NTSB National Transportation Safety Board

Importance of

Feedback

to Improve

Complex Systems

Presentation to: VR-56

Safety Stand Down

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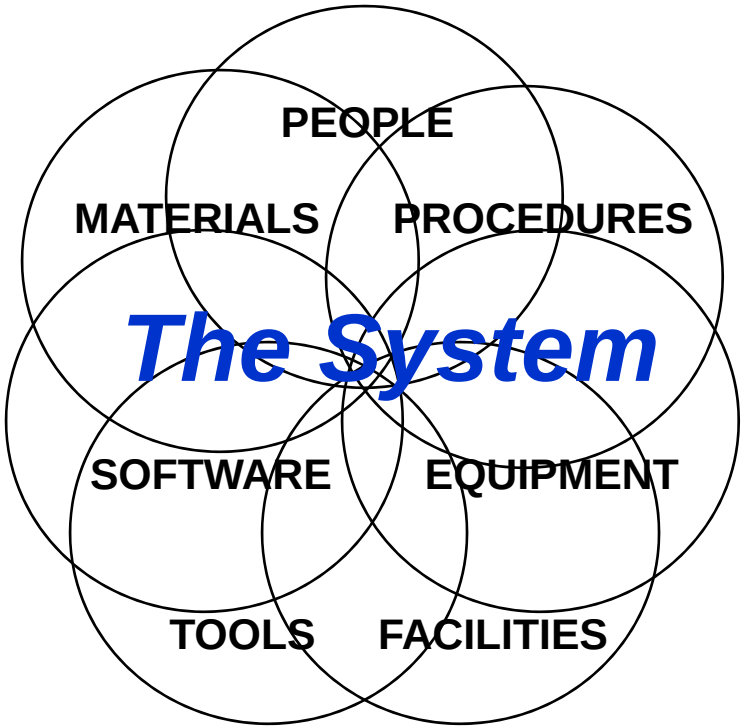
Outline

- The Context
- Two Ingredients for Improvement
  - "System Think" process
  - Feedback from front lines to fuel the process
- Commercial Aviation Successes and Failures
- The Role of Leadership

The Context: Increasing Complexity

- **More System *Interdependencies***
  - Large, complex, interactive system
  - Tightly coupled
  - Hi-tech components
  - Continuous innovation
- ***Safety Issues More Likely to Involve Interactions Between Parts of the System***



Effects of Increasing Complexity:

More "Human Error" Because

- System More Likely to be Error Prone
- Operators More Likely to Encounter Unanticipated Situations
- Operators More Likely to Encounter Situations in Which "By the Book" May Not Be Optimal ("workarounds")

The Result:

Front-Line Staff Who Are

- Highly Trained
- Competent
- Experienced,
-Trying to Do the Right Thing, and
- Proud of Doing It Well

. . . Yet They Still Commit

Inadvertent
Human Errors

When Things Go Wrong

How It Is Now . . .

You are highly trained

and

If you did as trained, you would not make mistakes

so

You weren't careful enough

so

You should be PUNISHED!

How It Should Be . . .

You are human

and

Humans make mistakes

so

Let's *also* explore why the system allowed, or failed to accommodate, your mistake

