

# A Clearer Vision of Risk: The New Domain of Human-Technology Interaction Failure Disasters

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**Lipscomb University**

DRJ Spring 2020 World Conference

A Clear Vision of Risk & Resiliency.

BREAKOUT TRACK 4 - SESSION 3

Tuesday, March 17, 2020

8:15 a.m. - 9:15 a.m.

Coronado Springs Resort, Walt Disney World  
Reedy Creek Improvement District, FL



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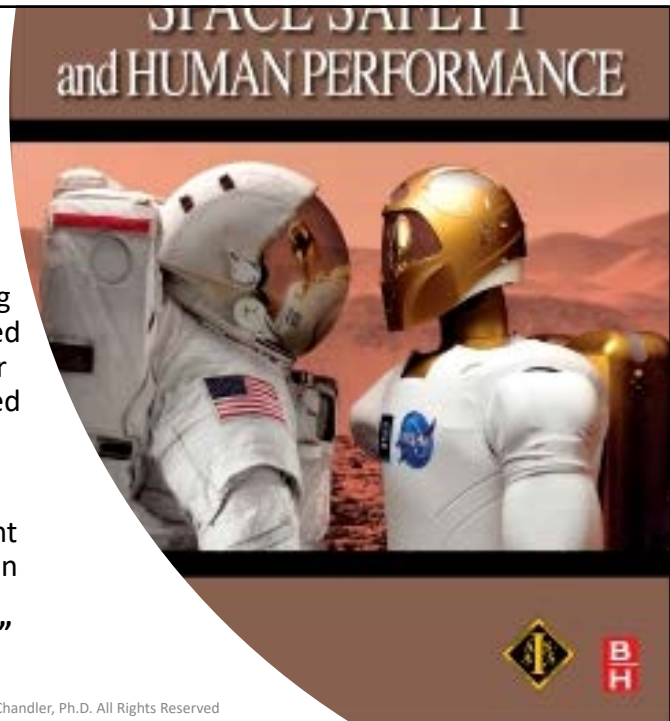
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## The Traditional Two Domain Paradigm for Performance Failures

Traditional common approaches to analyzing performance failures predictions have focused on either (a) **human performance factors** or (b) **technological failures factors** - as assumed "error mechanisms".

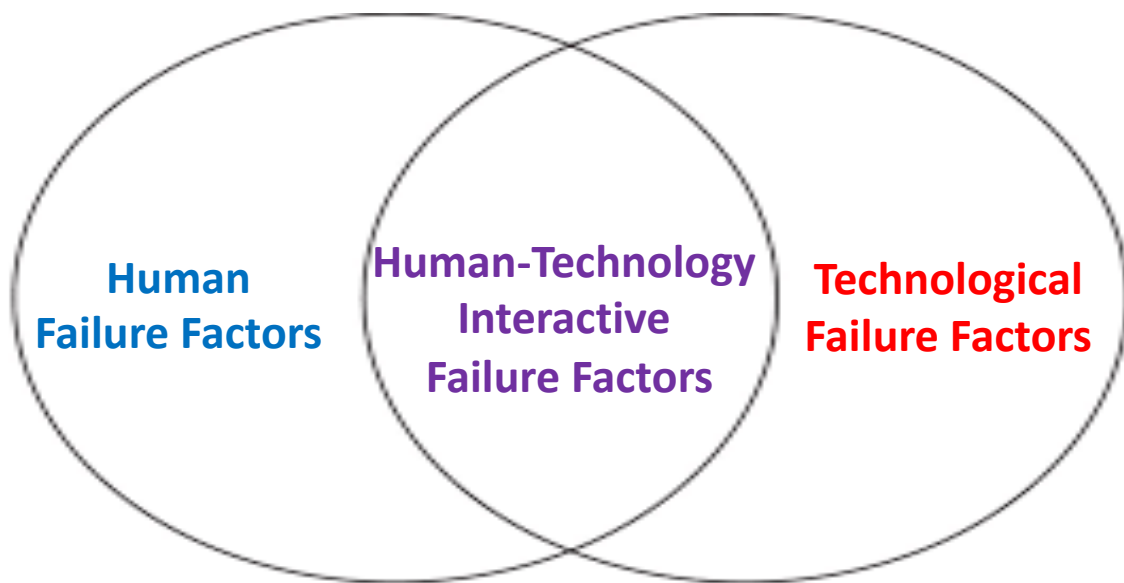
However, it is becoming increasingly apparent that the interdependent interaction of human and technological systems can combine to create disastrous failures in a "**third domain**" of factors.

