Human Factors
IN ACCIDENTS INVOLVING REMOTELY PILOTED AIRCRAFT

Peter W. Merlin
JACOBS/TYBRIN Group
NASA Dryden Flight Research Center

Disclosure Information

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Peter W. Merlin

I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation

Rise of the Machines

Increasing use of remotely piloted aircraft for civil and military applications has drawn attention to high mishap rates.

Some studies suggest that RPA accident rates exceed those associated with crewed aircraft by several orders of magnitude.

By far, the greater percentage of RPA mishaps is attributed to human factors. Between 21% and 68%

Humans in the Loop

Use of the term "unmanned" to describe any sort of autonomous or remotely piloted aircraft is often misunderstood to mean that there is little or no human-systems integration involved.

In fact, RPA operations involve numerous people in every aspect of control, operation, and maintenance regardless of the vehicle's level of autonomy.

In most respects RPA operations are identical to those involving conventionally crewed aircraft, but the geographic separation of aircraft and crew necessitates particular attention to Human-Factors Engineering when developing such systems.

Analysis of RPA Accident Data

Since RPA systems vary widely in size and complexity, the specific percentage of human-factors involvement varied according to aircraft model.

Human error can almost always be traced to a variety of underlying causes.
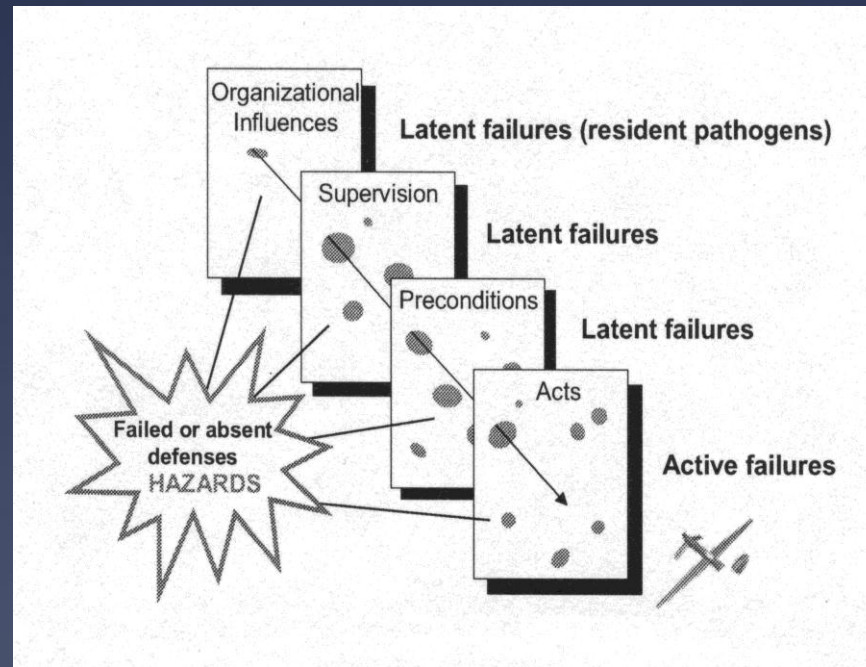
James Reason's "Swiss Cheese model" of safety vulnerability

Common Causes of RPA Mishaps

Cognitive Factors

Physiological Factors

Environmental Factors

Staffing Factors

Design Factors

Any of these, alone or in combination, can degrade human performance and increase the likelihood of a mishap.

Cognitive Factors
Pilot Workload

Workload = Task Demands + Human Response to Demands

Long-duration missions can present extended periods of low workload (navigation, system monitoring) interspersed with brief periods of high workload (takeoff, landing, mission operations).

Malfunctions or unexpected conditions can result in intensely high mental workload.

"There's a lot of stuff you're looking at while working the radios and checklists. It's a little too much for one pilot. You need an extra set of eyes because sometimes you're drowning in information."

Physiological Factors
Fatigue and Stress

Weariness resulting from insufficient sleep, extended periods of mental or physical work, or prolonged periods of anxiety can affect RPA operators during long-duration missions.

Operator fatigue may result in reduced reaction time and decreased vigilance that can degrade performance, productivity, safety, and mission effectiveness.

A survey of 66 Predator pilots found that nearly half suffered fatigue that impaired job performance, and 40% reported a moderate-to-high likelihood of falling asleep at their stations while operating a weapon-carrying remotely piloted aircraft.

"Pilots were found to have higher mental-fatigue scores than sensor operators, suggesting a possible task-related contribution to their fatigue."

Environmental Factors
Situational Awareness

Degraded situational awareness results from the failure to correctly perceive information, failure to integrate or comprehend information, or failure to project future actions or system states.

