

A Model of Monitoring as Sensemaking: Application to Flight Path Management and Pilot Training

Dorrit Billman

dorrit.billman@nasa.gov

Randy Mumaw

randall.j.mumaw@nasa.gov

Mike Feary

Michael.s.feary@nasa.gov



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Monitoring & the Sensemaking Model

- Motivation
- How is monitoring done: the Sensemaking Model
 - Situation Models & Mental Models
 - Sensemaking Cycle
 - Monitoring Context
- Training
- Perspectives

Motivation & Focus for Studying Monitoring

- Central to sociotechnical work, many domains
 - air traffic control
 - medicine (surgery, nursing)
 - nuclear power
 - shipping
 - ...
- Role of supervision/monitoring increases with increased automation
- Inadequate performance can contribute to serious accidents

Intro & Motivation

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https://upload.wikimedia.org/wikipedia/commons/thumb/5/59/Crash_Turkish_Airlines_TK_1951_cockpit_2.jpg/512px-Crash_Turkish_Airlines_TK_1951_cockpit_2.jpg

Motivation & Focus for Studying Monitoring

- Broadly important, specifically, for airline pilots
- Push to improve monitoring, particularly training
- Flight deck complex engineered environment
 - Our examples: airline pilot monitoring of the flight path, descent
 - Our focus: pilot (organizational, interface,...)
 - Our exploration: expert pilots, training exercise



Intro & Motivation

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What is monitoring?

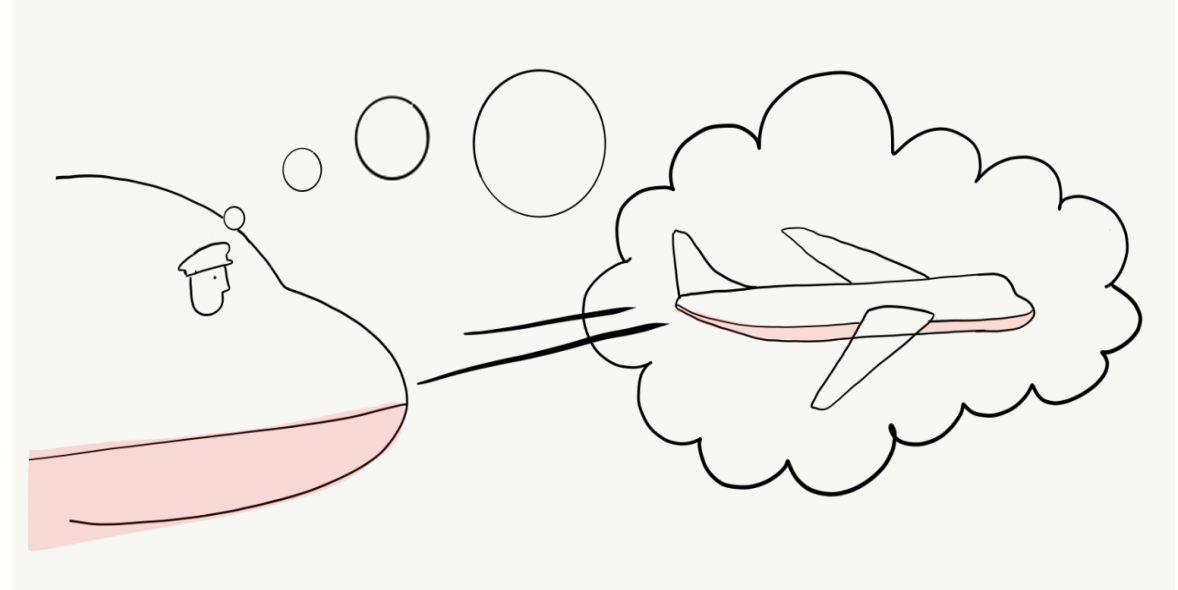
Intro & Motivation

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What is monitoring?

Not only to see but to understand!

In Aviation: Monitoring is
“Flying ahead of the plane.”
You know
where you are
where you are going
how you are getting there.

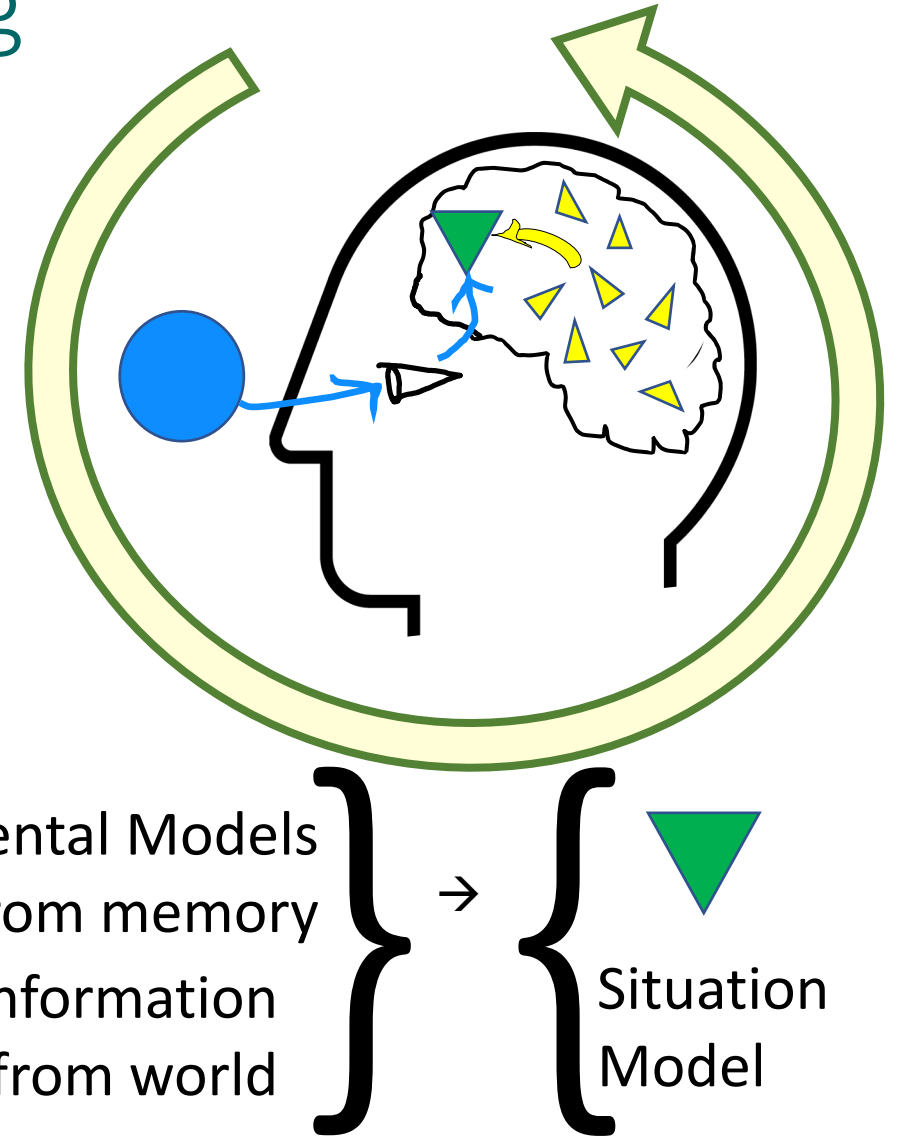


Sensemaking Model of Monitoring

Monitoring is a cycle of sensemaking activity that builds & updates the **Situation Model**.