and

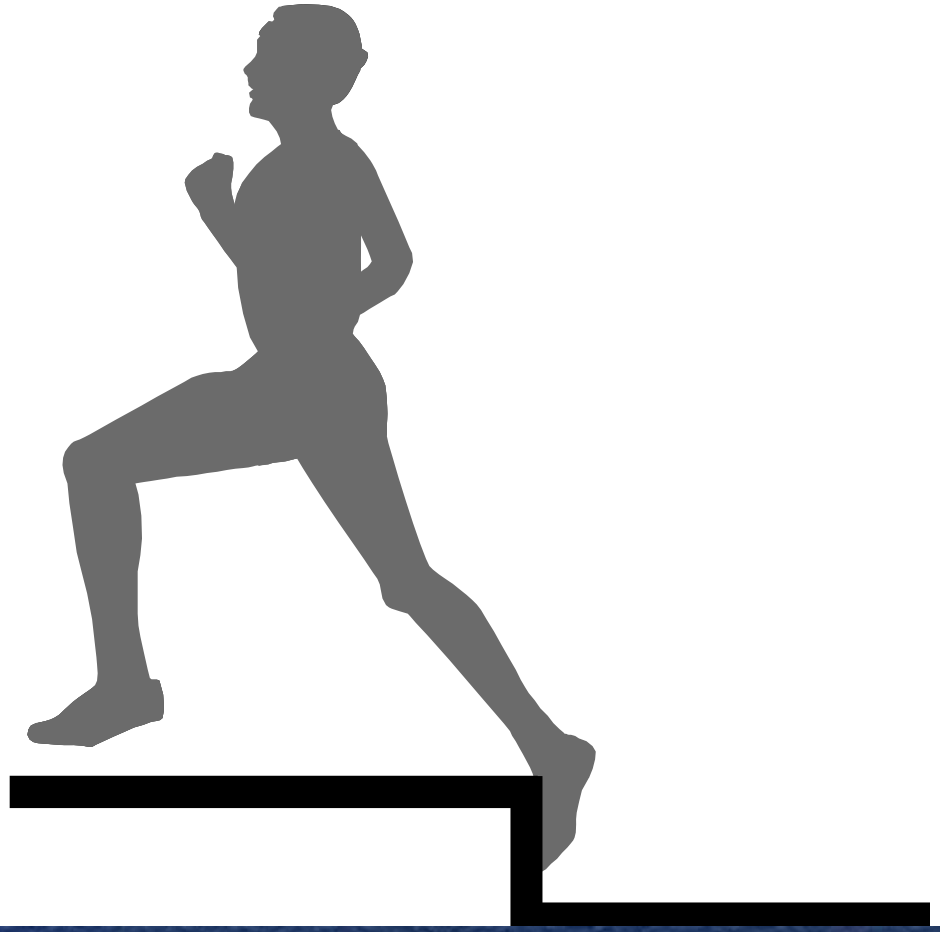
Let's IMPROVE THE SYSTEM!

Fix the Person or the System?

Is the Person *Clumsy?*

Or Is the Problem . . .

The *Step???*



Enhance Understanding of Person/System Interactions By:

- Collecting,
- Analyzing, and
- Sharing

Information

Two Objectives:

