



NTSB National Transportation Safety Board

What Transportation Accidents Reveal About Automation

Robert Sumwalt

April 13, 2012





Some things have changed



1981



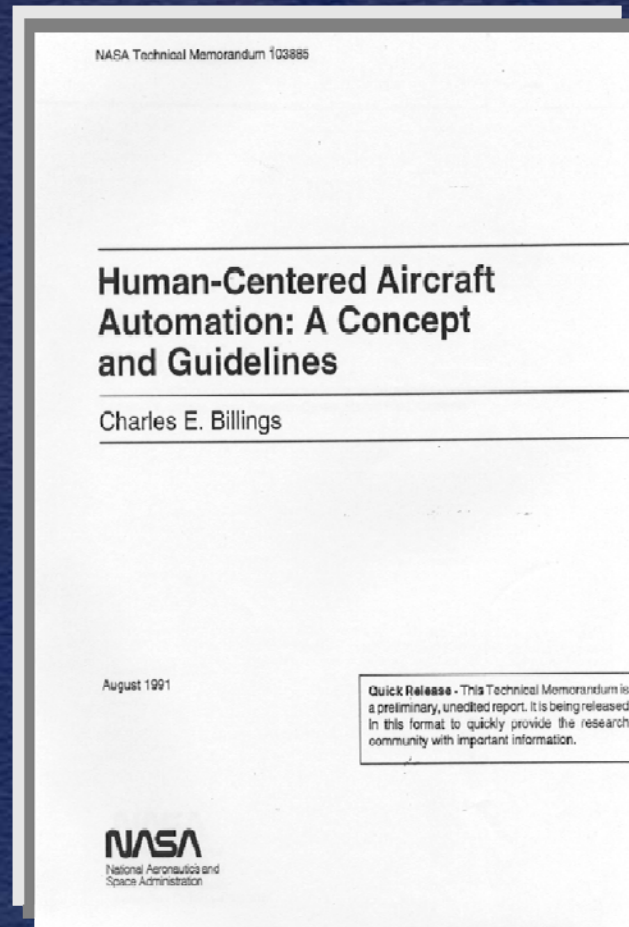
2004

But others have not ...

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Back to basics



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Principles of Human-Centered automation

- To command effectively, the human operator must be involved.
- To be involved, the human operator must be informed.
- The human operator must be able to monitor automated systems.
- Automation systems must be predictable.
- The automated system must also be able to monitor the human operator.
- Each of the elements of the system must have knowledge of the other's intent.

