Operations. A Wholistic View.

Human Systems integration division

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All technical systems fail

- Much of the cost of building and running technical systems goes into figuring out how things can fail, building in defenses, fail-safes, and redundancies.
- Safe organizations invest in failure
  - Procedures and backup plans
  - Practice, simulation, and training
  - Hard work, fortitude, and culture

Failure investment ≠ Failure proof

- All of this investment does not make systems failure proof!
- The goal of this investment should not just be to prevent failures from happening, or problems from occurring.
- The goal should also include preparing for, responding to, and recovering from failures (which will happen).

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Variability is a threat—minimize it	
Focus on incident rates	
Focus on what we don't want: injuries and incidents	
Procedures are complete and correct	
Systems are well designed, work as designed, and are well maintained	

** See Hollnagel, Wears, & Braithwaite (2015)*

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Impacts of systematically limiting data (by thinking only in terms of "safety I")

- Human performance includes both desired and undesired actions – actions that promote safety, as well as actions that can reduce safety.

- When our safety thinking systematically restricts the data we collect and analyze, it
  - Restricts our opportunities to learn, and it
  - Affects our policies and decision making.

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Holbrook, J. (2018, April). *Human performance contributions to safety in commercial aviation* [PowerPoint presentation]. NASA Ames Research Center, Moffett Field, CA.

A thought experiment

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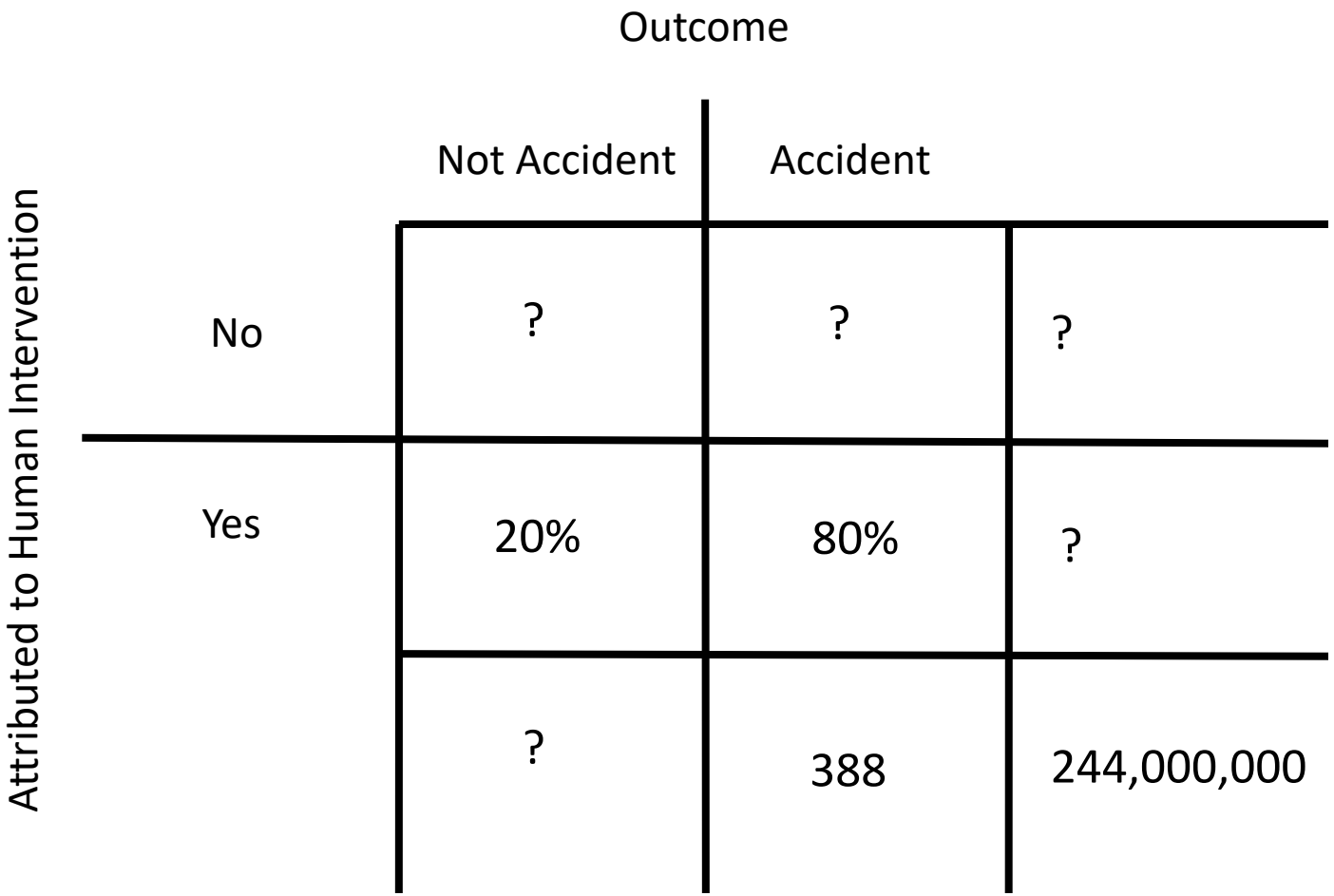
- World-wide jet data from 2007-2016 (Boeing, 2016)
  - 244 million departures
  - 388 accidents

