011 nose wheel light near the nose gear indicator optical sight.
  2. Require, near the optical sight, the installation of a placard which explains the use of the system.
  3. Require that the altitude select alert light system on the Eastern Airline configured L-1011 airplanes be modified to provide a flashing light warning to the crew whenever an airplane departs any selected altitude by +/- 250 feet, including operations below 2,500 feet.

Tenerife, Canary Islands, March 1977
- Worst aviation accident ever
- Two 747s collide on a foggy runway
- 582 fatalities
Accident sequence

- Terrorist bomb closes Las Palmas airport
- PanAm and KLM (and many other airplanes divert to Tenerife)
- Airplanes packed onto the taxiway, controllers try to clear the traffic jam
- KLM blocks PanAm and KLM wants fuel (1hr delay)
- KLM backtrack on Rwy12 for takeoff on Rwy30.
- PanAm backtrack on Rwy12 to C-3 then via taxiway to Rwy30.
- KLM attempts to takeoff while PanAm is still on runway.

Tererife Airport Diagram
Why?

- Production pressure
  - Regulatory pressure
  - Financial pressure
- Training captain mindset
- Captain/company relations
- Captain/FO relations
- Languages (Spanish, Dutch, English)
  - accepting a non-preferred clearance
- Confirmation bias

The value of CRM

United Airlines 232

Proximity of components
(United Airlines 232, July 1989)
Proximity of Components

Consequences of the disk rupture

- Number two engine fail
- No control of rudder, elevator, or ailerons

- Adjust attitude using engine thrust
  - More thrust -> nose up
  - Less thrust -> nose down
- Turn using differential thrust
  - Reduce right engine thrust -> turn right
  - Reduce left engine thrust -> turn left

United 232 Division of Labor

- First:
  - "I've got it."
- Then:
  - Captain manages all resources.
  - FO handles communication navigation
  - Dead-heading captain "flies" using thrust levers only.
  - Flt Engineer operates systems and backs up the others.

Export CRM to other Settings?

Swedish Ferry in the Finnish Archipelago

Bridge Resource Management
Surgical Teams