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Examining Pilot Response to Cybersecurity Events on the Flight Deck

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Cybersecurity in Aviation

- General focus of Cybersecurity: the systems
  - Hardening networks, Improving intrusion detections, Safe information sharing
- Little focus on human operator *(GAO, 2017)*

- Susceptibility to cybersecurity attacks increases in the aviation domain as technology such as electronic flight bags (EFBs) enter the flight deck *(Lundberg et al., 2014)*

GAO, Cybersecurity: Actions needed to strengthen U.S. Capabilities, GAO-17-440T (Washington, D.C., February 14, 2017)

Lundberg, D., Farinholt, B., Sullivan, E., Mast, R., Checkoway, S., Savage, S., Snoeren, A. & Levchenko, K. (2014). On the security of mobile cockpit information systems. *CCS'14*.

Goals of the Research

- Examine the human factors surrounding pilot detection of, and response to, a cybersecurity events on the flight deck
  - What factors influence detection and response?
  - Can pilots detect cybersecurity events?
  - How will they respond to a cybersecurity event?

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Methods

1. Literature Review
2. Pilot Questionnaire
   - 108 Pilots: 60 airline, 30 corporate, 18 GA
   - Majority over 2500 flight hours
   - Perceptions of, experience with, and response to cybersecurity events on the flight deck
3. Simulation Study
   - 36 Boeing 737 Pilots
   - 7 Scenarios, 1 Cybersecurity event
   - Measures
     - Pilot decision making: Behavioural Checklist
     - Pilot Perceptions and Reactions: Questionnaire/Interviews

Literature Review

350 Abstracts

45 Publications

27 Relevant Publications

3 Aviation
4 Network Security
8 Personal Computing
8 General
4 Corporate Information Security

Pilot Questionnaire

Simulation Study

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Literature Review Results: Cybersecurity Decision Process Stages

Susceptibility

An individual's perceptions/attitudes towards likelihood to experience a cybersecurity attack; trust in the systems, and subsequent behaviors to prevent attack.

Detection

Distinguishing system processes/ behaviors that are indicative of cybersecurity attack from normal activity.

Response

Response to a cybersecurity attack; how an individual decides to respond.

Literature Review Results: Influencing Factors

Stage		Susceptibility	Detection	Response
# of Supporting Studies		14	9	6
Factors Influencing Decision Process	Perceived Susceptibility	✕	✕	✕
	Perceived Safeguard Cost/Effectiveness	✕		✕
	System Trust	✕		
	System Reliability	✕		
	System Knowledge	✕	✕	
	Cybersecurity Knowledge/Experience	✕	✕	✕
	Saliency of Cybersecurity Event		✕	
	System Transparency		✕	

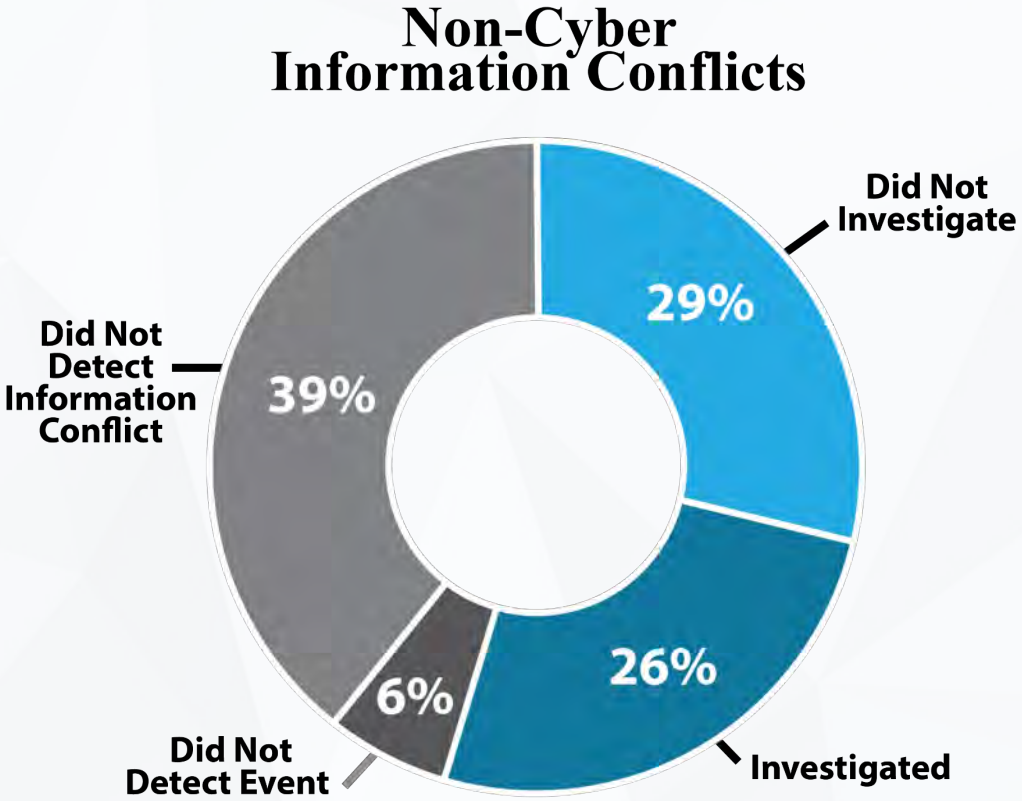
Questionnaire Results: Susceptibility to Cybersecurity Events

