



## Problem Solving/Decision Making and Procedures for Unexpected Events

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### **Goal:**

*To provide the FAA with insight into how resilience engineering concepts can be applied to help pilots better manage unexpected events including loss of control.*



# Disclaimer:



The views presented are those of the authors and do not necessarily represent the views of the U.S. Federal Aviation Administration

# Problem Statement

- Not all operational situations can be anticipated
- Not all failures can be anticipated
- Pilot in command is responsible for the safety of flight
- How do we better prepare pilots for unexpected events?



## Research Questions

- What are the behavioral markers or cognitive strategies that demonstrate resilience within pilots? Can the strategies be enhanced with training?
- Can these practices be translated to a higher-order taxonomy to provide pilots the ability to stabilize the situation as they troubleshoot?
- What are the recommended practices established regarding responding to unexpected events for pilots?



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## Intent of Research

Data to identify the requisite knowledge and skills for problem solving/decision making, and recommend procedures that the pilots may potentially use during unexpected events



## – Phase 1

- Literature review of resilience engineering across domains – what makes some individuals and teams more resilience than others?
- Examine a set of incidents/accidents to frame the literature across real events.
- Simulator observation of line crews going through normal training that includes modules where surprise is built in.

## Methods:

- Literature searches
- Key words include:
  - “resilience” yields 1.5 million returns
  - “resilience engineering” yields 616,000 returns
  - “resilience to surprise” yields 120,000 returns
- Literature that we are familiar with through our professional training, education and experience.

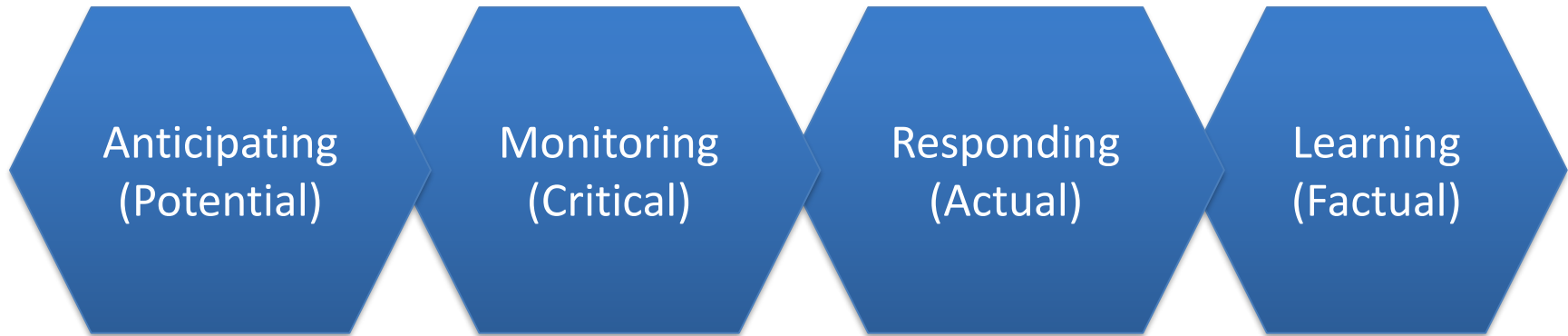


- In addition to deciding which articles are going to be meaningful, those that we kept were categorized from their domain. For example:
  - Resilience Fundamentals
  - Aviation including ATC
  - Healthcare
  - Chemical and Petrochemical industry
  - Nuclear Industry
  - Railways
  - Manufacturing
  - Natural Disasters
  - Military
  - Construction
  - Electricity distribution
  - Road transport
  - Shipping
  - Meteorology, Financial Services, Information Technology, Fishing, Space Flight, Firefighting



- Literature Review

- Resilience indicators discovered are based on the four cornerstones of resilience extensively covered in the literature base.