A thought experiment



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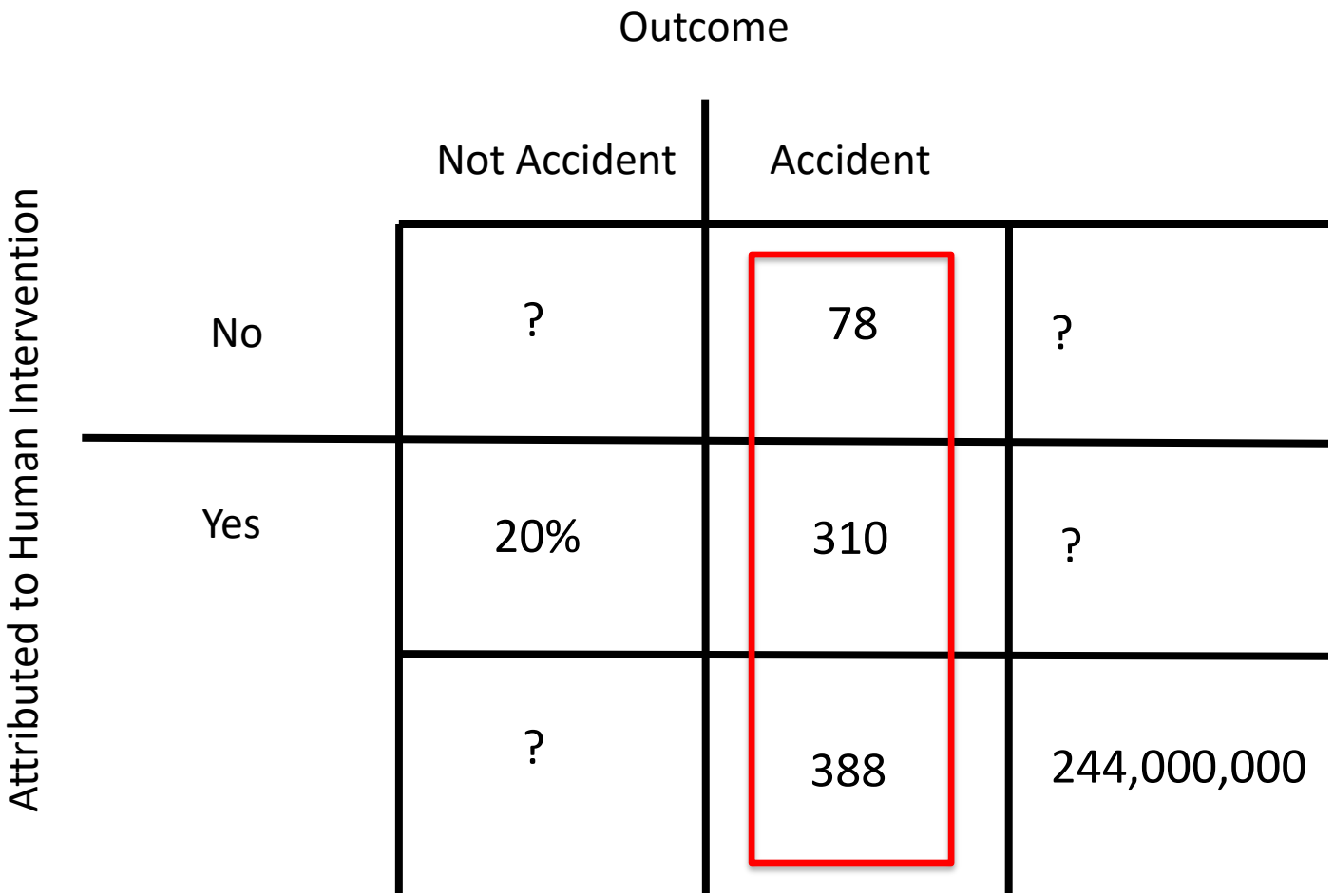

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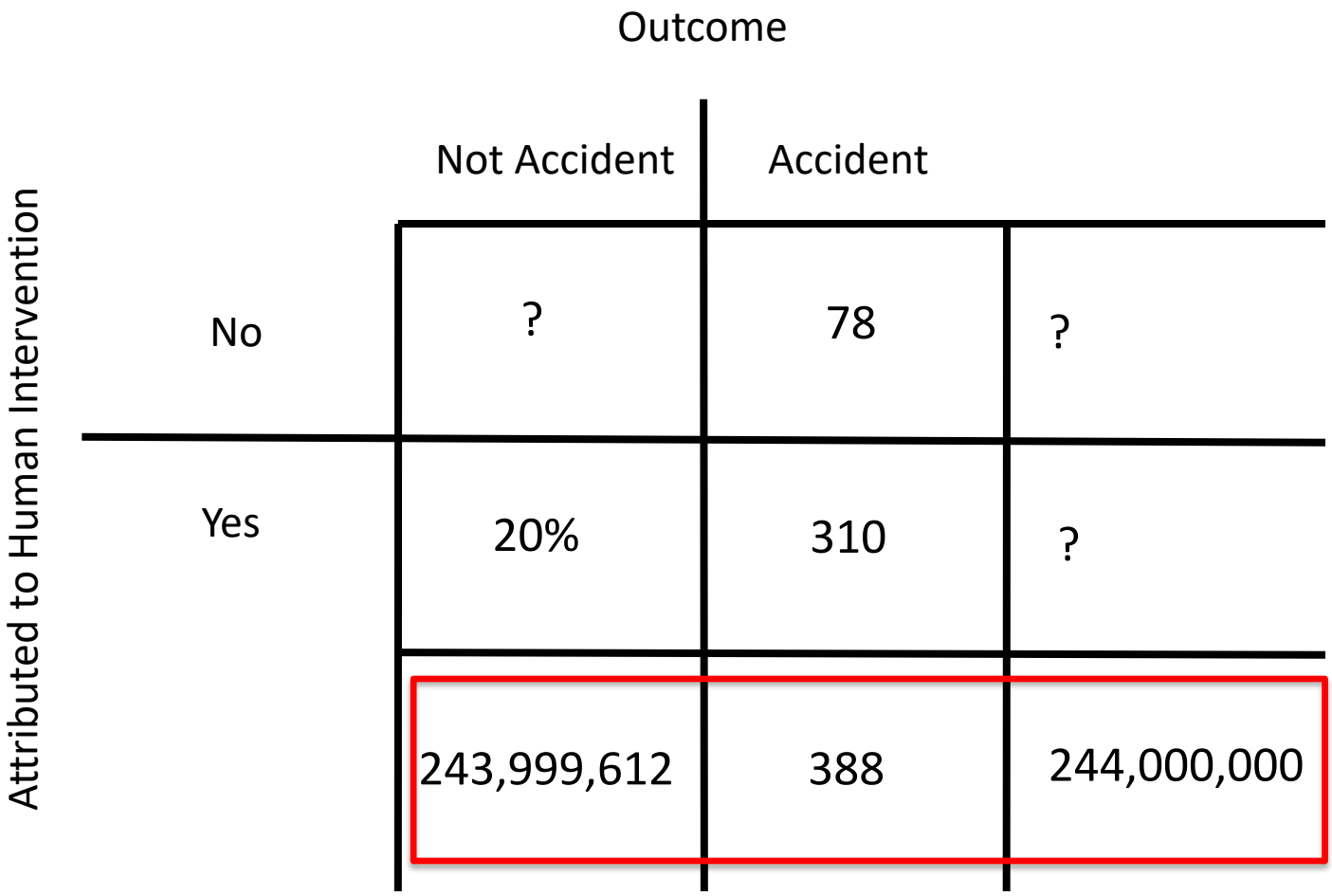