A **Situation Model** is a mental representation of the current status of a dynamically changing situation.

A mental model is long-term knowledge about “how something works”.

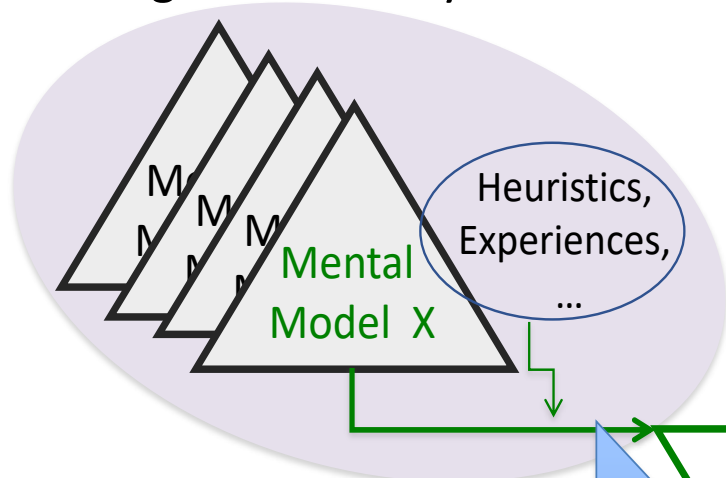


Sensemaking Model

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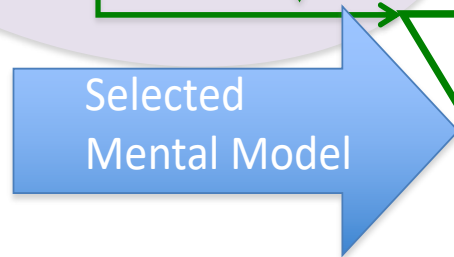
Initializing a Situation Model

Knowledge in Memory



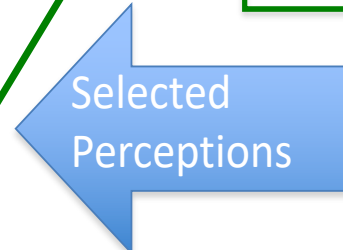
*What relevant do I know
to set expectations?*

Initializing a Situation Model



**Situation
Model**

Information in the World



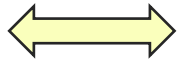
*What kind of situation
is this?*

Sensemaking Model

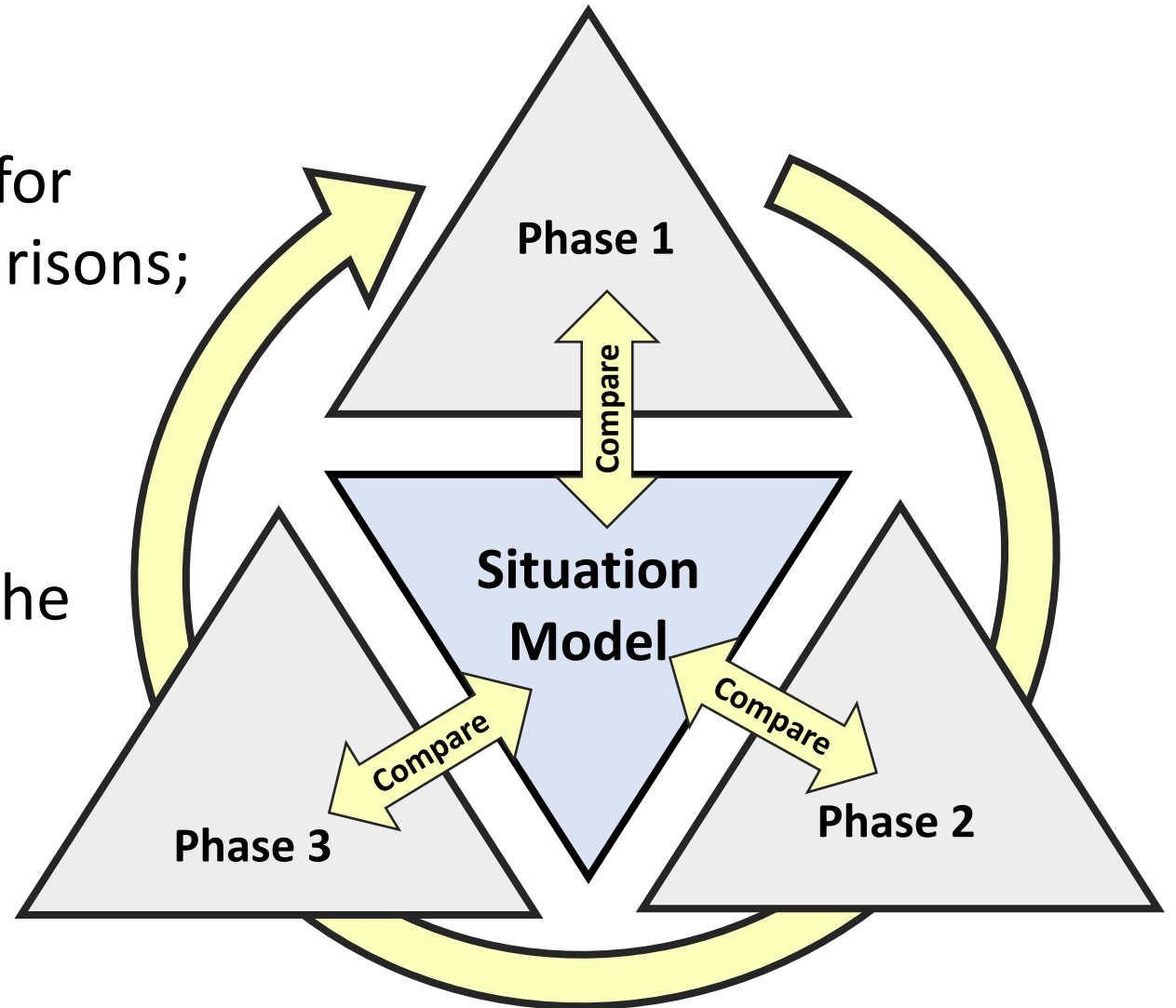
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Monitoring is a Sensemaking Cycle

- 1) Each phase
 - a) draws on the situation model for guidance, expectations, comparisons;
 - b) and also updates the model.



- 2) Sensemaking iterates through the phases, using the information integrated in prior cycles.
Not linear.



Sensemaking Model

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The Monitoring Cycle: Phase 1

What do I need to understand?