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## A Third Domain of Error Mechanisms



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## A Third Domain – Human-Technology Interactive Factors Failure

Recent disasters, (ranging from such varied settings as diverse as the B737 MAX aircraft cockpit; technology assisted health care; electrical grid monitoring; and AI semi-autonomous driving assist automobiles) novel risks for human-technological interactive systemic dependency have become an important area of concern.



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## Third Domain - Human- Technology Interactive Factors Failure



Disaster accident analysis and performance prediction for interdependent human-technology systems have traditionally been pursued as two separate failure processes but we now recognize a “new domain” of failure – the human-technology interactive factor failure.

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## Third Domain - Human-Technology Interactive Factors Failure



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Anticipating failures of joint human-machine systems requires a new visionary underlying model for risk and resiliency.

This session calls our attention to this critical emerging area of disaster risk and suggests some paradigmatic shifts to better improve resiliency – and save lives.

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## Human-Technology Interactive Performance When it Works – It Can Work Well



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When technologies that are meant to support human cognitive processes and, thus, have great potential to combat the shortcomings of manual systems and improve human performance (decisions and outcomes).

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## Human-Technology Interactive Performance When it Works – It Can Work Well

This is accomplished through more precise control, speeding up response and reaction adjustments automatically, generating cues, feedback, warnings and recommendations to help the user respond appropriately, prompts that promote the correct sequence of work or ensure the collection of critical information, and alerts to make the user aware of potential errors.



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## When It Doesn't Work – It Can be Disastrous

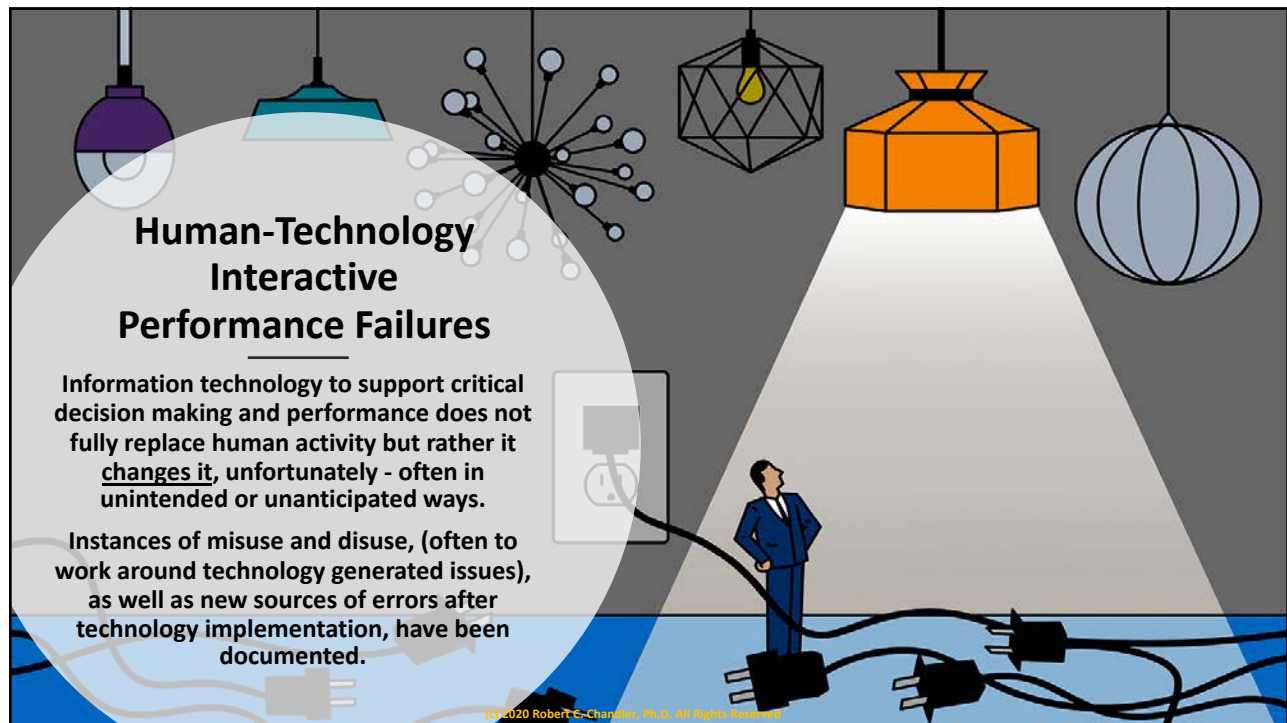
When technologies that are meant to support human cognitive processes and performance, thus, have great potential to combat the shortcomings of manual systems and improve human performance (decisions and outcomes) beyond their own capacities – but when operating in tandem with human capacity and decision limits can create a unique source of performance failure.