RPA pilots lack such physical cues as visibility, motion, sound, feel, and even smell.

Reduced cockpit visibility

Data link bandwidth limitations may reduce temporal/spatial resolution, color discrimination

Uplink/Downlink signal lag or interruption

Channelized attention

"It was like I had lost four of my five senses. Your vision is limited because there is only a single camera for forward visibility, you can't hear the engine, feel the aircraft's motion or acceleration, or smell a fuel leak or an electrical fire."

Staffing Factors
Training and Crew Coordination

Good training, effective communications, and teamwork are critical to the safe operation of remotely piloted vehicles.

Elements of an effective training program include the use of experienced instructors, well-defined standards, and an effective evaluation process.

Instructors should be sure to emphasize the value of effective crew coordination.

Inadequate training, failure to follow established procedures, and lack of crew coordination are common factors in RPA mishaps.

"This was one of those instances where he would have been better off not touching it. He just panicked, hit the button and threw away a $7-million airplane."

Design Factors
Human-Machine Interface

Many so-called "human errors" result directly from design shortfalls in the human-machine interface.

Cockpit displays need to present data in such a manner as to allow for efficient interpretation by the operator.

Control characteristics should be sufficiently forgiving to prevent catastrophic failure in the event that the pilot is slow to make a critical control input.

"Instead of physical switches you're using a keyboard and trackball and pulling down menus like you would on your personal computer to activate systems. Understanding where all of these system controls are located, and finding the right screen display to access the controls, is challenging."

Breaking the Mishap Chain

Increased automation can reduce workload
-   Beware complacency/over-reliance

Ensure adequate crew rest

Design to reduce task saturation

Design cockpit/GCS to increase situational awareness

Ensure proper composition, selection, and training of RPA crews

Well-funded maintenance programs and adequate spare-parts support are essential to safe flight operations

Human Factors Engineering is critical to design of the human-machine interface

Lessons of History

Mishap rates for remotely piloted and autonomous aircraft have been high and deserve additional study.

Learning from past experience is fundamental to the development of safe and efficient new systems and to improving existing systems.
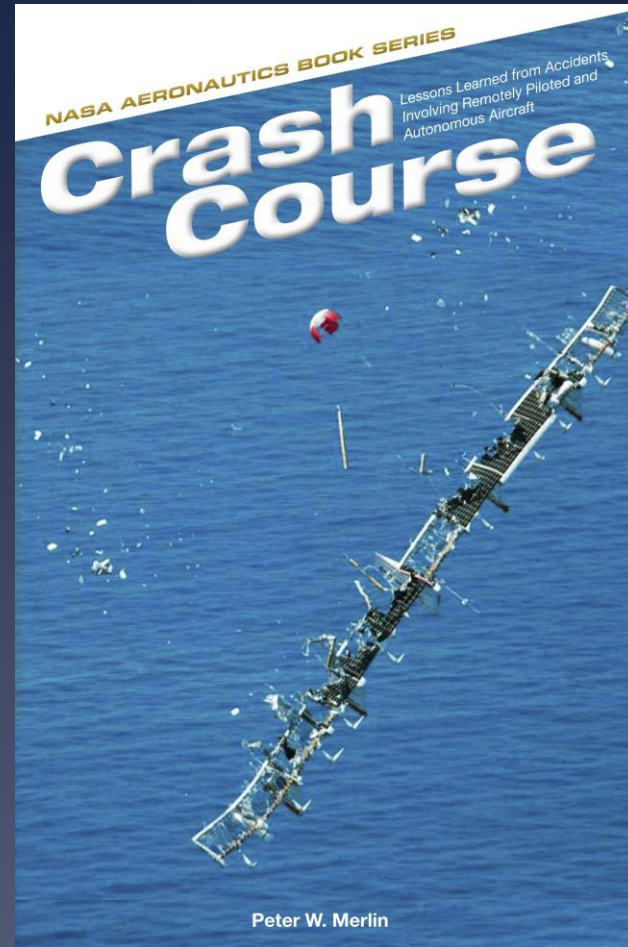
Future mishaps might be avoided through the collection, archiving, and study of data on past accidents and incidents to learn valuable lessons.

Although there are no humans on board remotely piloted aircraft, there are numerous humans involved in all aspects of RPA operations.

Human factors affect RPA safety at every level of design, management, maintenance, and flight operations.

Because human factors are consistently cited as a major cause of RPA mishaps, an understanding of the associated causal factors is essential for improving the reliability of remotely piloted aircraft.

Resources

Books and eBooks available
http://www.nasa.gov/

Questions?