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The Paradox of Automation

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Conflicts of Interest & Disclosures

- None

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What is The Paradox Of Automation?

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Outline

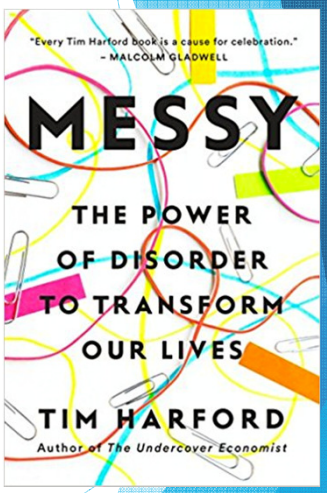
- Introduction to Paradox of Automation
  - Definition
  - Three Aspects
  - Things that May Happen
- Tragic Airline Examples
- Automation Bias
- Other Aspects
- Radiation Oncology Examples

Paradox of Automation

The more automated a system, the more important the human interaction, but the less likely that the human interaction is to be effective.

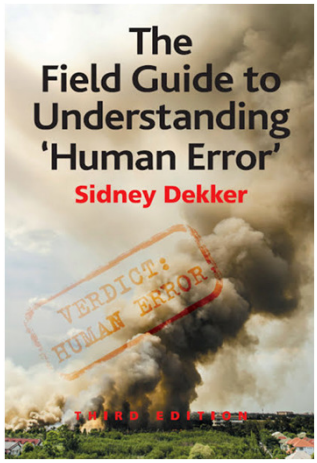
Three Aspects

- Automatic Systems accommodate incompetence
  - Easy to operate
  - Inexpert operator can function indefinitely before lack of skill apparent
- Automatic Systems erode skills of experts
  - No longer practice skills
- Automatic Systems tend to fail in unusual situations or failure results in unusual situations
  - Requires a particularly skillful response
  - See the first two aspects



Things that May Happen

- Mode Error
- Getting Lost
- Not coordinating
- Workload
- Data Overload
- Not Noticing Changes
- Not Noticing Non-Events



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Mode Error

- Also known as mode confusion
- User thinks system is in one mode
  - Behaves accordingly
  - System actually in different mode

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Getting Lost in Display Architecture

- Often one or few displays (screens, monitors, etc.)
- Typically many different pages or data sets
- May be difficult to find the correct one

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Not Coordinating Entries/ Interactions

- Multiple users should
  - Tell each other what they enter into the system
  - Check each other's work
- Pressure of circumstances or excessive repetition, this may not always happen

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Workload

- Automation designed to off-load work
- Required interaction with automated system often concentrates itself during busy times with competition for attention

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Data Overload

- Automated systems produce lots of data
- Displays can be cluttered
- Multiple visual and auditory indicators and warning can be distracting

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Not Noticing Changes

- Automated systems produce lots of data
- Sometimes a change in a parameter is not obvious to the human operator

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How to Notice Something Not Happening

- Studies on the monitoring of dynamic processes
  - Very difficult for humans to notice non-events
- Change is information
- Lack of change has had little information or adaptive value

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Tragic Airline Examples

- Air France Flight 447
- Air Asia Flight 8501

Air France Flight 447

- Takeoff from Rio de Janeiro on May 31, 2009 @ 7:29 pm
- Autopilot
  - Keeps plane on programmed route
- Fly-by-wire
  - Automated system inserted between pilot and plane's mechanics
  - Interprets pilots intentions and smoothly executes actions
  - Designed to prevent pilots from climbing too steeply
    - Prevents plane from stalling

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Air France Flight 447 – Three Pilots

- Marc Dubois
  - Seasoned veteran
  - Very little sleep the previous night
- Pierre-Cedric Bonin
  - Young and Inexperienced
- David Robert
  - Moderately Experienced
  - Recently become manager
  - Only flew part time