This occurs in human-technology interactive factor failure domain.




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## Human-Technology Interactive Performance Failures



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Errors can also be caused by over-reliance and trust in the proper function of technology. Technology can (does) occasionally malfunction, inadvertently misdirect the user, or provide incorrect information or recommendations that lead the user to change a previously correct decision or follow a pathway that leads to an error or disastrous failure.

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## “Vanderbilt UMC Nurse Indicted on *Reckless Homicide* Charge after Deadly Automated Computer Assisted Medication Dispensing Mishap”



A patient was taken to the radiology department to receive a full body scan, which involves lying inside a large tube-like machine. Because the patient was claustrophobic, a doctor prescribed a dose of Versed™ [Midazolam, marketed under the trade name Versed™, among others, is a benzodiazepine sedative medication] to help her relax.

A nurse went to fill this prescription order from one of the hospital's interactive automated computer assisted electronic prescribing cabinets, which allow staff to search for medicines by name through a choice support system to assist quality & safety control. The nurse could not find Versed™ on the list of options, so she triggered an “**override**” feature to search by drug name on a search query line (and that simultaneously unlocked access to more powerful medications subsequently available to be dispensed).

The nurse then typed the first two letters in the drug's name she was seeking—“V-E”—into the search for box and then quickly selected the first medicine suggested by the computer, and accordingly had it dispensed for the patient never realizing it was the drug **Vecuronium Bromide**, not **Versed™** which had topped the search results on the system.

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## Over-Reliance on Technological Assistance

Over-reliance on technology can result in serious consequences for patients.

Research studies have highlighted human **over-reliance on technology**.

Researchers identified two related cognitive limitations:

- (1) automation bias
- (2) automation complacency.



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## Automation Bias

The tendency to favor or give greater credence to information from technology and to ignore a manual source of information that provides contradictory information, even if it is correct, illustrates the phenomenon of automation bias.

This also leads to complacency or an erosion of manual skills to perform critical tasks in the absence of technological assistance.

## Asiana Airlines Admits Pilot Error to Blame for San Francisco Crash

Noah Rayman @noahrayman | March 31, 2014



Asiana Airlines says last year's Boeing 777 crash, which killed three and injured scores, was likely due to slow flying and failure to abort landing. A report to the National Transportation Safety Board also cites failure in speed-control features

Asiana Airlines said for the first time that pilot error was the "probable cause" of the deadly crash in San Francisco last year, according to newly released documents provided



The wrecked fuselage of Asiana Airlines flight 214 sits in a storage area at San Francisco International Airport on July 12, 2013 in San Francisco, Ca.