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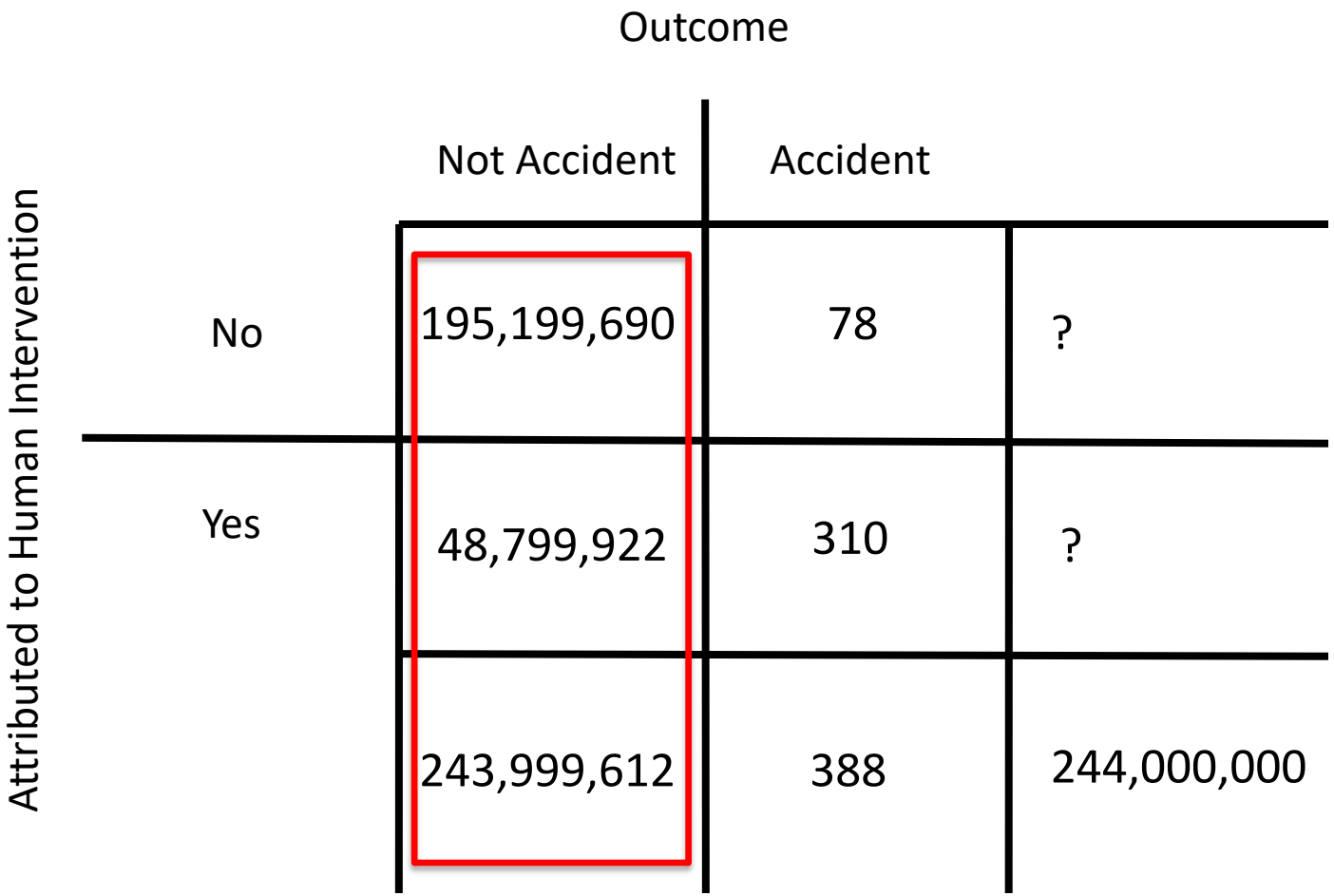

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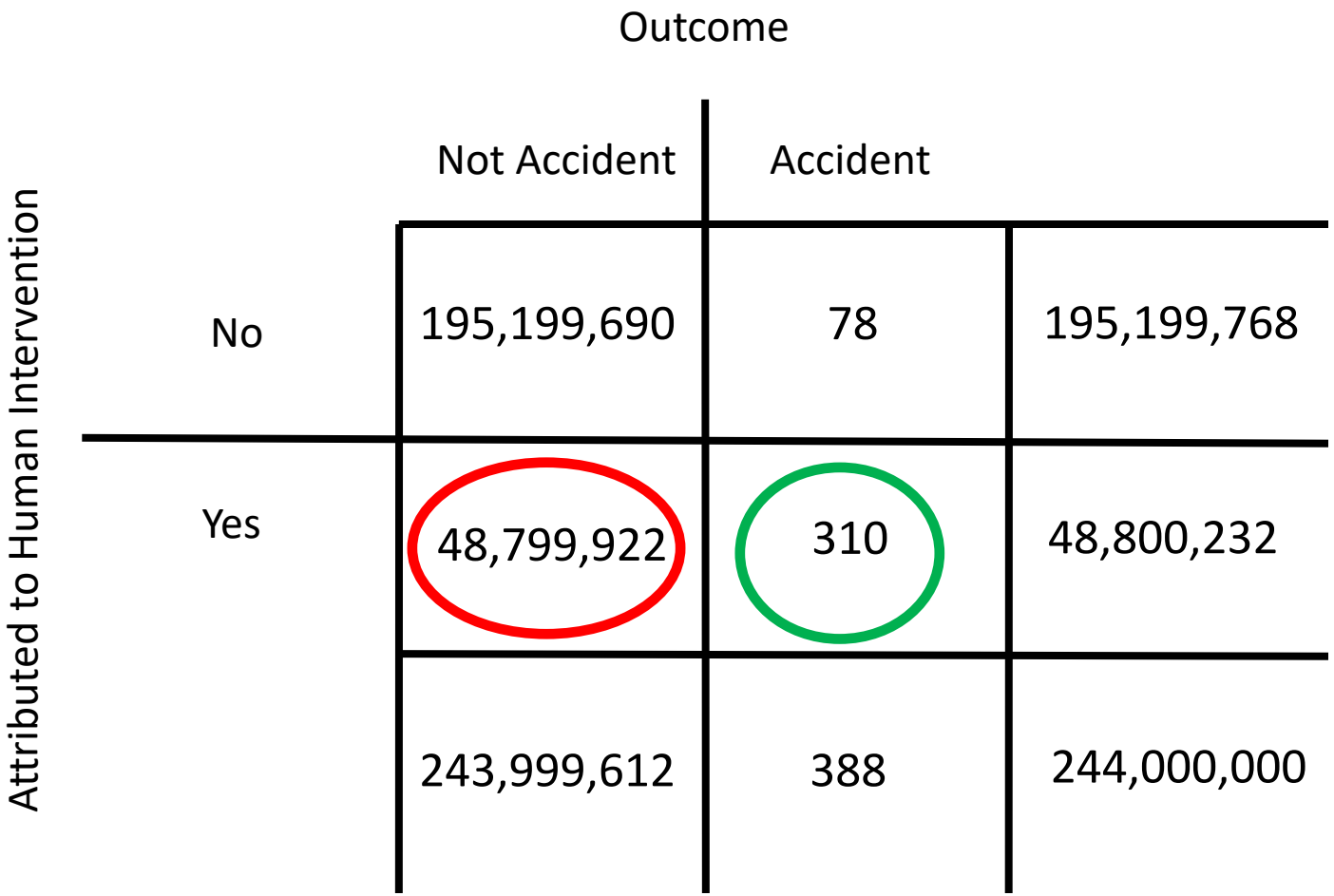

When we characterize safety only in terms of errors and failures, we ignore the vast majority of human impacts on the system.

A Couple of Problems with our Assumptions

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Pilots intervene in various ways on 100% of flights!

Our thinking affects our policies and plans

- When policy decisions are based only on failure data, they are based on a very small sample of non-representative data
  - Without understanding the mechanisms by which problems are solved, any estimate or claim about the predicted safety of autonomous machine capabilities is inherently suspect.
  - Removing the human demonstrated reliable source of safety-producing behavior without first understanding the capability being removed introduces unknown risks.