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Air France Flight 447

- 11:02 pm
  - Dubois left cockpit for a nap
- Plane approached thunderstorm
  - Air-speed Sensor Iced Over - Alarm Sounded
  - Auto-pilot disengaged due to air-speed sensor
    - Pilots had to take control of plane – 11:10 pm
  - Fly-by-wire system downgraded itself so pilot more in control
    - Plane started rocking side to side
      - Bonin overcorrected with sharp jerks of control stick
    - Bonin also pulled back on control stick
      - Plane started to climb steeply

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Air France Flight 447

- As the plane climbed
  - Started to lose speed and stall
  - Automated voice "STALL STALL STALL"
- Correct action to take
  - Put nose of plane down
  - Robert tried to do this
- Action taken by Bonin
  - Continued to pull back on stick
  - Negated action by Robert
- Dubois returned to cockpit
  - < 2 minutes after manual flight ensued
- Dubois determined plane stalled
- Too late to correct error
- Plane plummeted into ocean
  - 288 lives lost

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Air Asia Flight 8501

- Eerily Similar Situation to Air France Flight 447
- December 28, 2014
- Thunderstorm Caused a Distraction
- Flight Computer was turned off
  - Due to annoying warning lights from faulty wiring
  - Had been occurring for about a month
- Resulted in Autopilot Turning Off

File:AirAsia Airbus A320 - F-WWBS - MSN 5824 (10518004505).

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Air Asia Flight 8501

- Plane now flown manually
  - Inexperience pilot became disoriented
    - Plane banked left into a roll
    - Pilot pulled plane into steep climb
  - Experienced pilot had co-pilot level plane
  - Co-pilot continued to pull back on stick
  - Captain pushed stick forward to recover from stall
    - Actions negated by co-pilot
  - Plane plummeted into ocean
    - 162 lives lost

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Things that May Happen - Dekker

- Mode Error
- Not coordinating
- Workload
- Data Overload

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Automation Bias

- Following recommendations of automated system even when it contradicts training and other valid and available indicators

Royal Majesty Cruise Ship

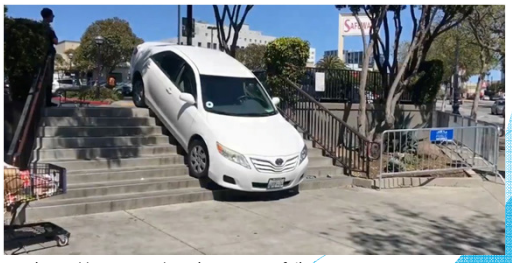
- June 10, 1995
- En route from Bermuda to Boston
- 52 minutes into voyage
  - GPS Antenna disconnected (probably kicked loose accidentally)
  - GPS receiver defaulted to dead reckoning mode
    - Used speed and course prior to disconnection to calculate current position
    - "Feeble" alarm sounded for 1 second – no one heard it
    - GPS data specified that is was in dead reckoning mode
  - Auto-pilot not programmed to recognize dead reckoning mode
    - Continued to use GPS data to steer ship for 36 hours
- Crew ignored numerous internal and external signs
- Ship grounded on shoals 16 miles off course

https://ti.arc.nasa.gov/m/profile/adegani/Grounding%20of%20the%20Royal%20Majesty.pdf

Automobile GPS Examples

https://abcnews.go.com/International/woman-drives-car-canadian-bay-gps-wrong-directions/story?id=39115061

http://nymag.com/selectall/2018/01/waze-app-directs-driver-to-drive-car-into-lake-champlain.html



https://nexter.org/google-maps-gps-fail

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Other Aspects

- Automation encourages a loss of concentration
- "Automated systems tend to lull us into passivity"