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## Automation Complacency

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Automation complacency is a closely linked, overlapping concept that refers to the monitoring of technology less frequently or with less vigilance because of a lower degree of suspicion of error and a stronger belief in its accuracy.

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## Automation Complacency



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End-users of a technology may tend to forget or ignore that information from the device may depend on data entered by a person or suspect data source.

In other words, processes that may appear to be *wholly automated* are often dependent upon source input at critical points and therefore require the same degree of monitoring and attention as manual processes.

These two phenomena can affect decision making in individuals as well as in teams and offset the benefits of technology.

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## Automation Complacency

These phenomena can affect decision making in individuals as well as in teams and offset the benefits of the assisting technology.

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## Automation Bias and Automation Complacency



Automation bias and complacency can lead to decisions that are not based on a thorough analysis of all available information but that are strongly biased toward the presumed accuracy of the technology.

While these effects are inconsequential if the technology is correct, errors are possible if the technology output is misleading.

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## Automation Bias and Automation Complacency



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An automation bias omission error can occur when users rely on the technology to inform them of a problem, but it does not successfully warn (e.g. excessive or overdose of warnings); thus, they fail to respond to a potentially critical situation because they were not prompted to do so.

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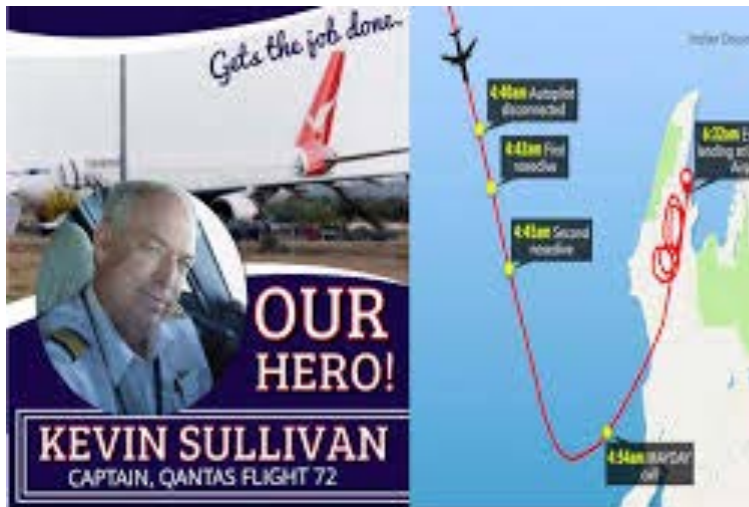


## Automation Bias and Automation Complacency

An automation bias commission error can occur when users make choices based on incorrect suggestions or information provided by technology.

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## Human-Technology Interactive Performance Failures in the Cockpit: The Case Study of Aircraft Flight Management

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## Automation Bias and Automation Complacency

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56% of pilots have fallen asleep while in charge of a plane, of the 56% who admitted sleeping, 29% report that they had woken up to find the other pilot asleep as well.

BALPA Study (2013)

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## Automation Complacency

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An Example: Both the pilot and co-pilot are believed to have nodded off as the plane flew on autopilot at 37,000ft, causing it to overshoot its destination city by 150 miles. ... Officials said controllers had tried repeatedly to make contact with the flight but could not wake up the flight crew.

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## Numerous Incidents Reported of Sleeping Crew while Flying on Auto-Pilot



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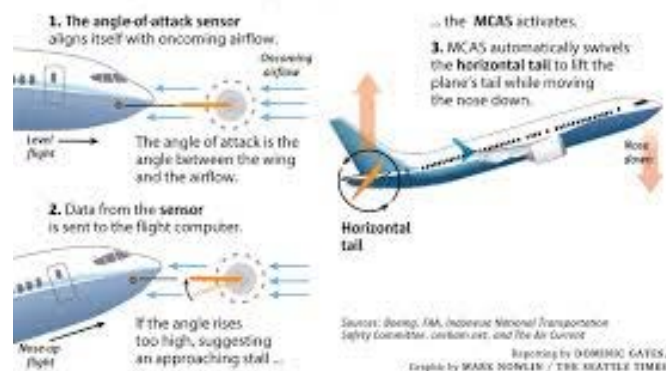
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## Boeing 737 MAX Human-Technology Interactive Factors

The issues with the B737MAX related to the interaction of the Maneuvering Characteristics Augmentation System (MCAS) automated “support” flight-control system interacted with the pilots attempting to fly the aircraft human performance.