Make the System

Less
Error Prone

and

More
Error Tolerant

The Health Care Industry

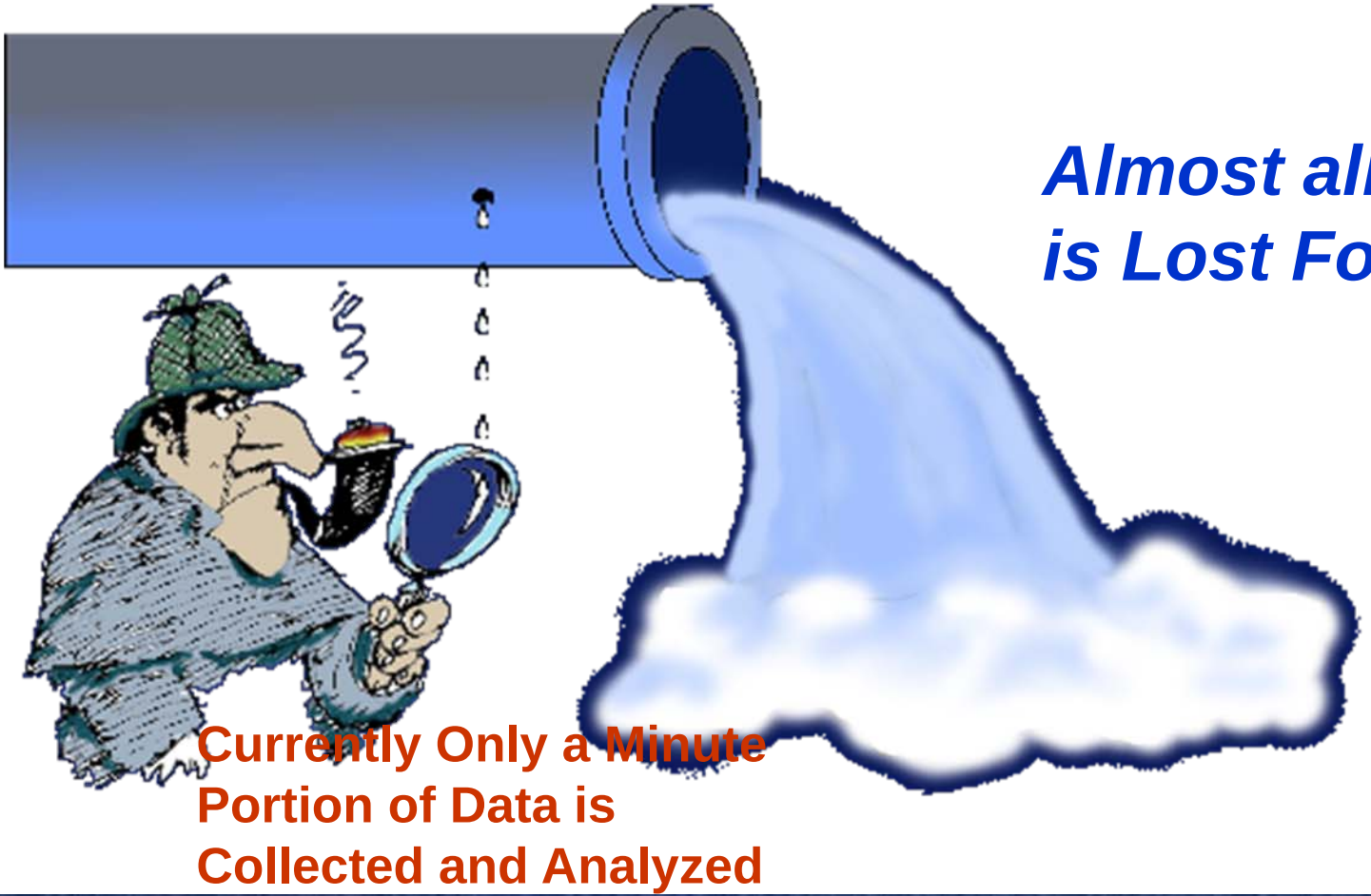
To Err Is Human:

Building a Safer Health System

"The focus must shift from blaming individuals for past errors to a focus on preventing future errors by designing safety into the system."