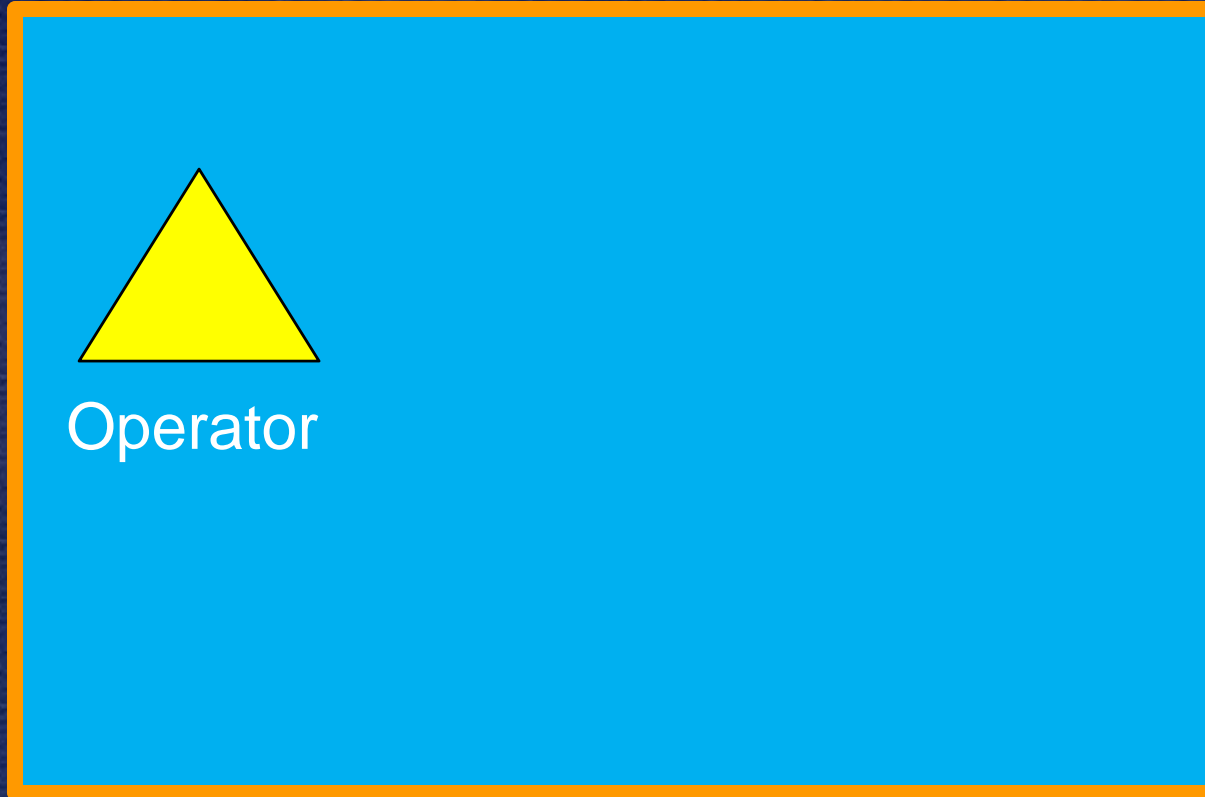
Source: Charles E. Billings

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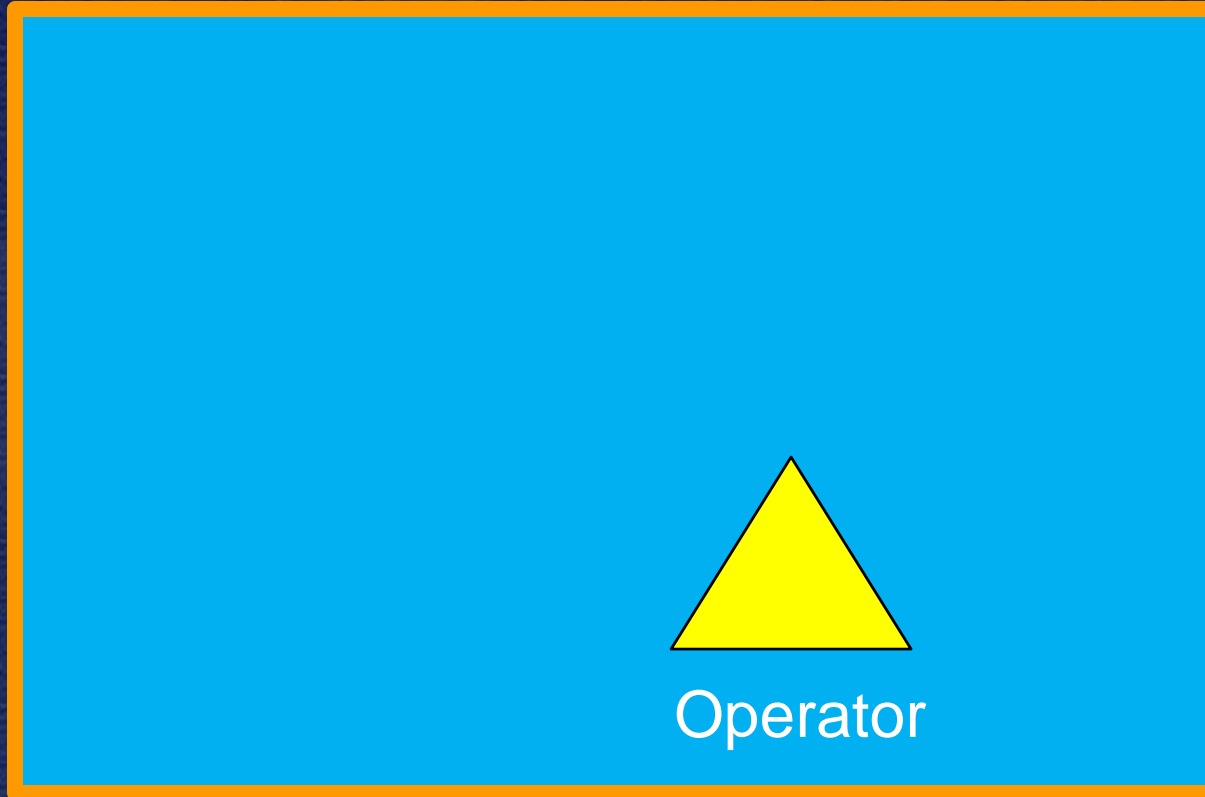
- Basically, the automation is there to support the human, and not the other way around.