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### How the MCAS (Maneuvering Characteristics Augmentation System) works on the 737 MAX



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## Boeing 737 MAX Human- MCAS Technology Interactive Factors

- Lion Air Flight 610
- Ethiopian Airlines Flight 302



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## Boeing 737 MAX MCAS Automated “Support” Flight-Control



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The digital displays for altitude, airspeed and other basic information displayed to the pilot and the co-pilot were dramatically different from each other **\*and\*** the cascades of warning tones and visual indicators added to the distractions for the pilot and co-pilot to maintain control of the aircraft.

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## Boeing 737 MAX MCAS Automated “Support” Flight- Control

In addition, the MCAS system “aided” the pilots by abruptly pushing **down** the nose of the aircraft while the automated computer voice simultaneously blared:

***“Don’t Sink! Don’t Sink!”***

Maneuvering Characteristics  
Augmentation System



Erroneous  
sensor  
data

Nose pushed  
down by  
MCAS

Source: Preliminary accident reports

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## Boeing 737 MAX MCAS Automated “Support” Flight-Control Assist System

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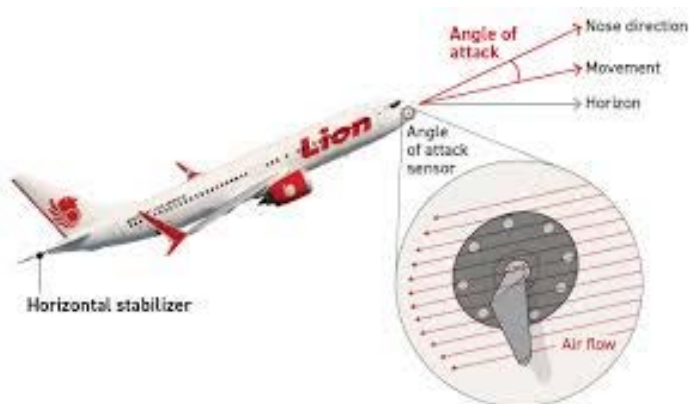
At that very same moment in the cockpit a second automated voice command warned the increasingly overwhelmed pilots that the plane was flying

***“too fast.”***

Meanwhile the automated feedback and control technology was again pushing the nose of the aircraft downward - ***further increasing*** its air speed.

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## Boeing 737 MAX Human-Technology Interactive Performance



In both of the two 737 MAX disasters, the **“left alpha vane”** data source was apparently sending erroneous input data to the MCAS program computer.

That system relied on a single input sensor for input data and this design element coupled with the aircraft manufacturer’s decision **not** to train pilots on the new system’s functioning (compared to previous aircraft’s versions) – all well as all of the psychological/audible “noise” in the cockpit created a perfect storm for the Human-Technology Interactive Performance

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***“They completely discounted the human factor component, the startle effect, the tsunami of alerts in a system that we had no knowledge of that was powerful, relentless and terrifying in the end.”***

— Dennis Tajer, the spokesman for the American Airlines pilots’ union, said of the disastrous Boeing 737 MAX Pilot- MCAS technology interaction.

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## Aeroflot Flight 1492

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An eerily similar Human-Technology Interactive Factors Failure also occurred on Aeroflot Flight 1492

While the two previous crashes involved **Boeing 737 MAX** aircraft, the latest accident involved a Russian-made **Sukhoi Superjet 100** aircraft.

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## Aeroflot Flight 1492

Like the Lion Air and Ethiopian Airlines crashes, Aeroflot Flight 1492 reported a failure of an automated system during the critical time period just following takeoff.