Institute of Medicine, Committee on Quality of Health Care in America, 1999

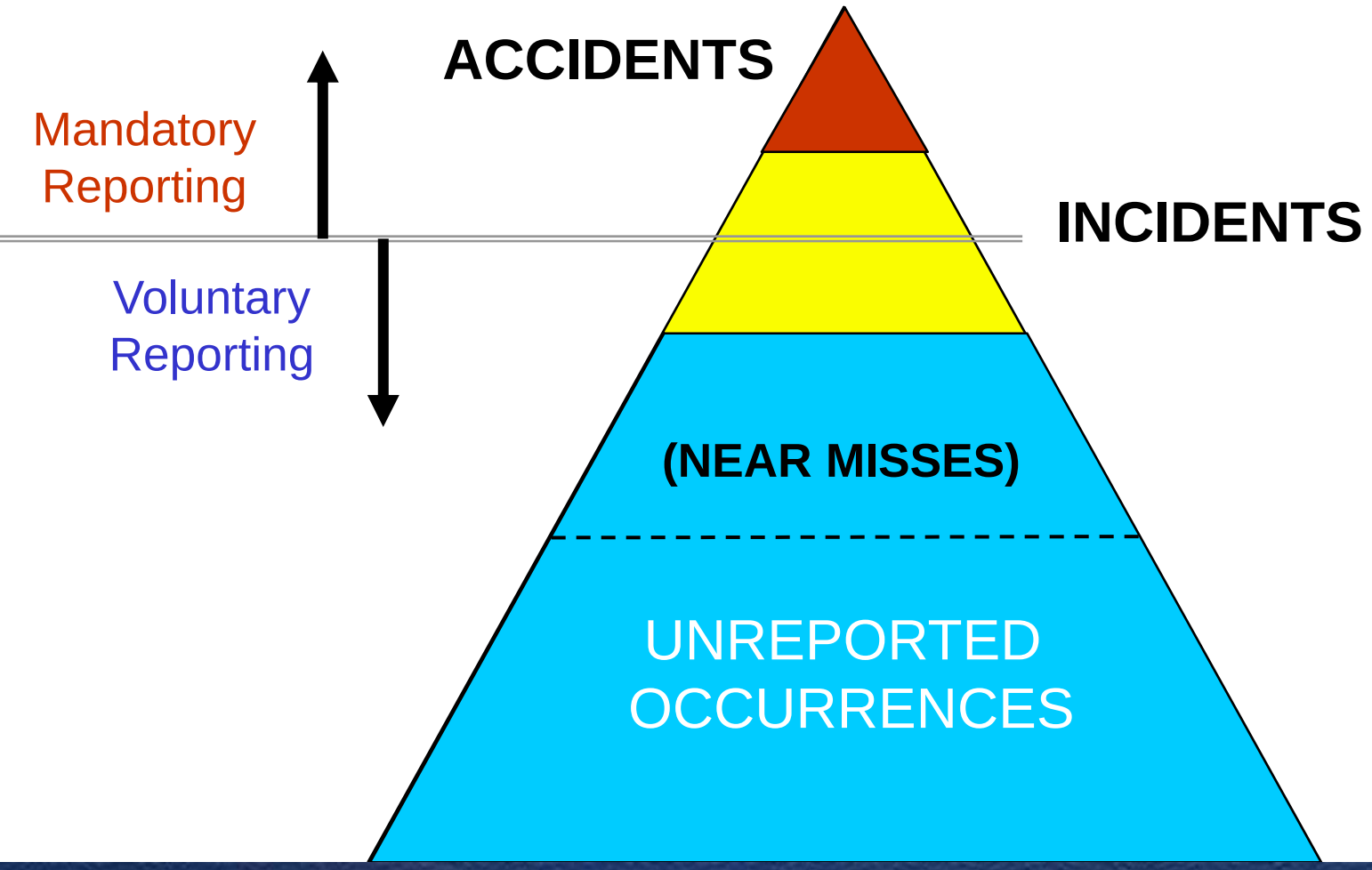
Current System Data Flow



Almost all Data is Lost Forever

Currently Only a Minute Portion of Data is Collected and Analyzed

Heinrich Pyramid



Major Source of Information: Hands-On "Front-Line" Employees

"We Knew About That Problem"

(and we knew it might hurt someone sooner or later)

Legal Concerns That Discourage Collection, Analysis, and Sharing

- **Public Disclosure**
- **Job Sanctions and/or Enforcement**
- **Criminal Sanctions**
- **Civil Litigation**