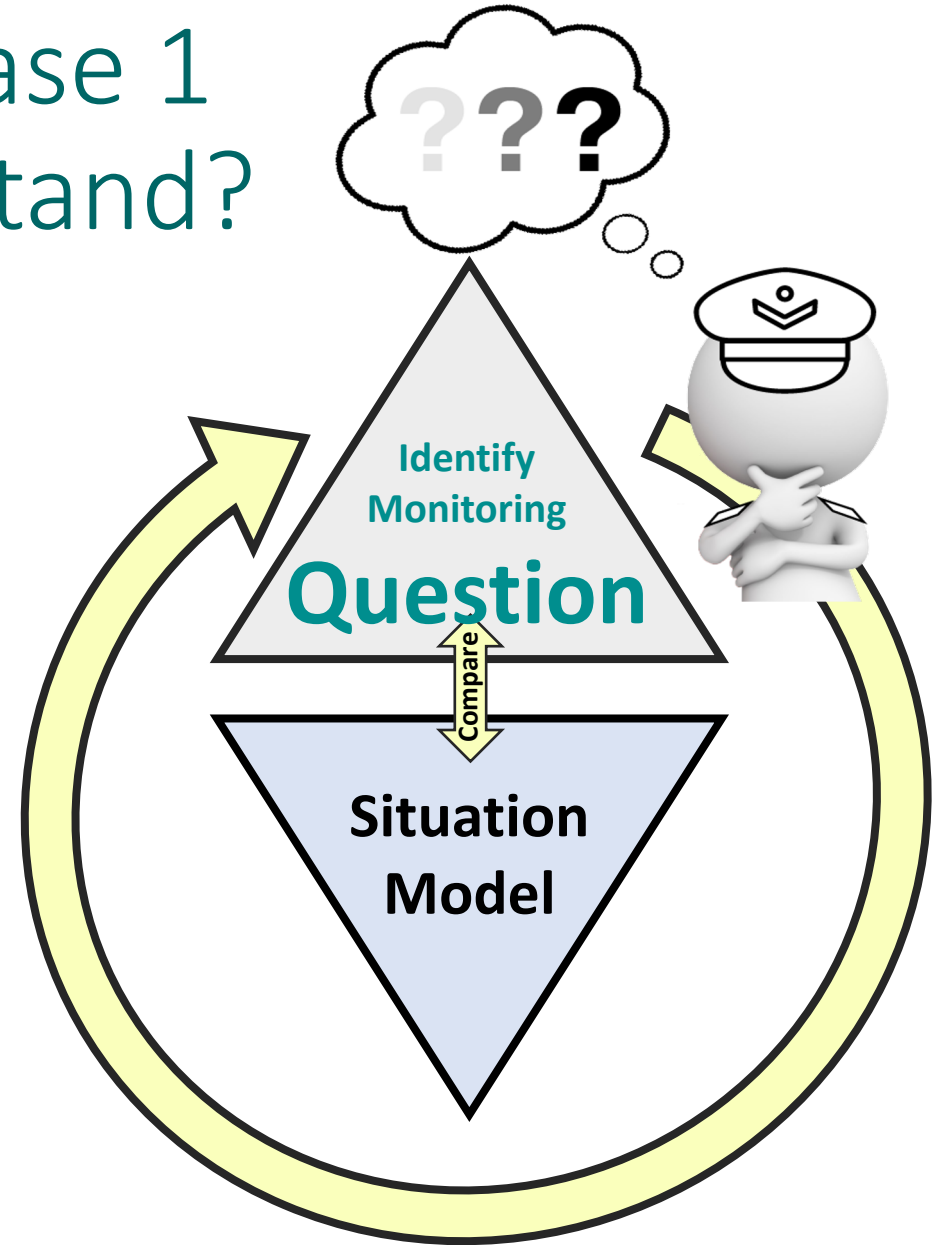
Identify what is the most important **question** to answer in this situation.

What do I need to know most now?

What are gaps or inconsistencies in my Situation Model?

Sensemaking Model

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The Monitoring Cycle: Phase 1

What do I need to understand?

Examples:

*Can I meet requirements on flight path?
("make next waypoint")*

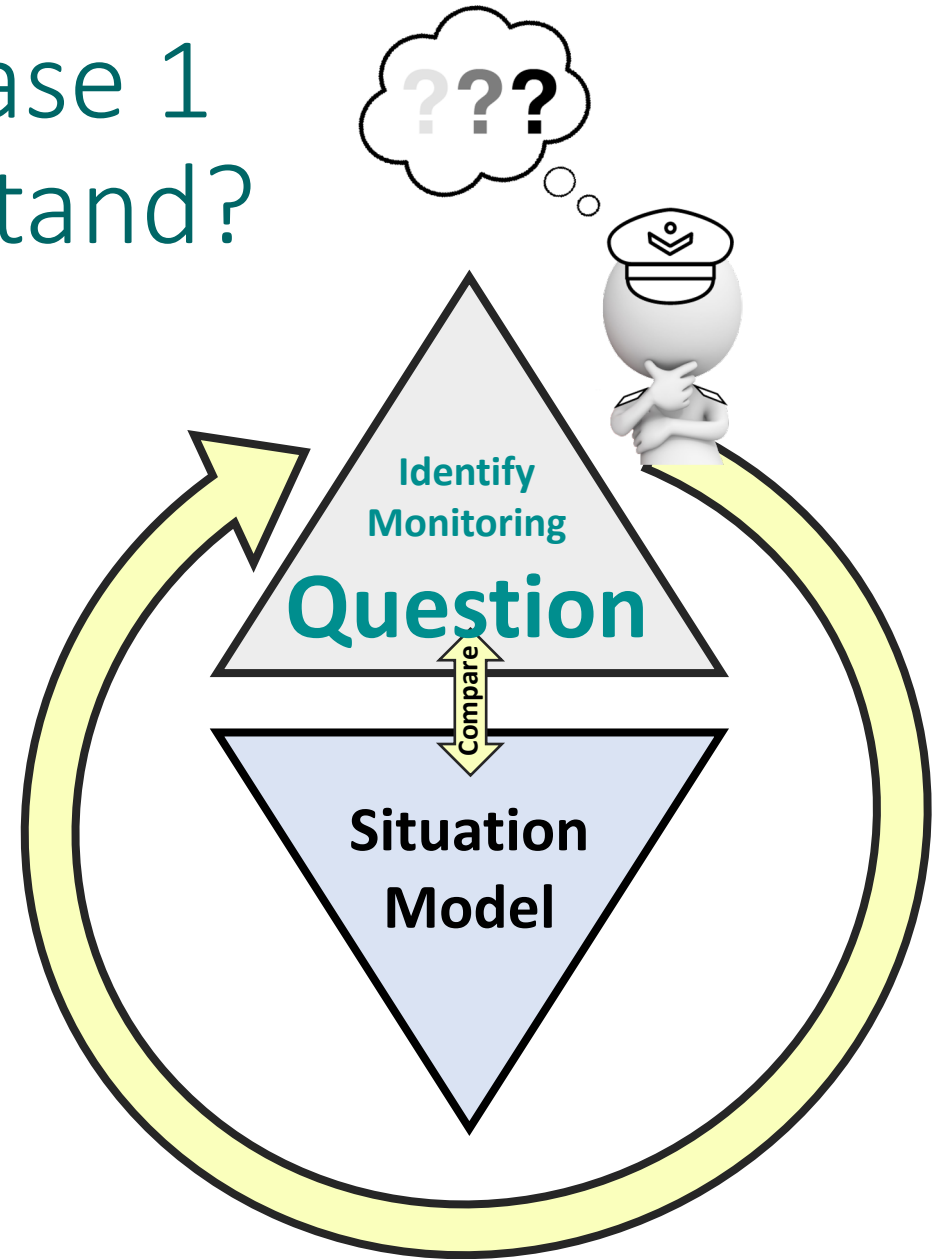
Why am I not as low as expected?

What are effects of this clearance
from Air Traffic Control?

How has airspeed changed
since last look?