Human-Centered Automation



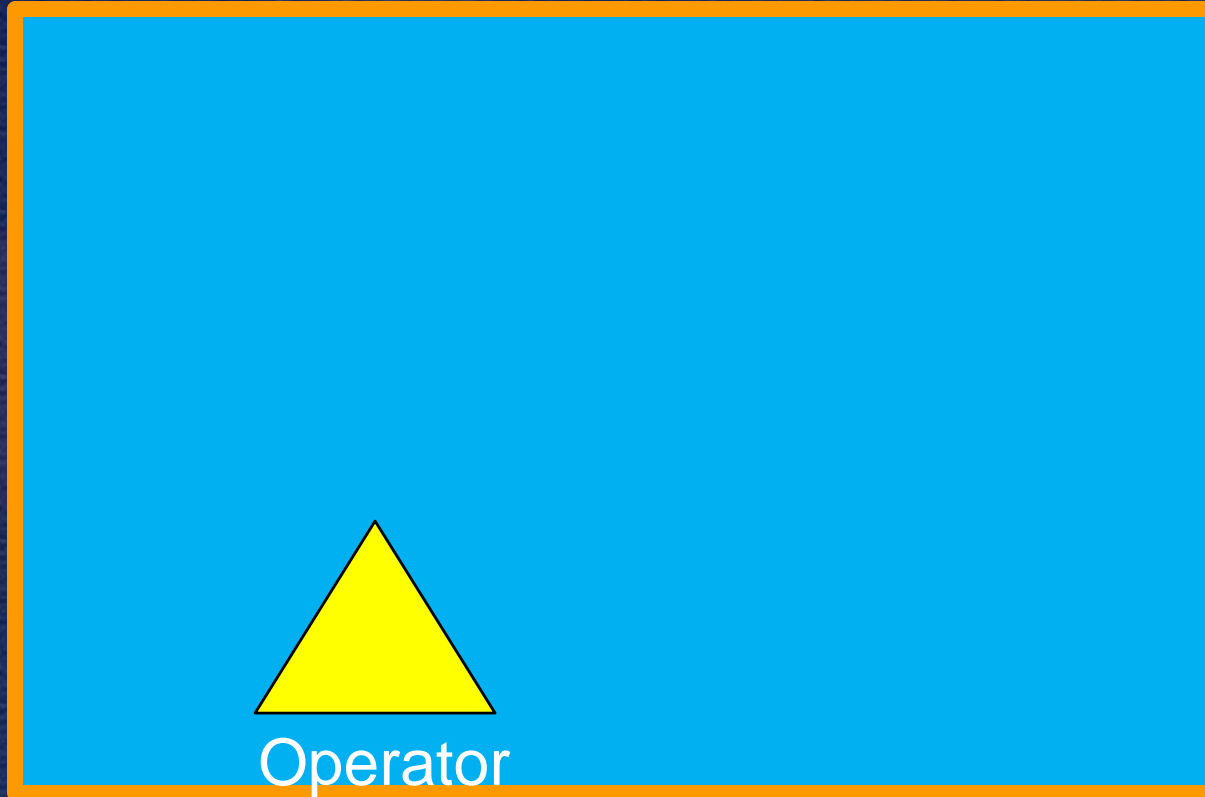
- The human operator is free to operate within the constraints of the automation.
- As long as the operator stays within “the box,” the automation is transparent to the operator.
- The operator is actively involved with controlling/monitoring the system.