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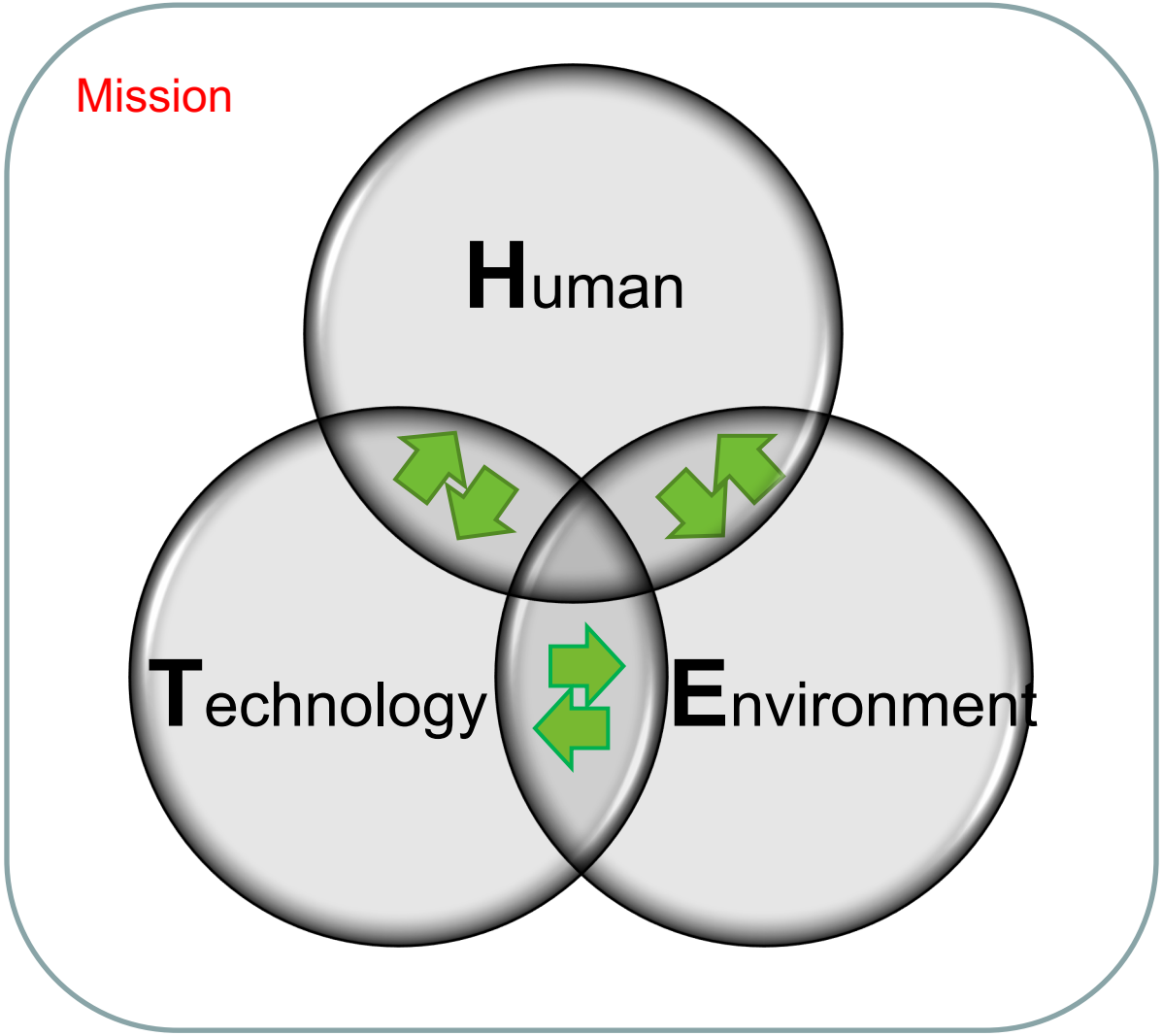
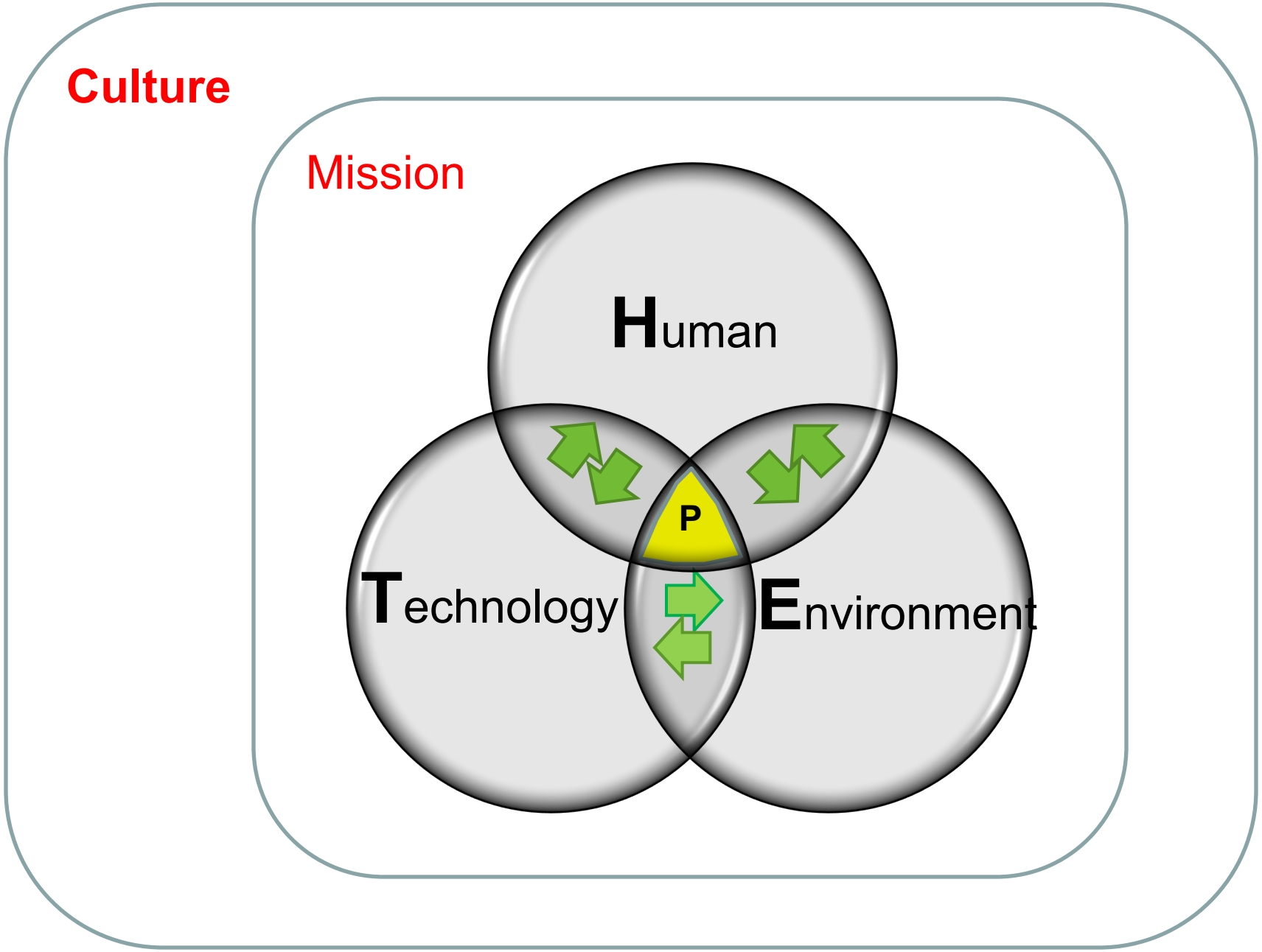
Guiding the Operation.
But how?