Sensemaking Model

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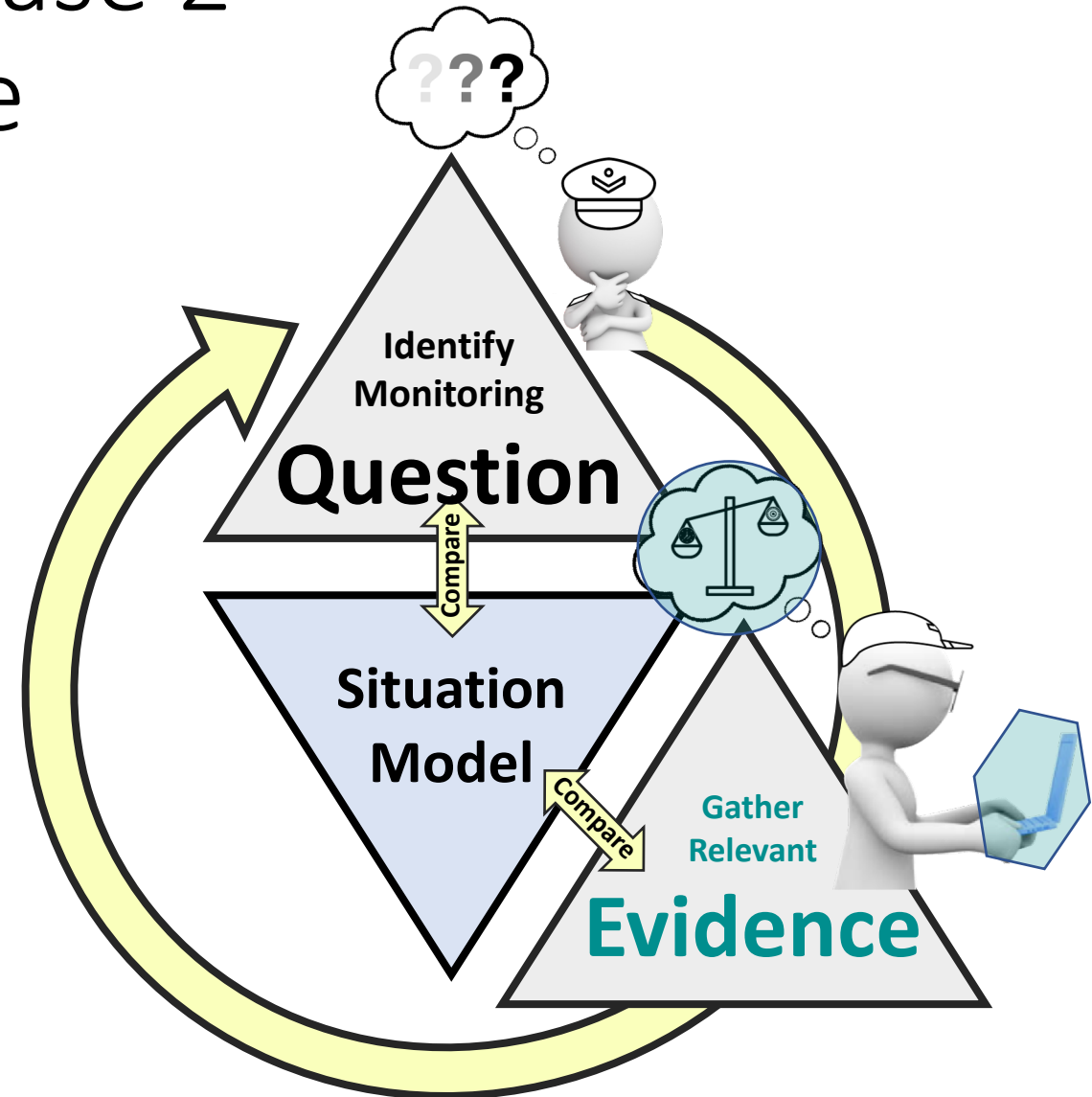


The Monitoring Cycle: Phase 2

Gather & Assess Evidence

Gather and assess relevant evidence:

1. Where do I find the variables needed for the question?
2. What are current values?
3. What are expected values?
4. What comparisons and judgements are needed ?



Sensemaking Model

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The Monitoring Cycle: Phase 2

Gather & Assess Evidence

Example: *Make next waypoint?*

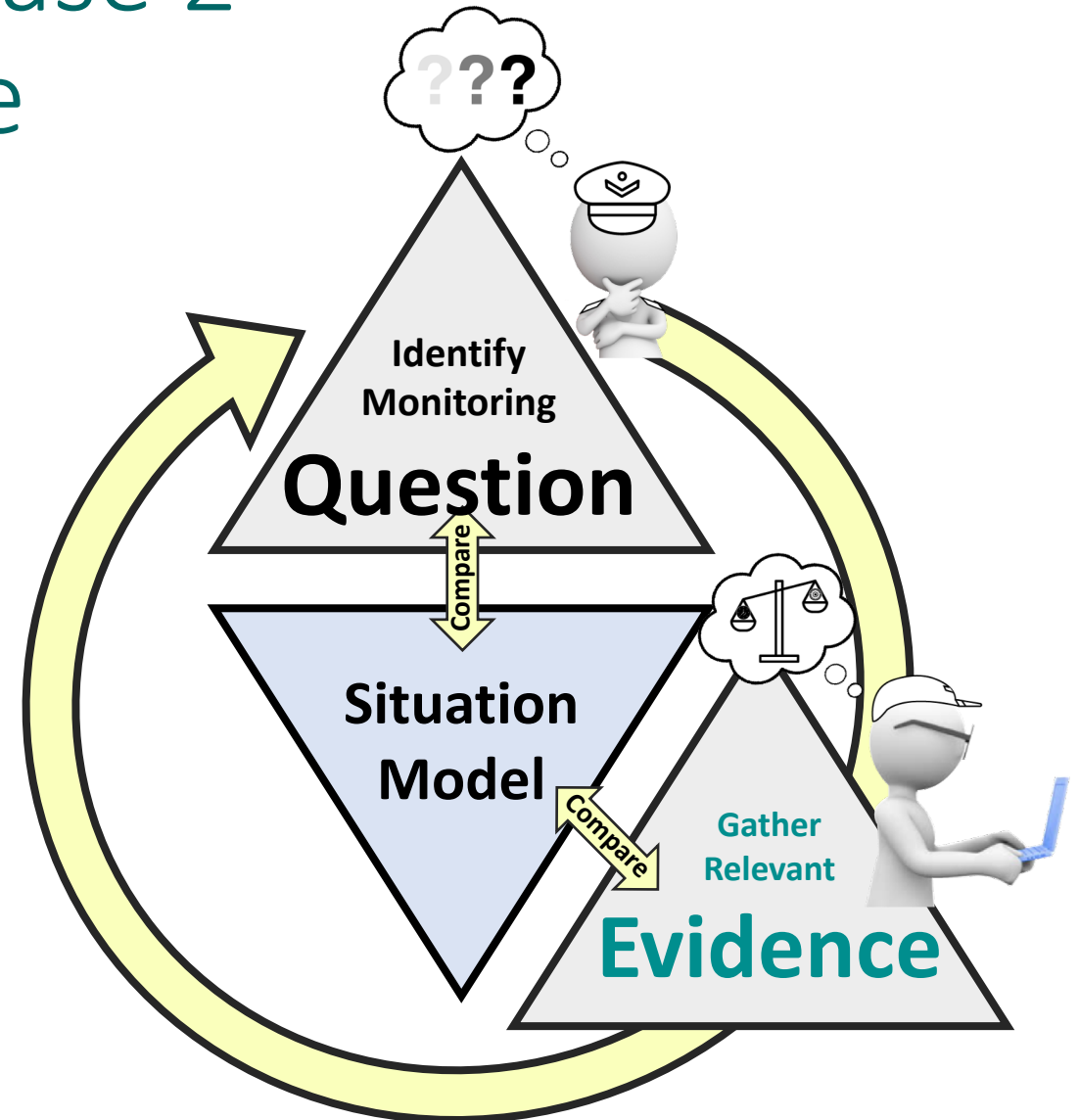
Info: {current altitude; waypt altitude;
change in speed also? distance;
tail wind ...}

Comparisons:

Mental arithmetic? in computer?