Human-Centered Automation



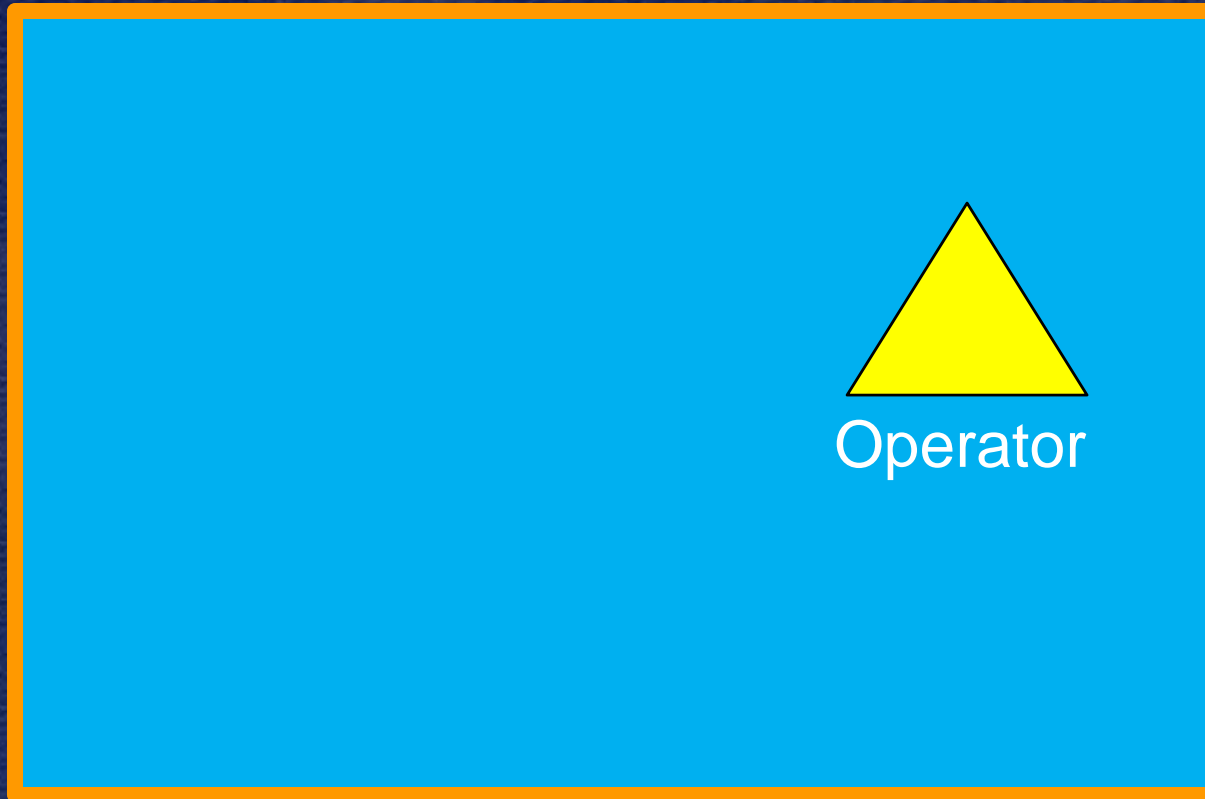
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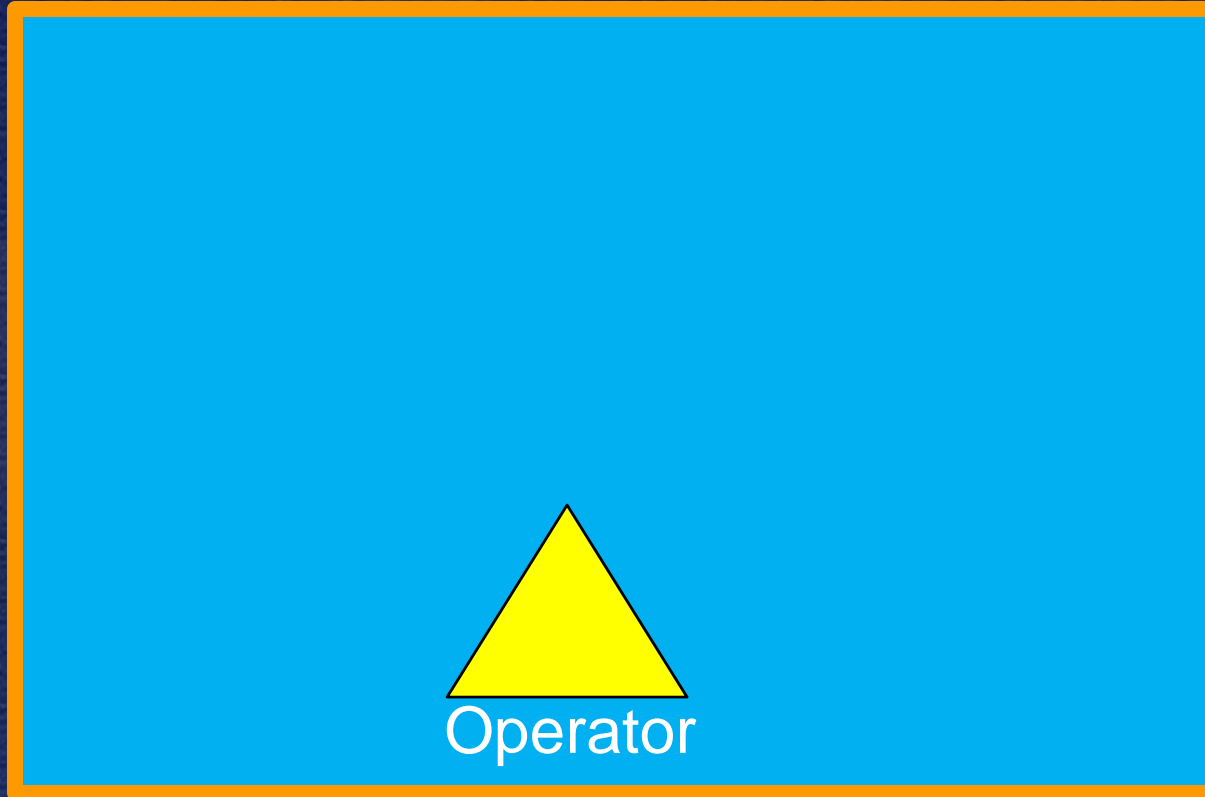
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