  Tim Harford, *Messy*

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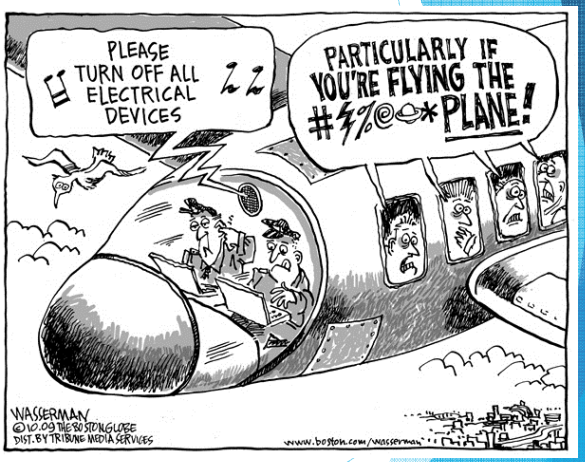
Northwest Airlines Flight 188

- San Diego to Minneapolis
- October 21, 2009
- Plane in auto-pilot
- Pilots on laptops
- Radio silence for 91 minutes
- Cruised past airport
- Contacted air traffic controllers
  - 36 minutes after scheduled to begin descent
  - 14 minutes after scheduled landing
- Both lost their licenses



http://archive.boston.com/bostonglobe/editorial_opinion/outofline/2009/10/pilots_on_laptops.html

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Radiation Oncology Examples

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Automated MV Imaging System

- Manually Start Imaging
- Automatically pulls patient information from Mosaiq
- Requires Manual Stop
- If not turned off, will take "images" of all MV fields for all patients until manually turned off
- Blank images in multiple patient's chart in Mosaiq

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Automated Plan Quality Management

- DosCheck Script in RS
- Run by CMD's for All Plans
  - Examples of Items Checked
    - Isocenter coincides with that set in CT-sim
    - High energy beam with pacemaker?
    - Same beam number used in multiple datasets?
    - Beam segment MU>5 MU and<999 MU
    - VMAT collimator angles non-zero

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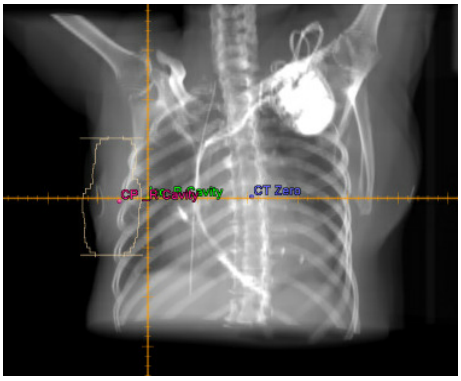
High Energy Beam for Defibrillator Patient



ROI Dose statistics [Beam Set

Name
Breast
Cavity
Clips
Cord
Cord+5mm
Defibrillator
External

Id	Check	RS Name Lengths, Pacemaker, Angles	
B9	Pacemaker	No Pacemaker ROI	✓
B10	BeamSet name length	2 R Cavity has 10 characters	i

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Well Known IMRT Error

- IMRT Highly Automated Process
- Scott Jerome Parks
  - IMRT plan modified after 4th fraction
  - Plan change was rushed
  - Physics staffing limited due to training
  - Computer crashes
    - During planning
    - During treatment
  - No pre-treatment QA completed
  - Treatment ensued with open fields
    - Failure to notice “something not happening”

SRS Example – Cone not Inserted for Tx

I - 8957 - Medical Event - [redacted] Texas

On June 6, 2012, the licensee notified the Agency that a medical event had occurred at its facility on June 5, 2012. The therapists failed to insert a conical collimator prior to a stereotactic radiosurgery (SRS) procedure which resulted in a dose being delivered to a patient that varied greater than 10% from the prescribed dose. Investigation revealed the conical collimator being used with the accelerator for the therapy did not have an interlock as required by Agency regulations. Also, the therapists failed to follow the registrant's procedures that would have verified the conical collimator necessary for the SRS was in place prior to treatment. Two violations were cited.

Should We Avoid Automation?

- Absolutely not!
- Automation has allowed us to make enormous advances in our field
- Consideration for and Awareness of Paradox
  - Using automated systems
  - Designing automated systems

Thank You!

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