Descend in this distance?

Does evidence answer the question?



Sensemaking Model

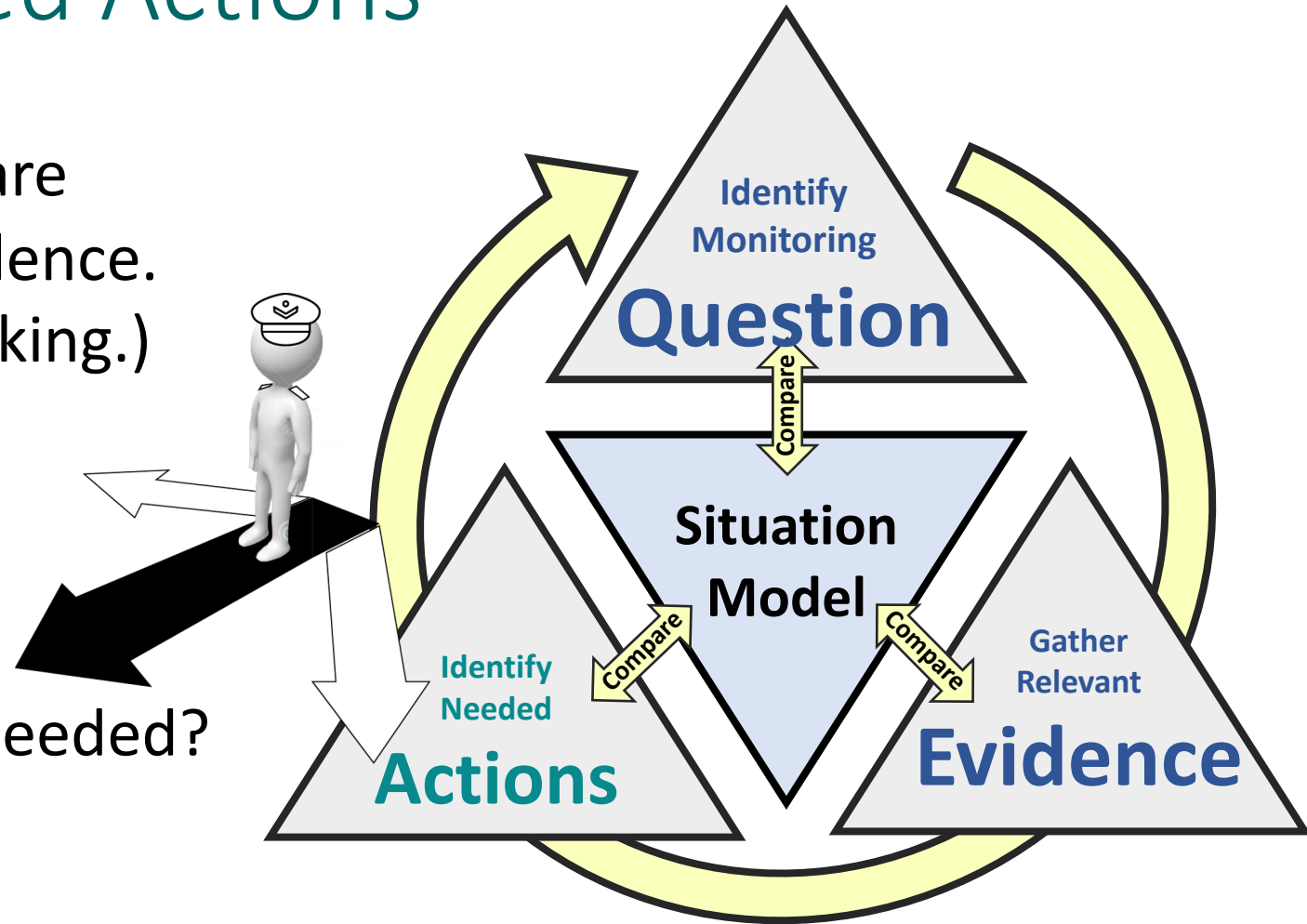
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The Monitoring Cycle: Phase 3

Identify Needed Actions

Identify what actions are needed, based on evidence.
(Supports decision making.)

What do we need to do?
Are we “ok” or are pilot control actions needed?
Need to talk to ATC?



Sensemaking Model

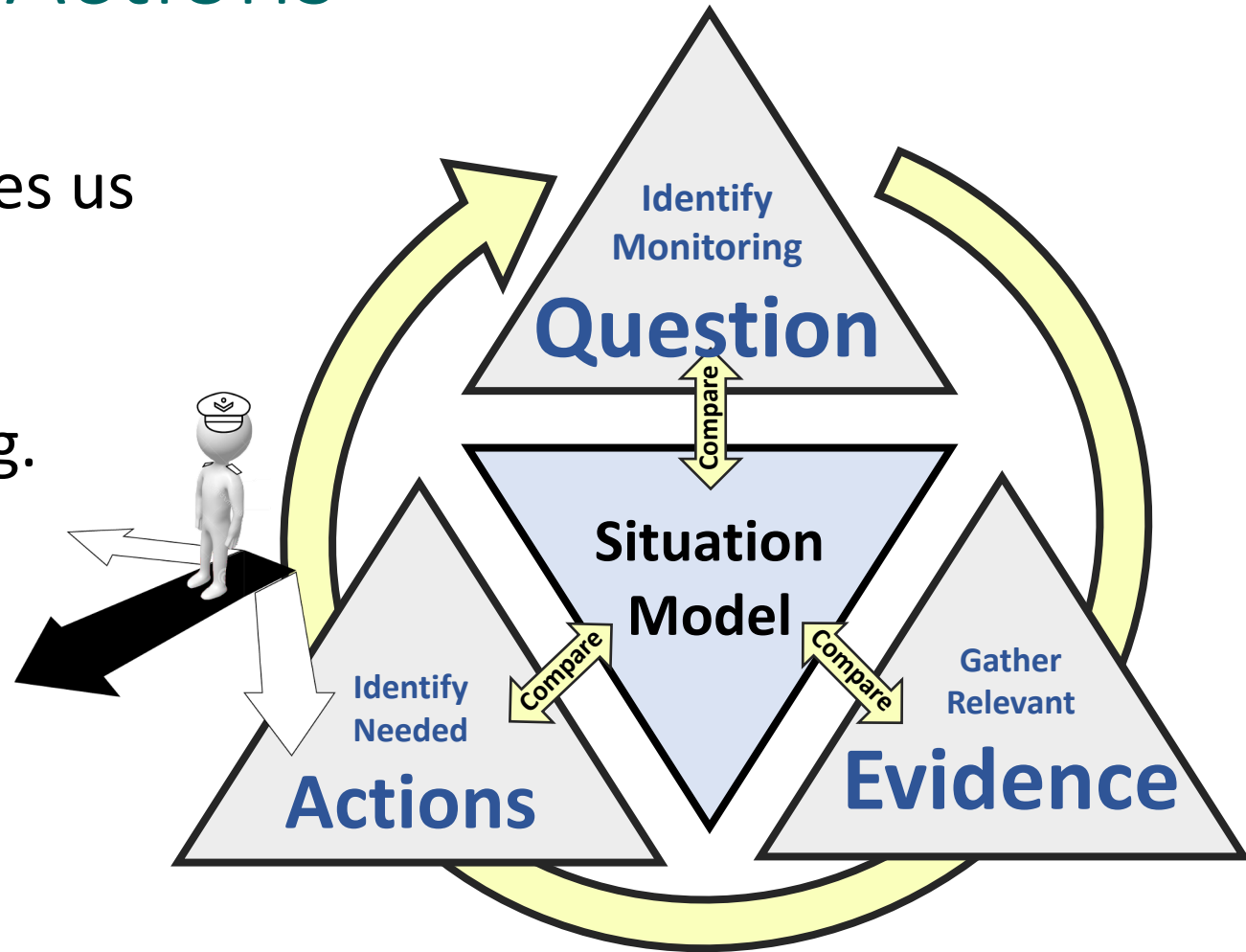
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The Monitoring Cycle : Phase 3