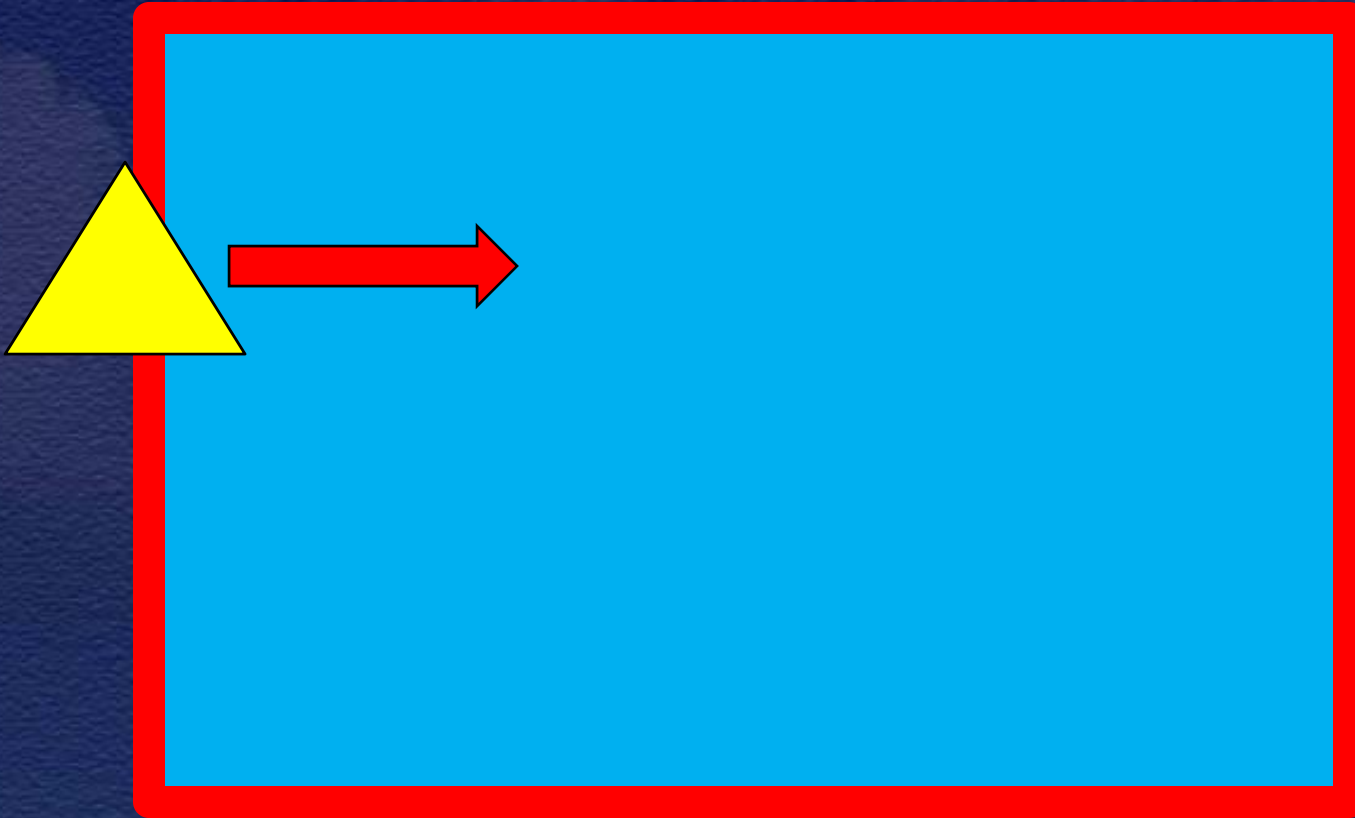
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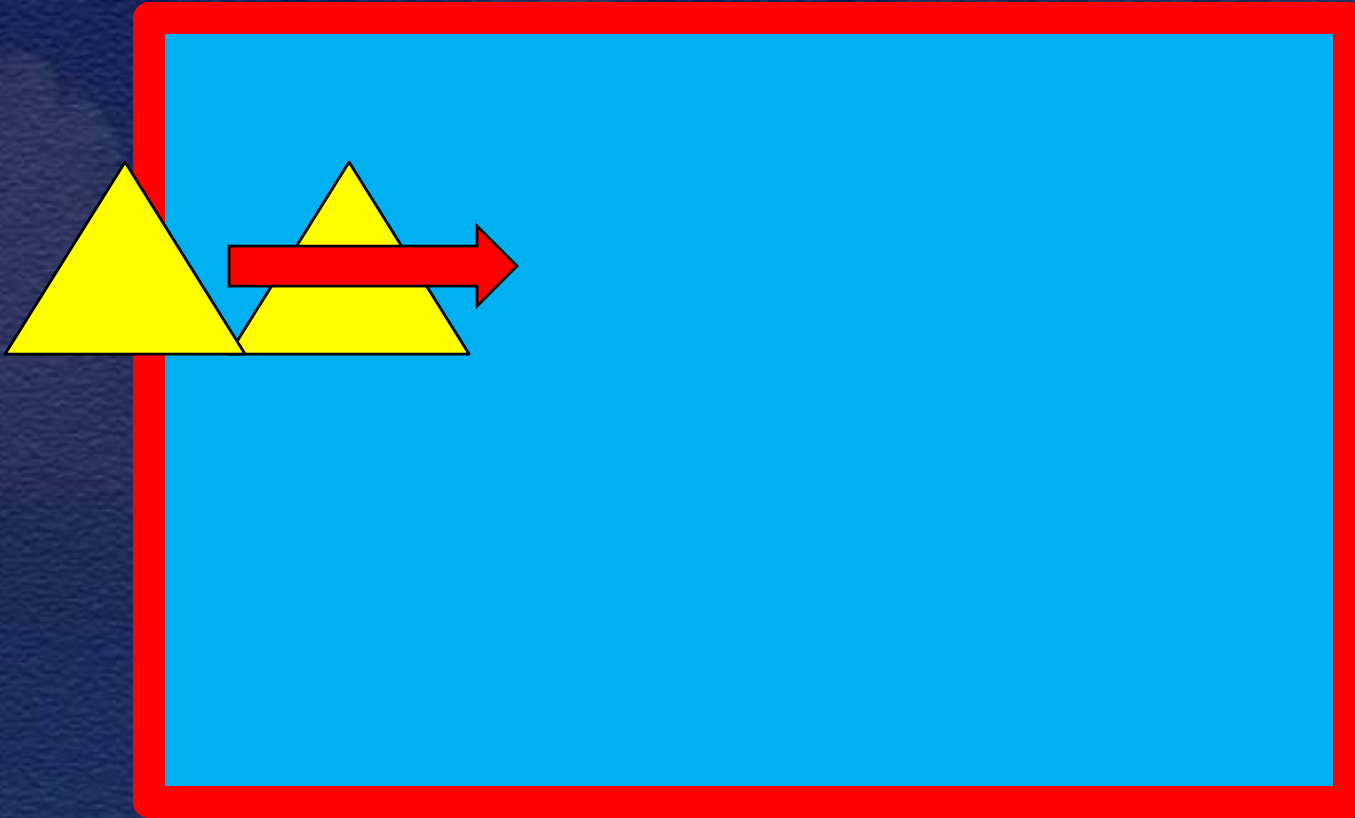
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Human-Centered Automation