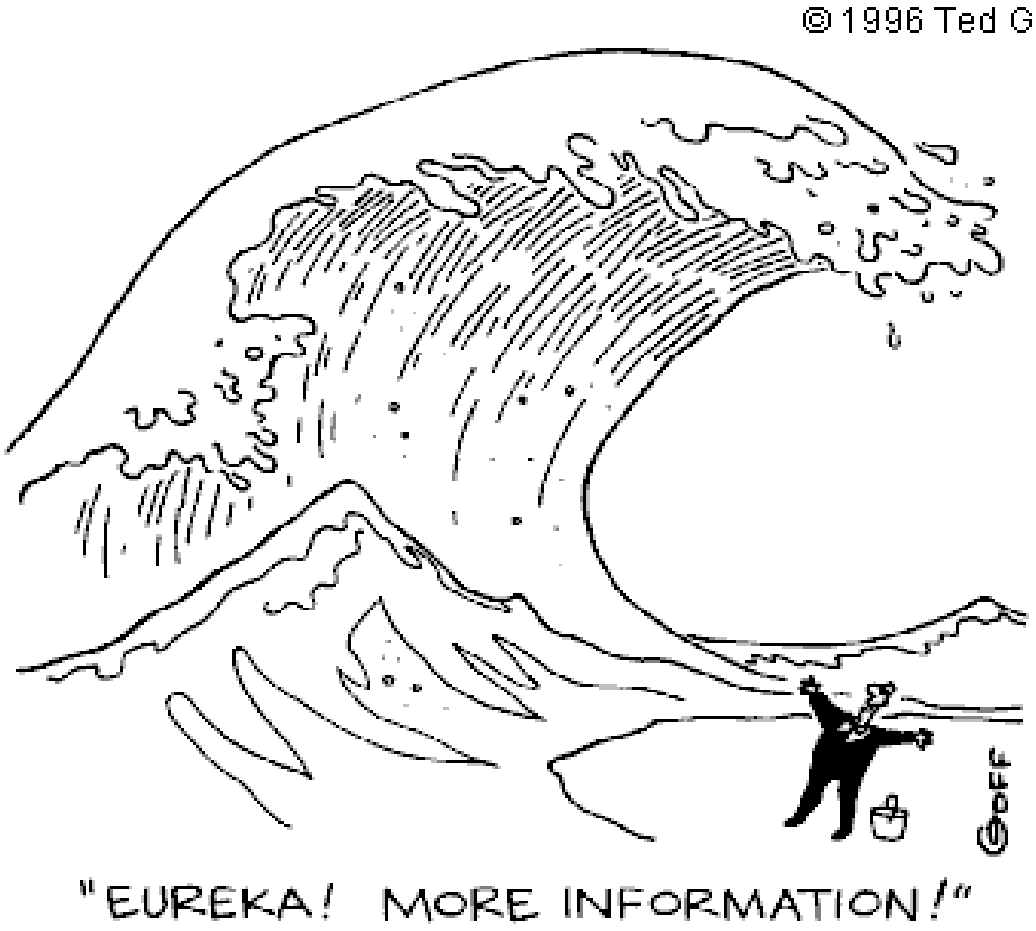
Next Challenge

Legal/Cultural Issues

Improved Analytical Tools

As we begin to get over the first hurdle, we must start working on the next one . . .

Information Overload



From Data to Information

Tools and processes to convert large quantities of data into useful information

Data Sources

Info from front line staff and other sources

DATA

Analysts

Tools

Processes

USEFUL

INFORMATION

Smart Decisions

- Identify issues
- ***PRIORITIZE!!!***
- Develop solutions
- Evaluate interventions

Aviation Success Story

65% Decrease **in Fatal Accident Rate,**

1997 - 2007

largely because of

System Think

fueled by

Proactive Safety

Information Programs

P.S. Aviation was already considered *VERY SAFE* in 1997!!

Failure: Could Better Information Have Broken the Chain?