Identify Needed Actions

Examples:

- Ok, autoflight mode takes us to waypoint.
- Use different mode.
- * Unclear, keep checking.
- Can do speed or alt, not both.
- Unable: ask ATC for relief.



Sensemaking Model

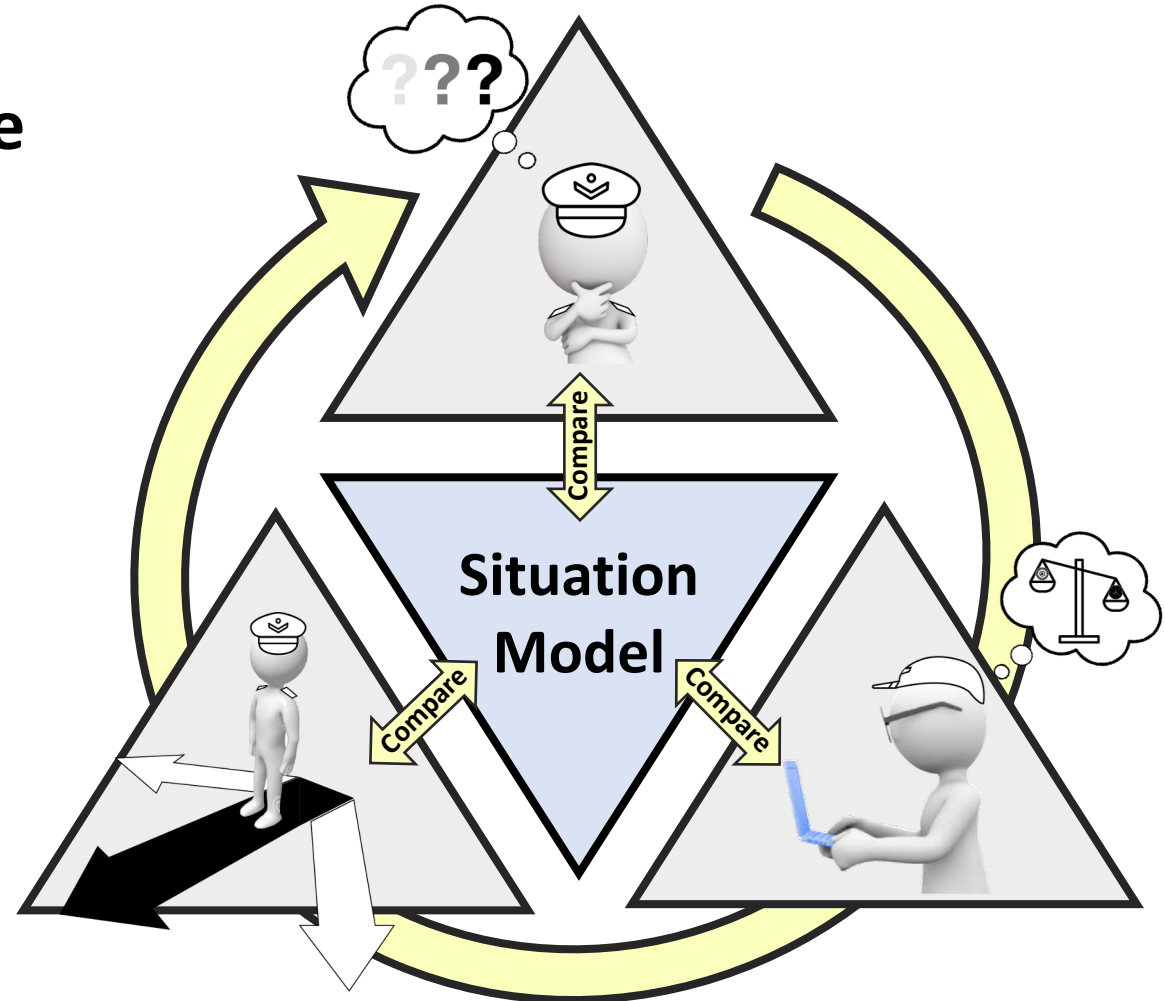
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Monitoring as sensemaking

**Person is active
throughout monitoring cycle**

Monitoring guided by
situation model

Situation Model updated by
monitoring



Sensemaking Model

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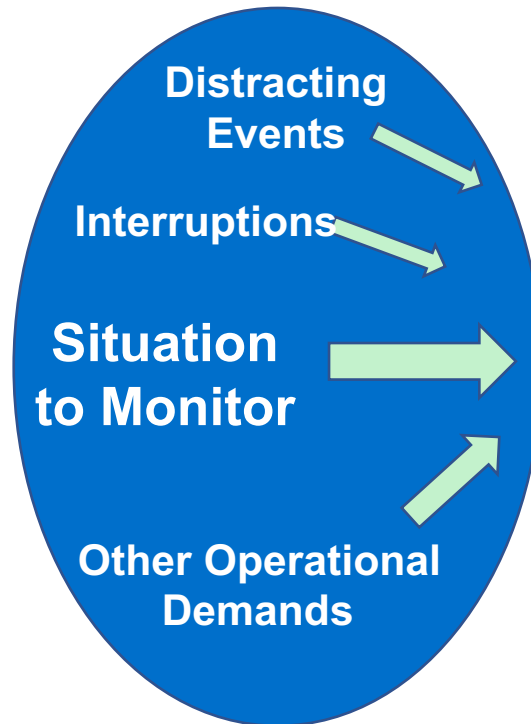
The Monitoring Cycle (typically) Occurs in a **Complex** Context

Complexity comes from

1. the situation being monitoring
2. **competing tasks and demands on attention.**
3. **team context and communication.**