If the operator attempts to operate outside of “the box,” the automation informs, cautions, or warns, the operator to return to within the box, or automatically takes over to place vehicle back within the box.

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Human-Centered Automation

Advantages

- Allows/requires operator to remain actively engaged in control loop.
- System will intervene if operator attempts to take the vehicle “outside of the box.”

Disadvantages

- ??

Non Human-Centered Automation



- The human operator is removed from the control loop.
- The operator's involvement is limited to monitoring the system.
- He/she may be passively engaged, or not engaged at all.



Washington DC Subway (WMATA)



Dr. Tom Sheraton

- “The human is seen as an essential element in the system for monitoring the automation, to act as a supervisory controller over the [automation], and to be able to step in when the automation fails.”
- “But it has become evident that the human, when put in the role of monitor, supervisor, and automation backup in the case of failure, may not perform well.”
- Reference: “Human centered automation: oxymoron or common sense?”

Colgan Air flight 3407

HOT-2: gear's down.

HOT-1: flaps fifteen before landing checklist.

HOT-2: uhhh.



National Transportation Safety Board Board Meeting

22:16:27

130 knots **2280** feet **Shaker ON** Pusher **OFF** Power Condition Flap



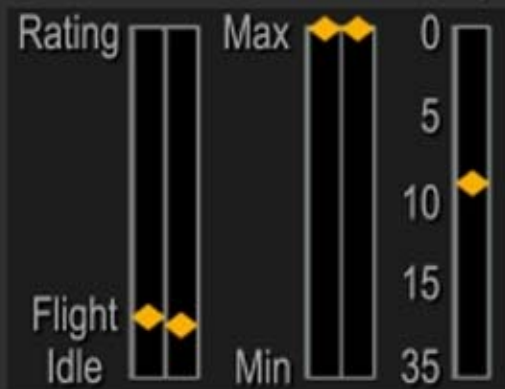
Heading **247**°



L

R

Pedal



Flight
Idle

Min

Auto Pilot **OFF** Gear **DOWN**

Colgan Air flight 3407

- February 12, 2009
- 10:17 pm Eastern Standard Time
- Colgan Air, Inc.
 - Operated as Continental Connection
- Bombardier DHC-8-400
- On approach to Buffalo, New York
- 50 fatalities
 - 2 pilots
 - 2 flight attendants
 - 45 passengers
 - 1 home resident killed

History of flight

- Approximately 3 miles from outer marker:
 - power was reduced to slow for approach
 - gear extended
 - props to max RPM
- Airspeed decreased 50 kts in 21 seconds

HOT-2: gear's down.