- By understanding the complexity of the operation and of the operator.
- By creating a clear, coherent, consistent, and comprehensive guidance throughout.
- The 4C's, THE Model, and the 4P's.



THE Model



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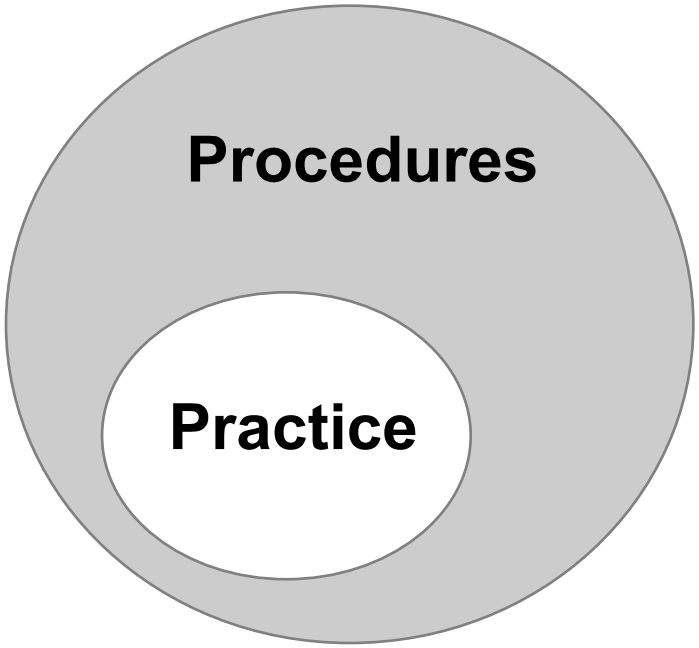
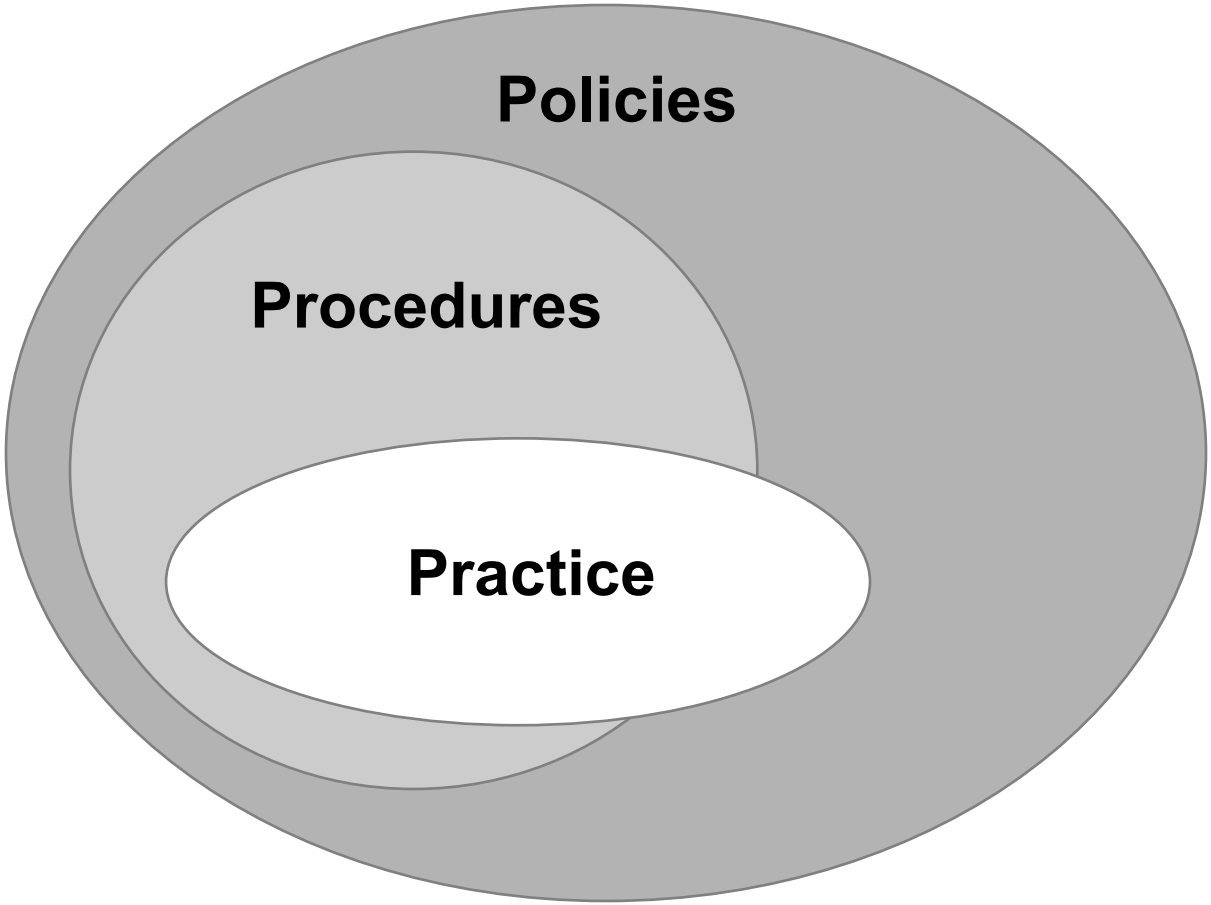