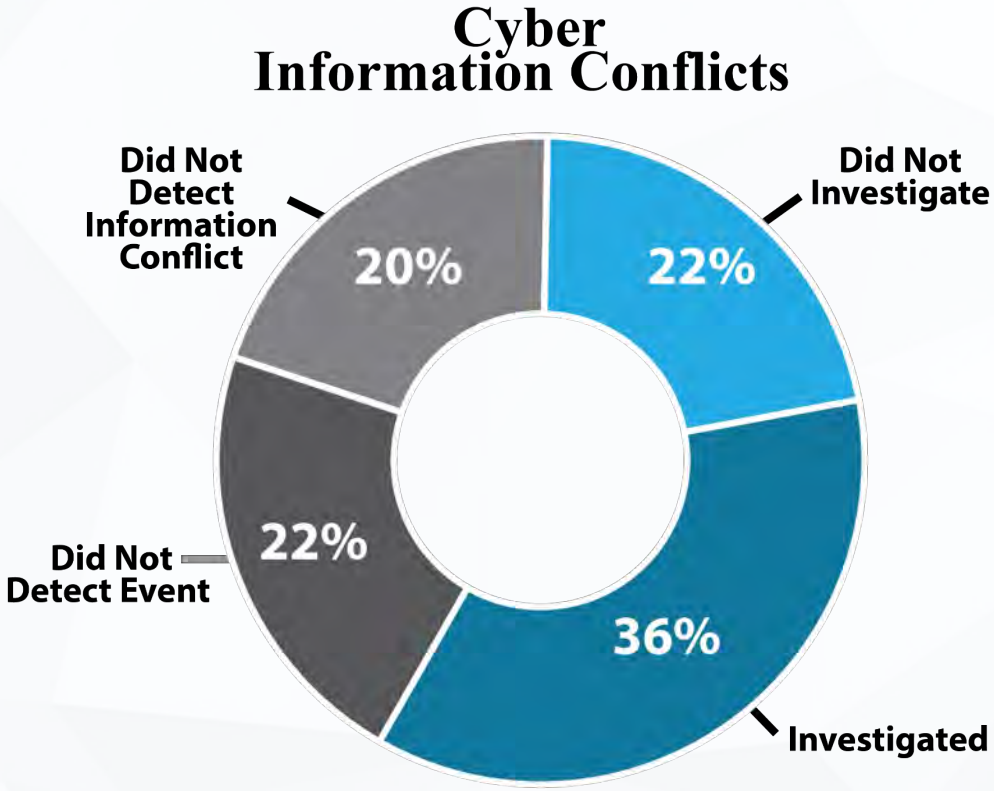
- Perceived Susceptibility
  - 78% of pilots thought EFBs or flight deck systems are vulnerable
  - Pilots appear to have moderate to high levels of perceived susceptibility for EFB systems compared to flight deck systems
  - 50% of pilots report using EFB for personal use
- Trust
  - 89% of pilots expressed moderate to complete trust in their flight deck information
- Safeguard Cost
  - Only 54% of pilots would be willing to use EFB solely for flight/company business
  - 23% wanted to continue personal use
  - 23% were willing to limit to company use or issued an EFB only during flights
- Cybersecurity Knowledge
  - Only 4 pilots of the 108 had received any SOPs or training on cybersecurity
  - Only 5 pilots of the 108 had received training