HOT-1: flaps fifteen before landing checklist.

HOT-2: uhhh.



National Transportation Safety Board *Board Meeting*

22:16:27

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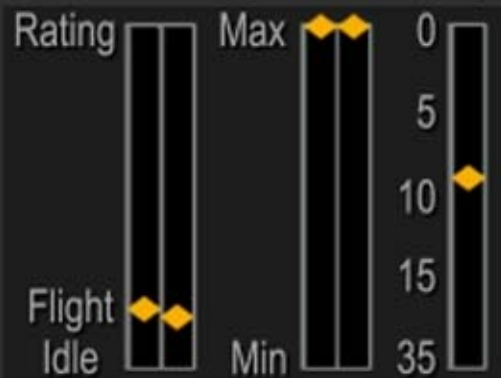
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L

R

Pedal



Auto Pilot **OFF** Gear **DOWN**



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National Transportation Safety Board

Office of Research and Engineering

Flightpath

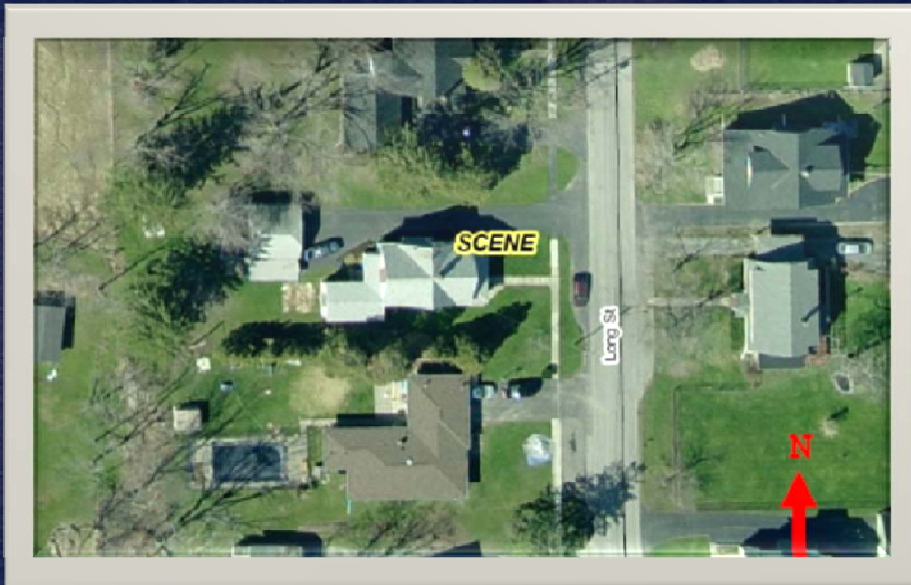
Loss of Control on Approach
Colgan Air, Inc., Operating as
Continental Connection Flight 3407
Bombardier DHC-8-400, N200WQ

Clarence Center, New York

February 12, 2009

DCA09MA027

Board Meeting





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Non Human-Centered Automation