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# Qantas Flight 72



Following a Qantas flight in which the captain reported struggling to wrestle control of an Airbus A330 aircraft away from its automated systems – later describing the near-disaster as a ***“knife-fight with this airplane”*** – there was a debate about how much autonomy computers should have when it comes to controlling a passenger plane.

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# Qantas Flight 72



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## Qantas Flight 72

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*"The hierarchy of this particular airplane is that the computer is number one and the pilot is number two," Captain Kevin "Sully" Sullivan later told investigators.*

*"If they, for example, decide that you're over-speeding and stalling then they're going to protect you. There is no right to veto."*

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The House Committee on Transportation & Infrastructure

"A slow reaction time scenario (>10 seconds) found the failure to be catastrophic...."

Slide based on Boeing's MCAS "Coordination Sheet" June 11, 2018

COORDINATION SHEET

NO.	NAME	PHONE	EMAIL	ORGANIZATION
1	...	...	...	...
2	...	...	...	...
3	...	...	...	...
4	...	...	...	...
5	...	...	...	...
6	...	...	...	...
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... (item D) were performed. These failures were arrested by use of the ... when the pilot recognized and reacted to the runaway. Assessment ... WUTs only i.e. within the operational flight envelope, but not assessed by minimum trim dive recoveries (normal operating envelope). With pilot training to recognize the runaway and use of teamwork, the failure was found Hazardous, which is the same as the item C finding. A typical reaction time was observed to be approximately 4 seconds. A slow reaction time scenario (>10 seconds) found the failure to be catastrophic due to the inability to arrest the airplane overspeed.

## Why Do these Types of Disasters Occur?

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An increased reliance on computer automation coupled with flight crews who are not necessarily well-versed on the intricate workings of those assist systems may be creating some brand-new challenges for pilots in the **Third Domain** of causative factors.

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## Causes of Automation Bias and Complacency

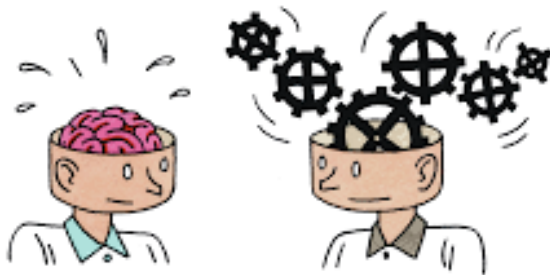


In human decision-making, people have a tendency to select the pathway requiring the least cognitive effort, which often results in letting technology dictate the path.

This aspect is likely to play a greater role as people are faced with more complex tasks, multitasking, heavier workloads, or increasing time pressures—common phenomena in our professional fields.

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## Causes of Automation Bias and Complacency

People often believe that the analytic capability of technology is superior to that of humans, which may lead to overestimating the performance of these technologies.

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## Causes of Automation Bias and Complacency

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People may reduce their effort or shed responsibility in carrying out a task when an automated system is also performing the same function.

It has been suggested that the use of technology convinces the human mind to hand over tasks and associated responsibilities to the automated system.

This mental handover can reduce the vigilance that the person would demonstrate if carrying out the particular task independently or with their sole responsibility.

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## Causes of Automation Bias and Complacency

Perceived reliability and trust in the technology. While once believed to be a general tendency to trust all technology, today, automation bias and complacency are believed to be influenced by the perceived reliability of a specific technology based on the user's prior experiences with the system.

When automation is perceived to be reliable at least 70% of the time, people are less likely to question its accuracy.

ational-Attitude Quote

**There is one potential problem with automation: that it will be accompanied by complacency and ignorance.**

—Richard de Crespigny

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# Causes of Automation Bias and Complacency

## Confidence in decisions.

As trust in technology increases automation bias and complacency, users are less likely to be biased if they are confident in their own decisions.



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## Recommendations Include:

The use of technology is considered a high-leverage strategy to optimize clinical decision making—but only if the users' trust in the technology closely matches the reliability of the technology itself.

Therefore, the following strategies to address errors related to automation bias and complacency focus on the following suggestions:



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# Recommendation

Improving the reliability of the technology itself.