Procedures
Practice


Policies
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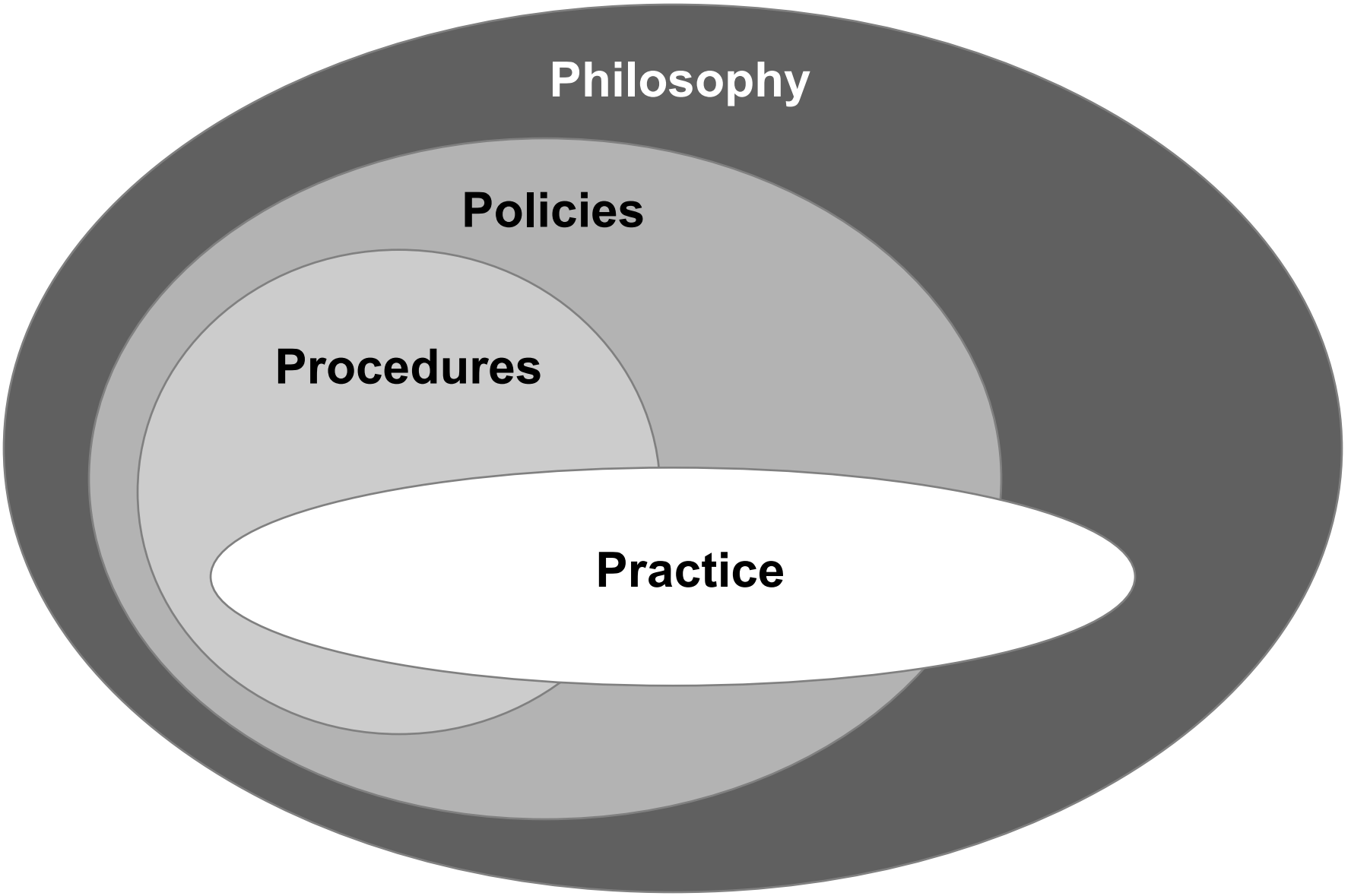
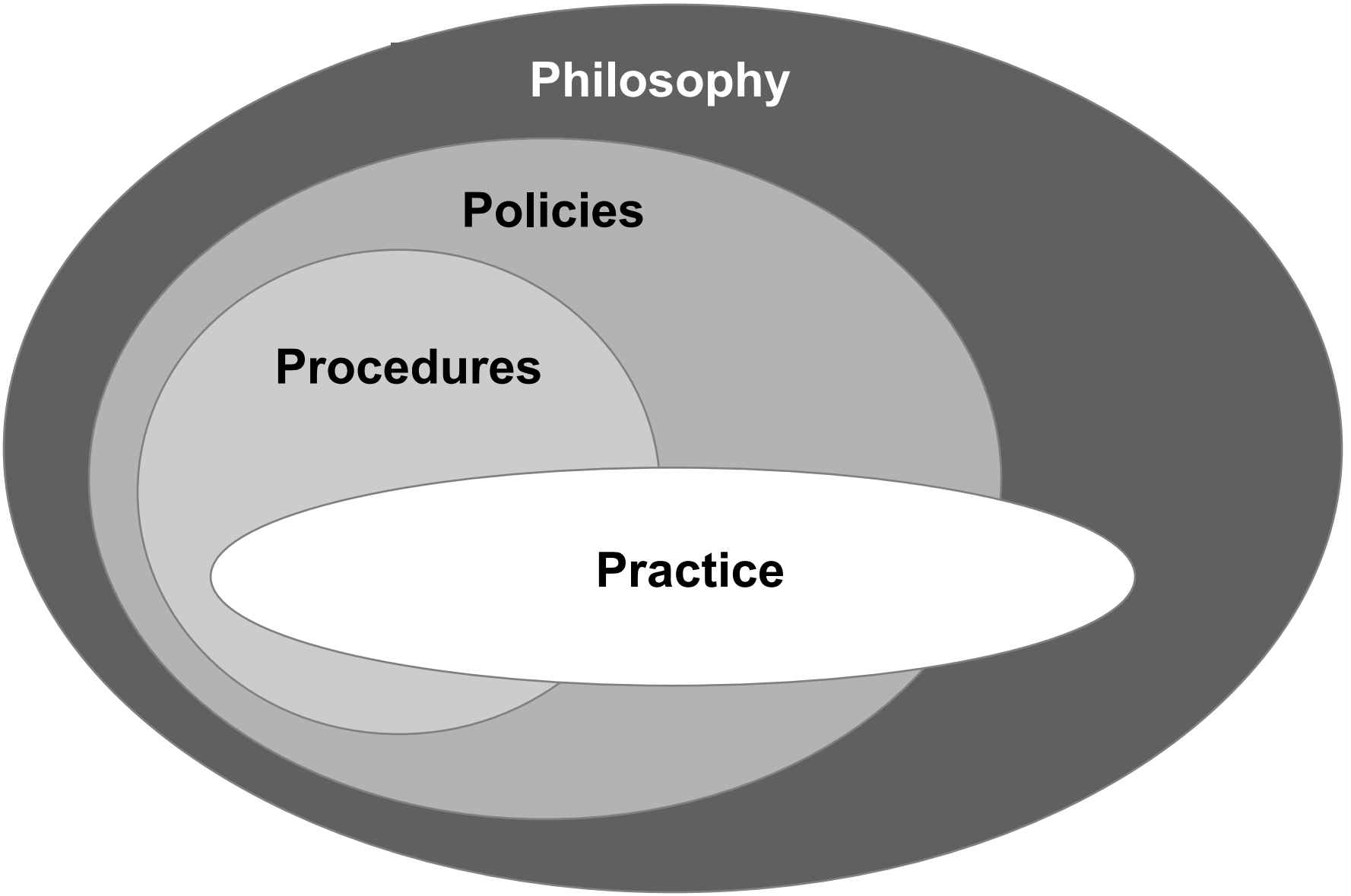

Philosophy
Policies
Procedures
Practice

The 4P's



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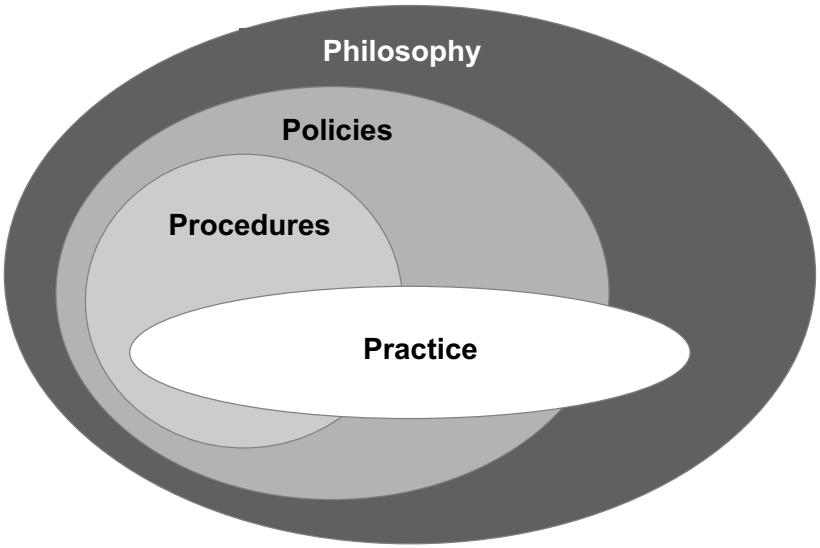


- Not a theoretical model.
- The result of observations.
- That's the way it's out there right now.
- The question is whether you want to make it explicit or not.