## **Anticipation:**

- Identify contextual factors that can effect performance
- Replan action sequence
- Still discussing risk when everything seems fine
- Understanding that past success does not guarantee future safety

## **Monitor:**

- Managing the trade-off space
- Good communication and leadership
- Prioritizing actions/decisions



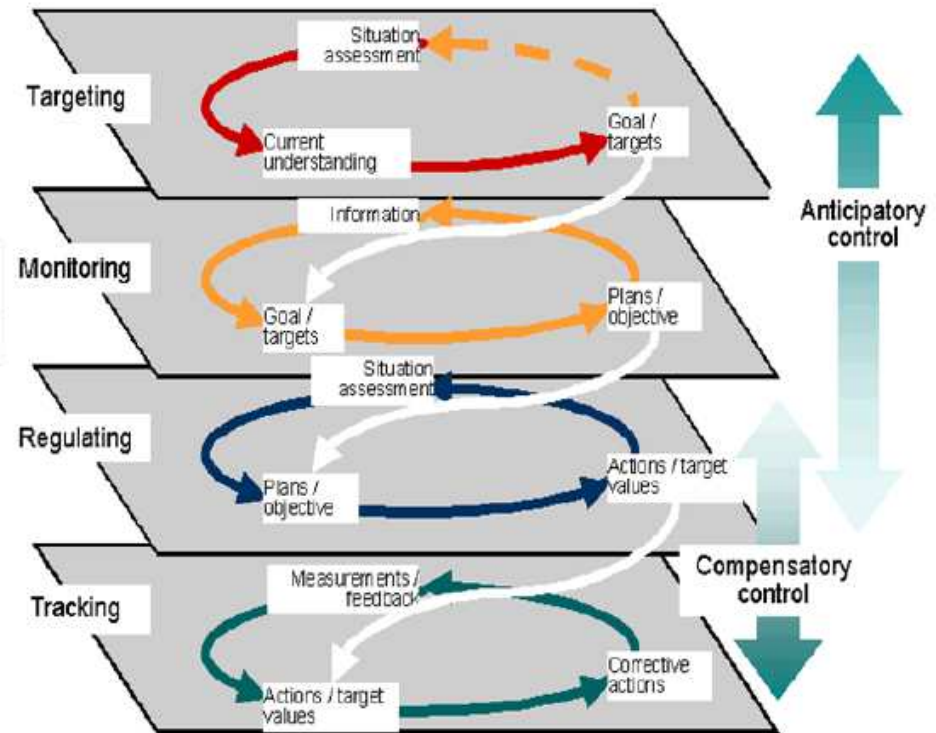
## **Respond:**

- Collaborative work
- Planning and handling sacrifices well as needed
- Open to fresh perspectives
- Matching capacity to demand as much as possible

## **Learn:**

- Good leadership
- Good communication
- Ability to self-critic and to be open to honest view of performance

- The cognitive models used and relation to the four cornerstones





## – Phase 2

- Simulator observation of line crews going through normal training that includes modules where surprise is built in.

### SUCSESSES

- Completed 40 hours of observation – (10 crews)
- Past experiences (pilots were very willing to help out).

### CHALLENGES

- Getting permission from both organizations took longer than expected
- Moving from reviewing accident reports to the simulator, not as fruitful as expected.
- Granularity was not enough to be fully insightful
- Starting in one aircraft type only (Cessna Sovereign/CE-680)



– Phase 3

- Task - Collected ten FAA Part 121 accidents, incidents, and related reports (Part 121 = air carrier operations)
- Event data sources included
  - National Transportation Safety Board (NTSB) accident/incident database
  - National Aeronautics and Space Administration Aviation Safety Reporting System
  - Databases from other worldwide investigative agencies
- Events that were successful events/accidents and where searching databases using the words/phrases
  - Unexpected
  - Surprise
  - Startle



# How are these skills and behaviors recognized in a Cockpit Voice Recorder transcript/event report?

- Consider US Airways 1549 (Hudson River, NY)
  - 15:27:21: *“I’m starting the APU”*
    - While not mentioned in the emergency checklist, the captain anticipated the need for electricity and (responded) turned-on the APU
    - Helped the aircraft stay in the normal law mode (concluded by NTSB report)
  - 15:30:19: *“No lets stay at two”*
    - The captain decided to stay at “flaps 2” because, in his experience, adding more flaps would have only marginally increased stall speed, while drastically increasing drag
    - The captain gracefully extended the adaptive capability of the system (aircraft + pilots) using his knowledge of how the aircraft would handle

- The four cornerstones: For example  
Monitoring (targeting)