Monitoring Requires Task & Attention Management

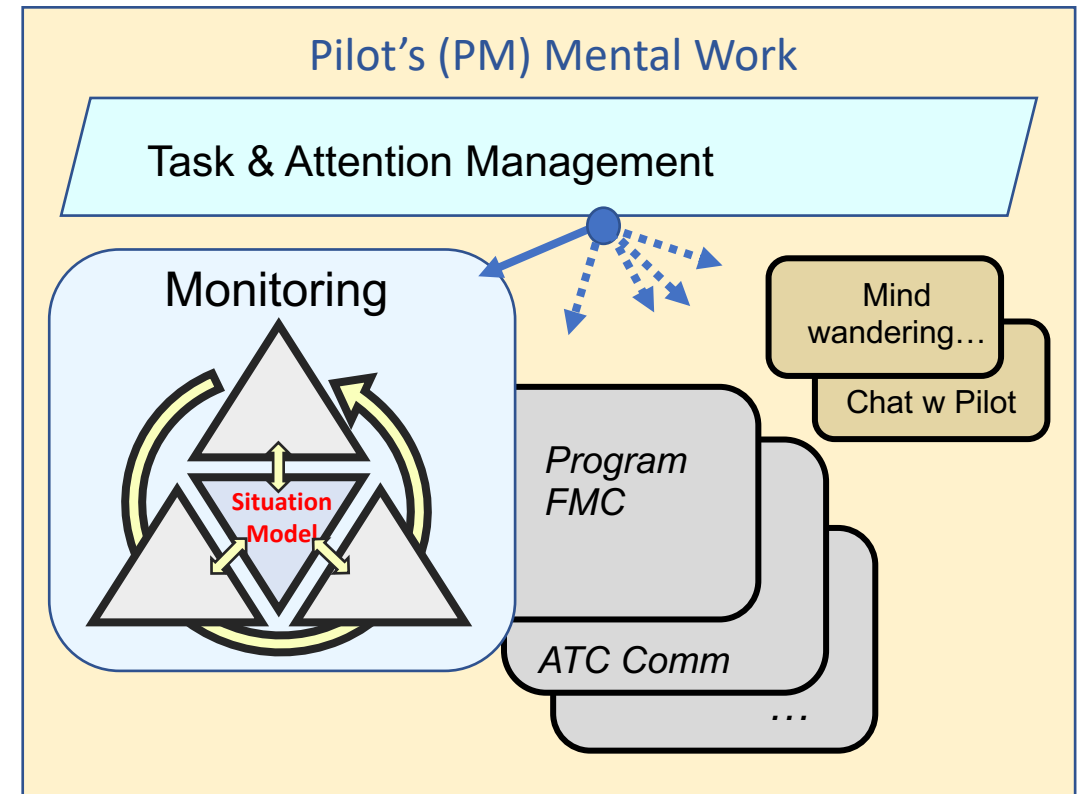
- 1) Externally, world has operational tasks; interruptions; distractions.



Events in the World

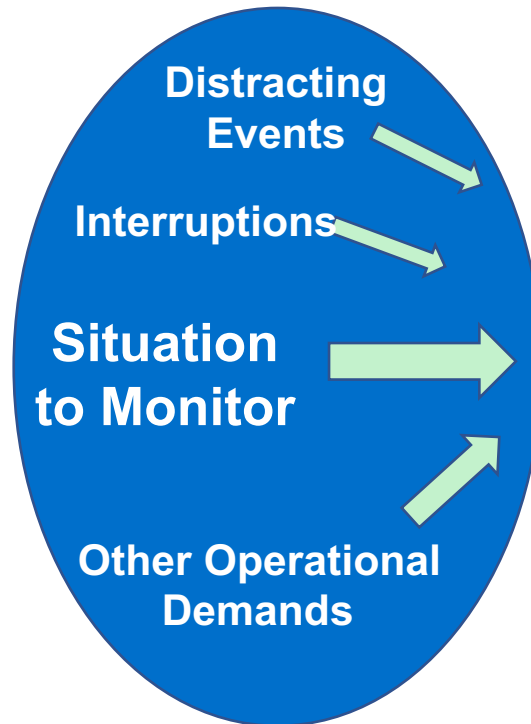
Sensemaking Model- Context
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inform & impact
PM's Mental Work



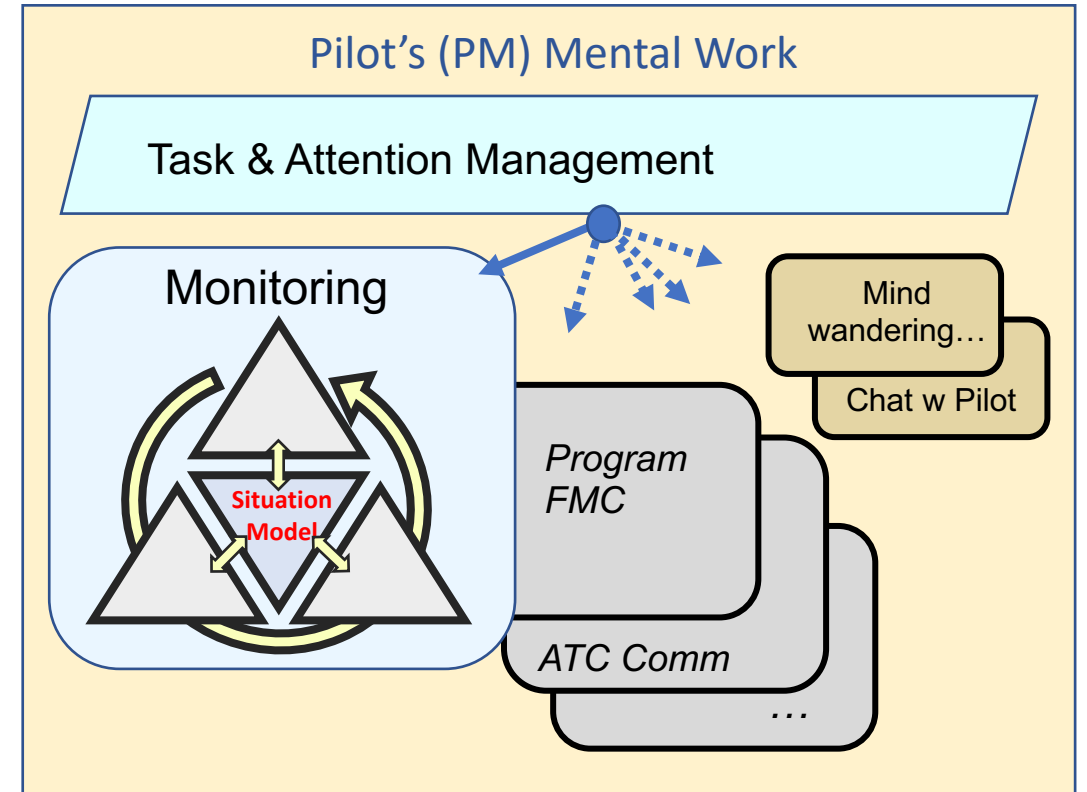
Monitoring Requires Task & Attention Management

- 1) Externally, world has operational tasks; interruptions; distractions.
- 2) Internally, attention must select currently relevant mental work; schedule; & screen distractions.