Figure 1. Mean Number of Problems on Target Items per Flight

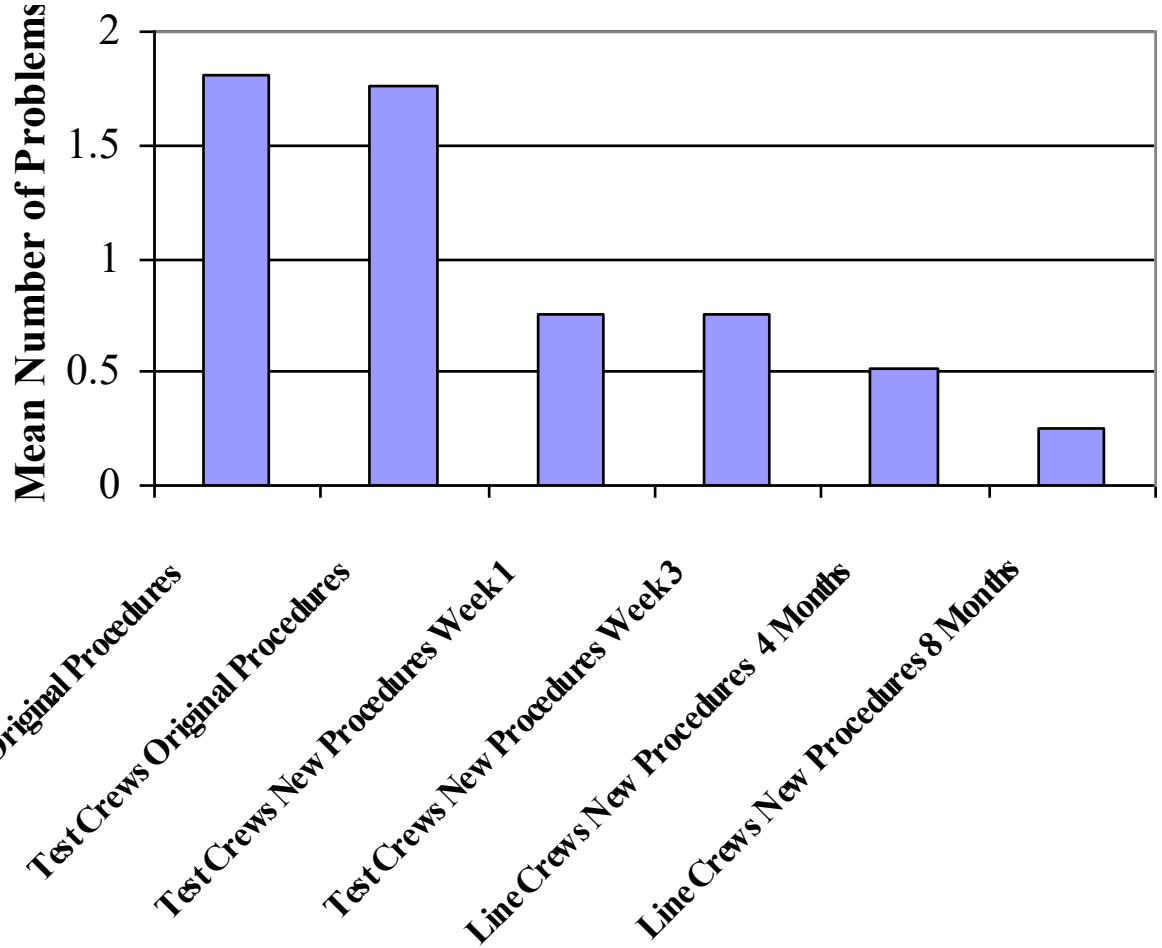


Figure 2. Average standard deviation in proportion of problems

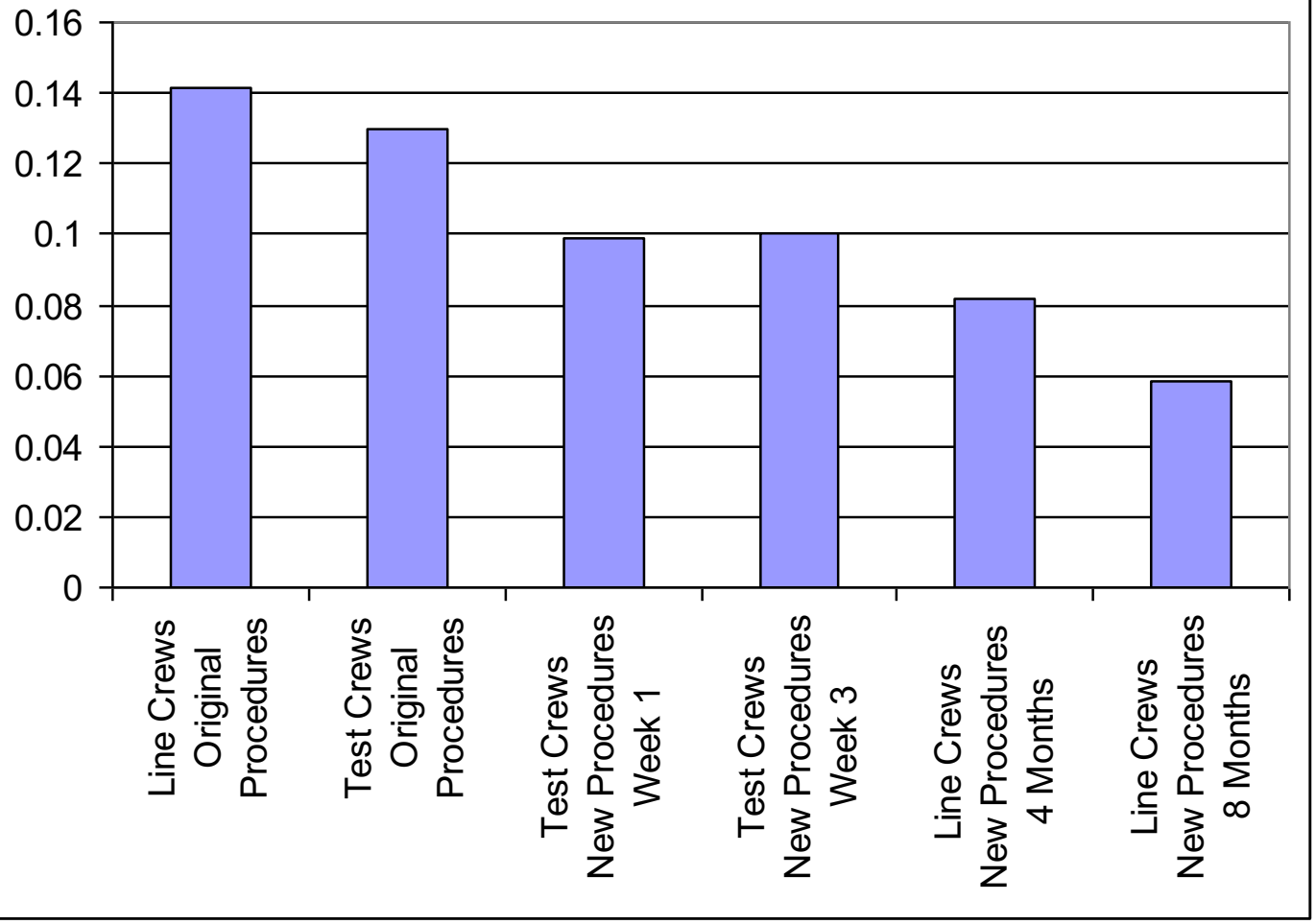
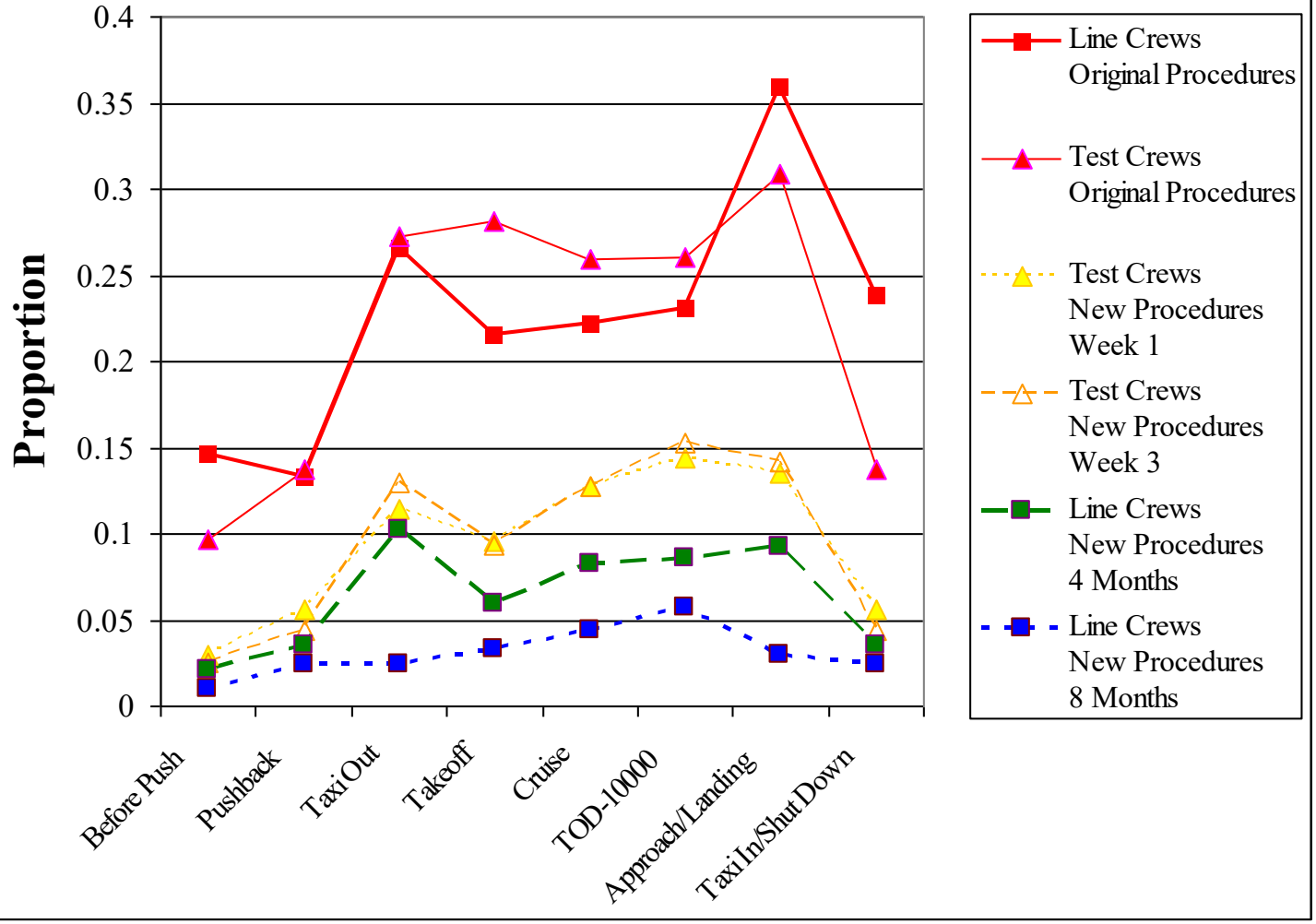


Figure 3. Problems on Target Items by Phase of Flight



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Additional Information:

NASA/TM—2016–219421

NASA

Designing Flightdeck Procedures