Behaviors seen on the flight deck



Methods – Knowledge – Skills – Strategies

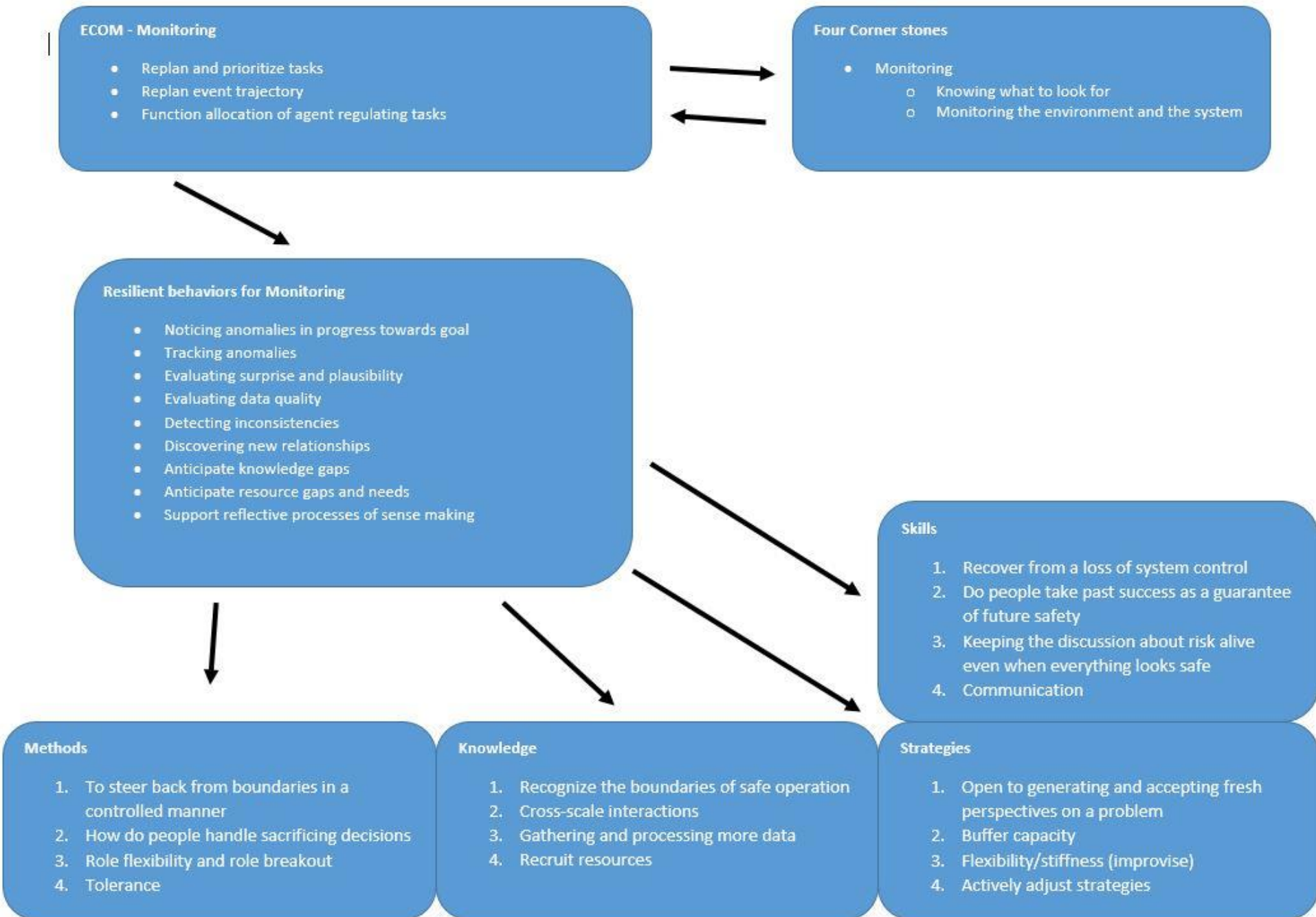




The real value in this research is to discover the following which can possibly lead us to trainable behaviors

- Methods: *a way, technique, or process of or for doing something*
- Knowledge: *the fact or condition of knowing something with familiarity gained through experience or association*
- Skills: *the ability to use one's knowledge effectively and readily in execution or performance*
- Strategies: *a careful plan or method*

## Cognitive model for assessing resilience – Extended Control Model (ECOM)





## FAA goal for the research

Data to support training and operational guidance for methods, knowledge, skills and strategies to enable crews to be more resilient when faced with unexpected events



- Questions?
- Thanks!