In addition, users need to more accurately assess the reliability of the technology, so that appropriate monitoring and verification strategies can be employed



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# Recommendation

FMEA Form												
Name: _____			Prepared By: _____									
Insider: _____			FMEA Date (Orig.): _____				(Rev.): _____					
Failure Mode	Potential Failure Effects	Potential Causes	Current Controls	SEVERITY (1-10)	DETECTION (1-10)	RPN	Action Recommended	Resp.	Actions Taken	SEVERITY (1-10)	DETECTION (1-10)	RPN
What is the impact on the customer if this failure is not prevented or corrected?	What causes the stop, change or failure to go wrong? (How could it occur?)	What controls exist that either prevent or detect the failure?					What are the recommended actions for reducing the occurrence of the failure or improving detection?	Who is responsible for making sure the actions are completed?	What actions were completed (and when) with respect to the RPN?			
Mount	Coffee too strong or weak	Faded level marks on carafe	Visual Inspection	4	128	128	Replace old carafes	Mei	Carafe replaced 9/15	4	1	24
					0							0
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**Analyze and address vulnerabilities.**

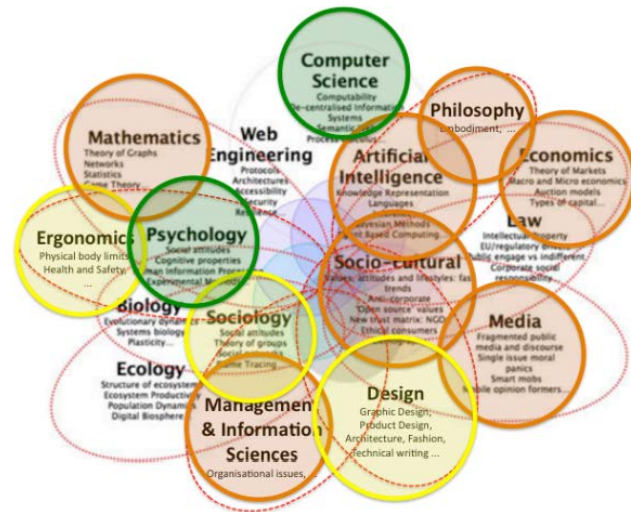
Conduct a proactive risk assessment (e.g., **Failure Mode and Effects Analysis [FMEA]**) for new technologies to identify unanticipated vulnerabilities and address them before undertaking facility-wide implementation.

Also encourage reporting of technology-associated risks, issues, and errors.

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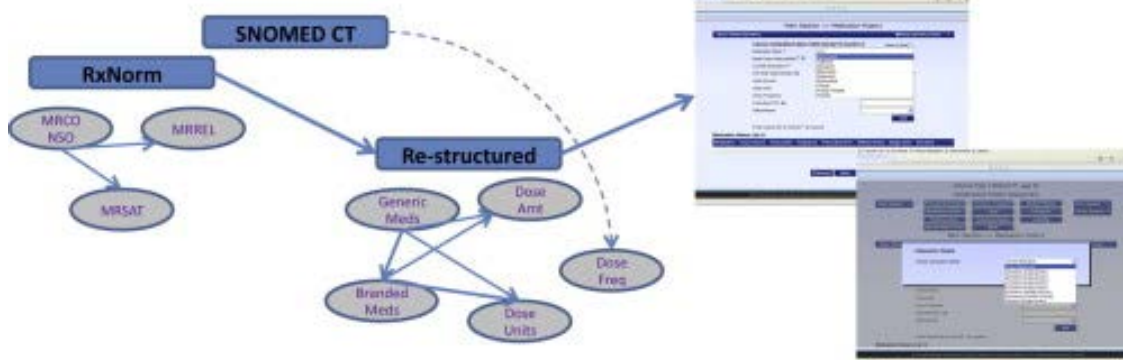
## Recommendation

Limit interactive human-computer interfaces to situations where it is appropriate.



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### Design the technology to reduce over-reliance.