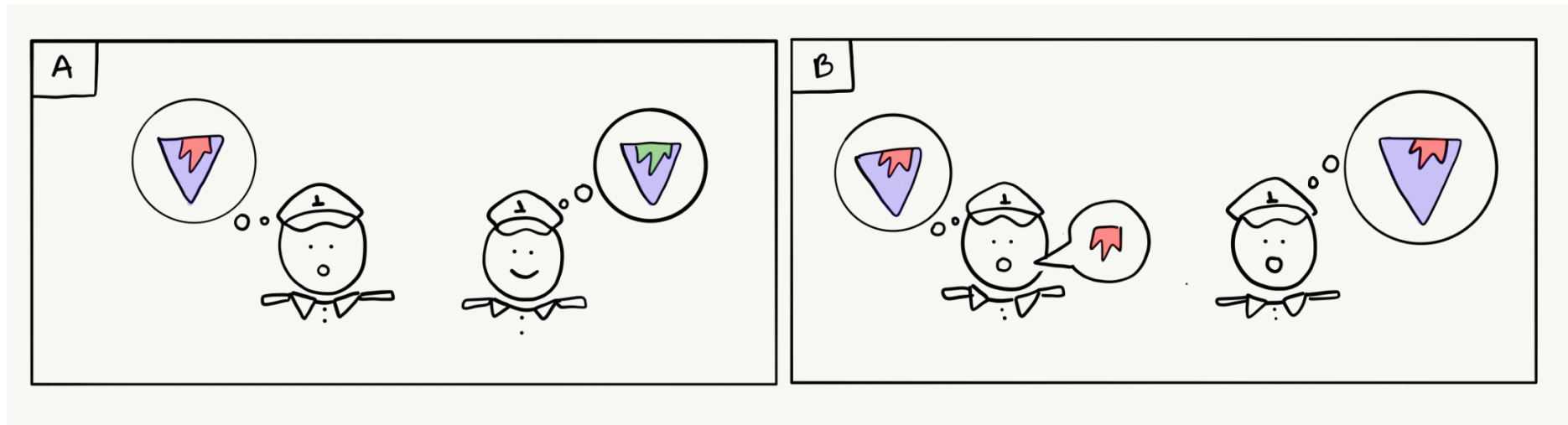


Events in the World

inform & impact
PM's Mental Work



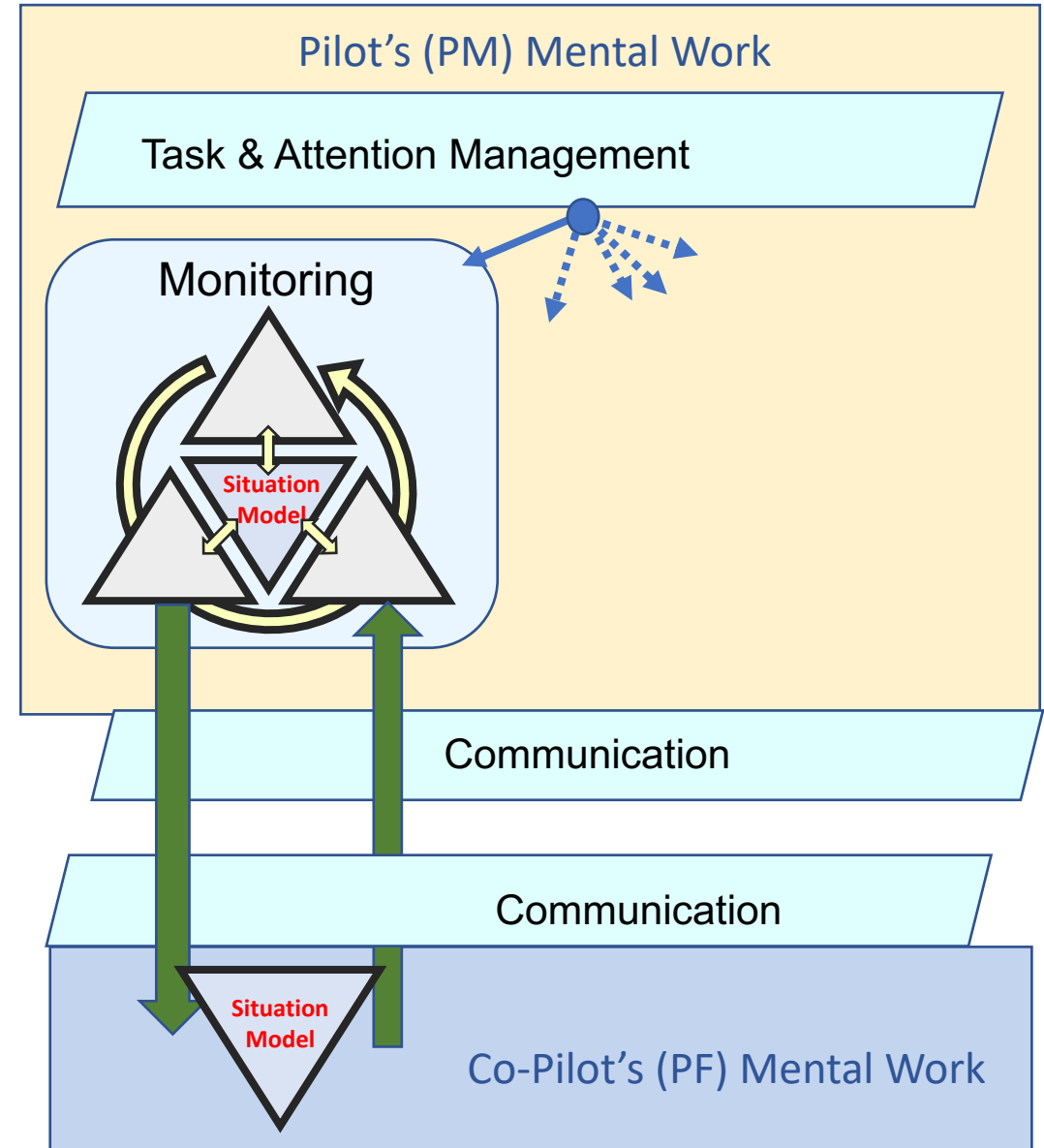
To be useful the situation model has to be shared



Monitoring Requires Communication

- 1-Share strategic changes to the situation model.
- 2-Collaborate on monitoring process.
- 3-Team members' models should be consistent but may detail different aspects.

Sensemaking Model- Context
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Monitoring is an Active Sensemaking Process

The Monitoring Cycle

1) consists of

- identifying the relevant question
- finding and assessing evidence
- identifying the implications for action

2) Depends on and aids
task management
communication

Sensemaking Model

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Monitoring is NOT (just)

Where you
point
your eyes



Being
“vigilant”



Following
procedures



Implications for Training

- Attitude: go-find-out vs "move your eyes around a lot"
 - Inquire & Share
- Concepts:
 - Situation Model- drawing on mental models, operational knowledge,....
 - Monitoring cycle- guided by and updating the Situation Model
 - specify question; gather & assess evidence; identify implications
- Examples of challenging situations and how the experts
 - ask, assess, and conclude
 - communicate
 - aid task management
- Assessment
 - multiple measures
 - verbalization (& other actions) in carefully designed challenge scenarios

Sensemaking Model- Context

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Perspectives

- 1) Established models of monitoring (e.g., SEEV & NT-SEEV models Wickens et al 2009; Situation Awareness models e.g., Endsley, 1995) tend to emphasize
 - exogenous, perceptual/attention processes.

- 2) Our approach emphasizes
 - strategic, goal-driven inquiry.

Related to sensemaking (Weick et al 2005) and in-context studies (Roth, et al 1994).
Our complementary perspective may be particularly helpful for training.

- 3) Our future work includes training and model development.

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Thank you!
Chat Comments and Questions?

Dorrit Billman
dorrit.billman@nasa.gov

Randy Mumaw
randall.j.mumaw@nasa.gov

Mike Feary
Michael.s.feary@nasa.gov