Questionnaire Results: Cybersecurity Detection and Response

- Only 4 of 108 pilots reported experiencing what they thought was a cyber event
  - Three of these were pilots who received training or SOPs on cybersecurity
- The 4 pilots who experienced what they believe to be a cybersecurity event responded similarly to other abnormal behavior on the flight deck
  - Overriding automatic processes
  - Alerting ATC/Dispatch
  - Landing at nearest airport
  - Using encrypted data
- Pilots who did not experience an event were asked how they believe they would respond
  - Responses were similar to actual responses reported

Simulation Study Results: Pilot Response to Cyber and Non-Cyber Events





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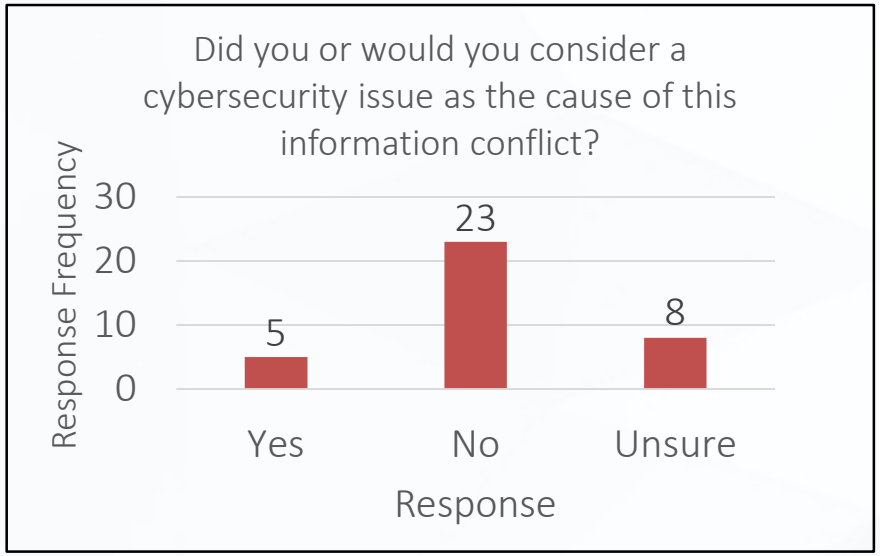
Simulation Study Results: Participant Cybersecurity Perceptions

- 1 participant (3%) cited possible cybersecurity issue before priming
- 5 participants (14%) thought the information conflict could have been due to a cybersecurity event when specifically asked
- 4 participants (11%) had received training or SOPs on flight deck cybersecurity



Response	# Responses
Pilots would not be able to detect a cyber-attack	9
Maintain SA and monitor any change on displays	5
Crosscheck between multiple devices and displays	4
Consider last crew input on traffic display	2
Monitor EFB usage, unusual emails, notifications	2

1 Reason when asked "How could you know a cyber-attack is occurring on your cockpit displays?"

Trust and Concern Level for Flight Deck Systems and EFB

Flight Deck Trust

- "I never (or rarely) have an issue or experience to question trust in the systems
- "Systems onboard would be difficult to hack or compromise"
- "We have standby instruments and ways to verify information"

EFB App Trust

- "I've experienced issues with the programs [on the EFB]" such as "inaccurate or wrong data"
- There's a potential for "privacy issues and hacking"
- It's an "external source that is a backup to onboard systems"

- **High levels of trust** in both systems
  - Slightly higher for Flight Deck
- **Low levels of concern** with respect to information security of data
  - Slightly lower for Flight Deck

System	Trust Level	Concern Level
Flight Deck Systems	*4.67*	*1.50*
EFB Application	*4.19*	*1.83*

Note: average results based on 5-point Likert scale with 1=not at all, 5= completely or extremely

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Implications

- Cybersecurity threats are not on pilots “radar”
- Pilots appear to respond to cybersecurity events in the same manner as to system anomalies
  - Likely because they are perceived as anomalies
- This is not necessarily a bad thing
  - Pilots currently do not receive training and do not have expertise in cybersecurity response
  - As a result, best response may be to treat as any other anomaly and follow procedures

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Questions?

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