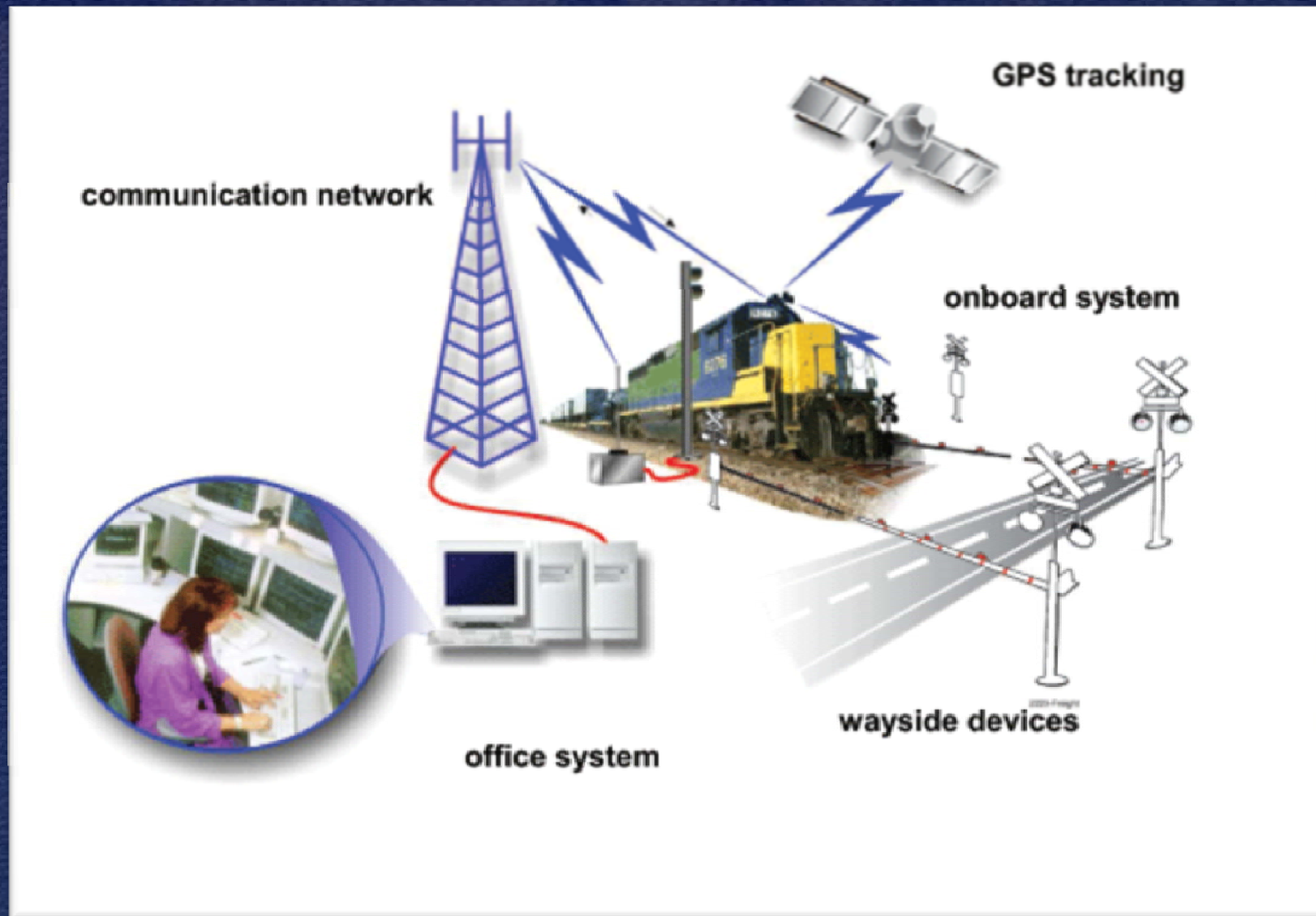
Advantages

- ??

Disadvantages

- The human operator is removed from the control loop.
- The operator's involvement is limited to monitoring the system.
 - Humans aren't good monitors
- The operator be may be passively engaged, or not engaged at all.
- The operator may rely totally on the automation not monitor/control.
 - Primary/backup inversion

Positive Train Control



System Safety Order of Precedence

1. Design for Minimum Risk (engineering solution)
 - Hazard is corrected and eliminated
2. Control/Guard Solution
 - Guards put up to decrease exposure
3. Personnel Warning System
 - Warn personnel if you can't eliminate or control the hazard
4. Develop Procedures and Training

Ref: MIL-STD-882D, "DOD Standard Practice for System Safety"

Dr. David Woods

“One of the myths about the impact of automation on human performance is as investment in automation increases, less investment is needed in human expertise.

“In fact, many sources have shown ...

“... increased automation creates new knowledge and skill requirements.”



M/V Crown Princess



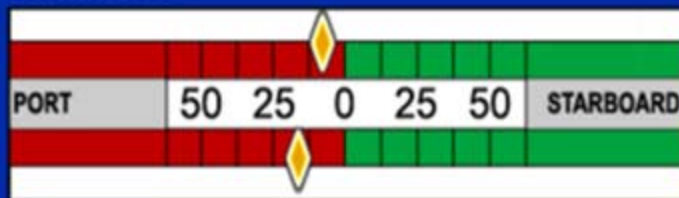
- **Length:** 947 ft
- **Breadth:** 118 ft
- **Speed:** 21.5 kt
- **Built:** Italy, 2006
- **Flag:** Bermuda
- **Propulsion:** diesel electric, twin screw
- **Tonnage:** 113,561
- **Passengers:** 3285
- **Crew:** 1260



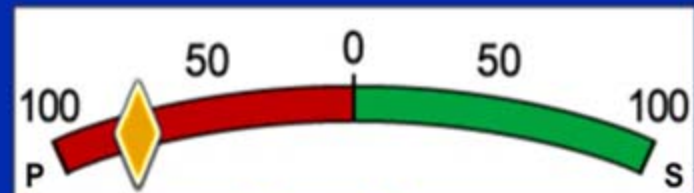
Time: **15:24:57**

Heeling: **24**

Command



Response



Crown Princess



Contributing to the cause of the accident:

- the captain's and staff captain's inappropriate inputs to the vessel's integrated navigation ...
- and the inadequate training of crewmembers in the use of integrated navigation systems.



Summary

- Automation needs to support the operator, not the other way around.
- Humans are not good monitors of highly automated, highly reliable systems.
- Human operators need to be actively engaged in the control loop.
 - No cats watching TV
- Don't forget the need for training



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