- **Strasbourg, France, 1992**
- **Risk Factors**
  - *Night, Mountainous Terrain*
  - *No Ground Radar*
  - *No Ground-Based Glideslope Guidance*
  - *No Airborne Terrain Alerting Equipment*
- **Very Sophisticated Autopilot**
- **Autopilot Mode Ambiguity**

Autopilot Mode Ambiguity

- **"3.2" in the window, *with a decimal*, means:**
  - **Descend at a *3.2 degree angle (about 700 fpm at 140 knots)***
- **"32" in the window, *without a decimal*, means:**
  - **Descend at *3200 fpm***
- **Clue: Quick Changes in Autopilot Mode Frequently Signal a Problem**
  - ***Flight data recorder readout program could have helped safety experts uncover this problem***

Another Failure:
Inadequate “System Think”

- **1995 – Cali, Colombia**
- **Risk Factors**
  - ***Night***
  - ***Airport in Deep Valley***
  - ***No Ground Radar***
  - ***Airborne Terrain Alerting***
    Limited to “Look-Down”
  - ***Last Minute Change in Approach***
    - ***More rapid descent (throttles idle, spoilers)***
    - ***Hurried reprogramming***
- **Navigation Radio Ambiguity**
- **Spoilers Do Not Retract With Power**

Recommended Remedies Include:

- **Operational**
  - ***Caution Re Last Minute Changes to the Approach***
- **Aircraft/Avionics**
  - **Enhanced Ground Proximity Warning System**
  - **Spoilers That Retract With Max Power**
  - **Require Confirmation of Non-Obvious Changes**
  - **Unused or Passed Waypoints Remain In View**
- **Infrastructure**
  - **Three-Letter Navigational Radio Identifiers**
  - **Ground-Based Radar**
  - **Improved Reporting of, and Acting Upon, Safety Issues**

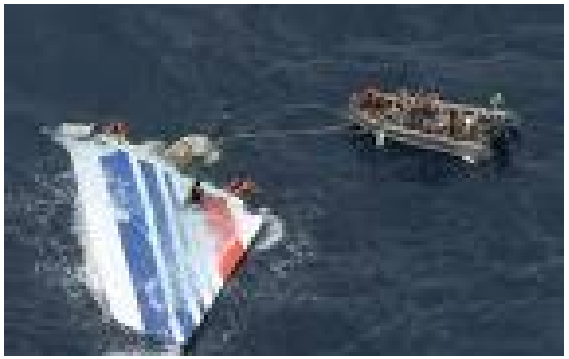
Note: All but one of these eight remedies address system issues

Automation vs. Pilots

- **2009 – Amsterdam**
  - Inoperative Left Radar Altimeter
  - Pilots Selected Right Side Autopilot
  - Aircraft Vectored Above G/S
  - Autothrust Commanded Throttles to Idle
  - Right Autopilot Using Left Radar Altimeter, Unknown to Pilots
  - Pilot Attempted Go-around, Unsuccessful

- **Queries: Why Not**
  - Design Autopilot to Use Same Side Altitude Information?
  - Let Pilots Select, or Tell Pilots Source of Information?

Air France Flight 447??



- **The Conditions**
  - Cruise, Autopilot On
  - Night, IMC, Turbulence,
    Coffin Corner
  - Pitot Tubes (3) Frozen
  - Autopilot Inoperative Without Airspeed
  - Alpha Protections Disabled
  - Pilots' Responses Inappropriate
- **Queries**
  - System Behavior Known re Loss of Airspeed Information in Cruise?
  - Pilot Training re Loss of Airspeed Information in Cruise?

Conclusions

- ***YOU*** **are one of the best sources of information about problems in the system; and**

- ***YOU*** **should take advantage of every opportunity to report those problems**

The Role of Leadership

- Demonstrate Safety Commitment . . . BUT
- Accept That Mistakes Will Happen
- Include "Us" (*e.g.*, System) Issues,
  Not Just "You" (*e.g.*, Training) Issues
- Make Safety a Middle Management Metric
- Engage Labor Early
- Include the ***System*** --
  Manufacturers, Operators, Regulator, and Others
- Encourage and Facilitate Reporting
- Provide ***Feedback***
- Provide Adequate ***Resources***
- ***Follow Through*** With Action

Thank You!!!

Questions?