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October 2016

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Designing Flightdeck Procedures: Literature Resources

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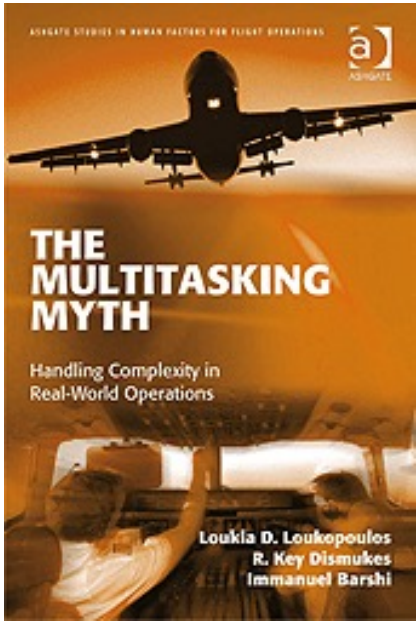

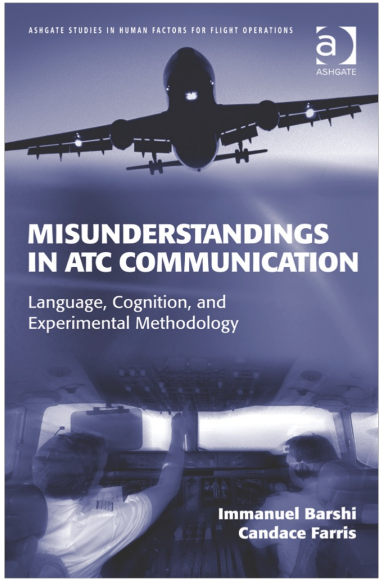

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Thank you!

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