## Recommendation

The design of the technology can affect the users' attention and how they regard its value and reliability. For example, the "auto-complete" function for drug names after entering the first few letters is a design strategy that has often led to selection of the first, but incorrect, choice provided by the technology.

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## Recommendation

- **Keep it Simple!**

Studies have found that providing too much information, sounds, noise, commands, feedback, instructions or on-screen details can decrease the user's attention and care, thereby increasing automation bias or overwhelm them at critical moments.

# KISS

**keep.it.simple.stupid.**

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## Recommendation

- **Provide more training.**

Include information about the limitations of such technology, as well as previously identified gaps and opportunities for error.

Allow trainees to experience automation failures during the training (e.g., technology failure to issue an important alert; discrepancies between technology entries and human input entries).



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## Recommendation

Experiencing technology failures during training can help to reduce errors due to complacency and automation bias by encouraging critical thinking when using automated systems.

Allowing trainees to experience automation failures may increase the likelihood of recognizing these failures during daily work.



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## Recommendation

### Reduce task distraction.

Although easier said than done, leaders should attempt to ensure those using technology can do so uninterrupted and are not simultaneously responsible for other tasks.

Automation assisted human performance failures are more likely to occur if the user is required to multitask or is otherwise distracted or rushed.



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## Conclusions

Technology assistance can play an important role in the design and improvement of many types of human performance systems; however, it must be viewed as supplementary to good judgement, situational awareness, critical decision making, and vigilant attentiveness.



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## Conclusions



Although its use can make many aspects of performance systems safer and more effective, professionals must continue to apply their specialized knowledge and critical thinking skills to use and monitor technology that is assisting them in order to provide optimal performance and avoid the ***Third Domain*** of performance failure.

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# Questions? Comments? Observations?

## Phrases for Asking for Giving Your Opinion



- In my opinion,...
- I feel that...
- I would say that...
- It seems to me that...
- In addition to that ...
- Furthermore ...
- First of all, I would like to say ...
- First ..., second ..., third ...
- I tell you all this because ...
- I base my argument on ...
- I'm already thinking that because ...
- You took the words right out of my mouth.
- That's very important point.
- You are right.
- I strongly agree with you.
- You're quite right.
- I am of the opinion that ...
- I'm sorry but I'm of a different opinion.
- I don't agree with you about ...
- Moreover ...
- Another example of this point is that ...



- Speaking personally...
- Sorry, I can't accept your opinion that ...
- As I see it...
- Well, if you ask me...
- I'm not sure if ...
- I'm not satisfied that ...
- I'm not convinced that...
- I doubt that ...
- In my view...
- I think that...

www.englishgrammarhere.com



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## Dr. Bob Chandler

Dr Chandler is a Tennessee based, internationally recognized, expert on topics related to critical incidents, disasters, crisis and emergencies. He is also a consultant and trainer assisting schools and school districts as well as administrators, faculty and staff with all aspects of crisis and consequence management services. He holds an academic appointment as Professor at Lipscomb University (Nashville, TN) and oversees the graduate and professional programs in communication.

Dr. Chandler is a scholar and researcher on a wide range of relevant areas, and is the author, editor or co-author of nine books and more than 175 academic and professional papers. His research and applied models have been widely adopted and he is an acclaimed speaker and featured presenter. His research into human factors and social scientific variables related to messages, comprehension, understanding, decision-making and human behavior has been applied in a wide range of practical applications and adopted as solutions for fundamental challenges in both routine and extreme contexts. He is a trainer and consultant for a wide range of crisis management focal areas. He is a highly regarded speaker and presenter at many prominent national and international conferences and events.

As a professional consultant, he has assisted with crisis management planning, mitigation, assessment, preparation and implementation for a wide range of clients including primary, secondary and higher education institutions (with specialized projects in student co-curricular, student and youth travel, and study abroad program plans; local, state and federal government agencies; regional, national and international not-for-profit organizations; as well as businesses in sectors including manufacturing, financial services, retail, health care, among others.



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