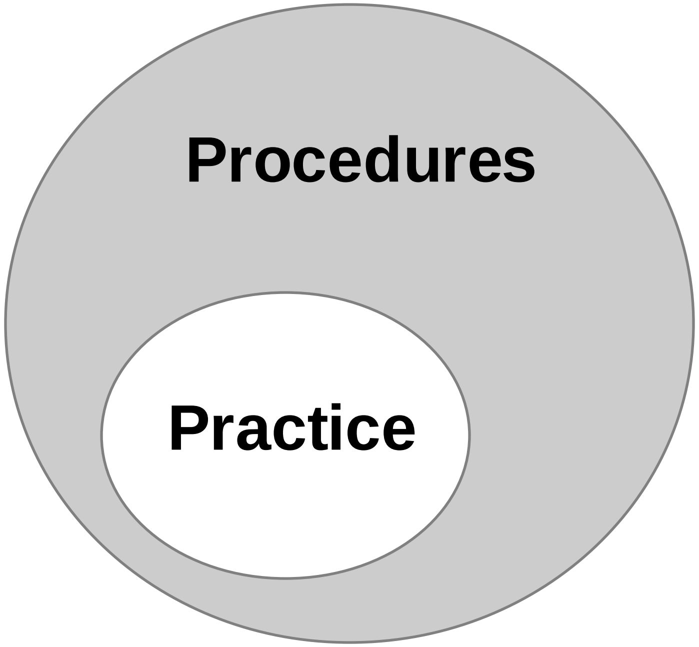
Why Didn't They Just Follow the Procedure?

Webinar
January 30th, 2025

Human Systems
integration division

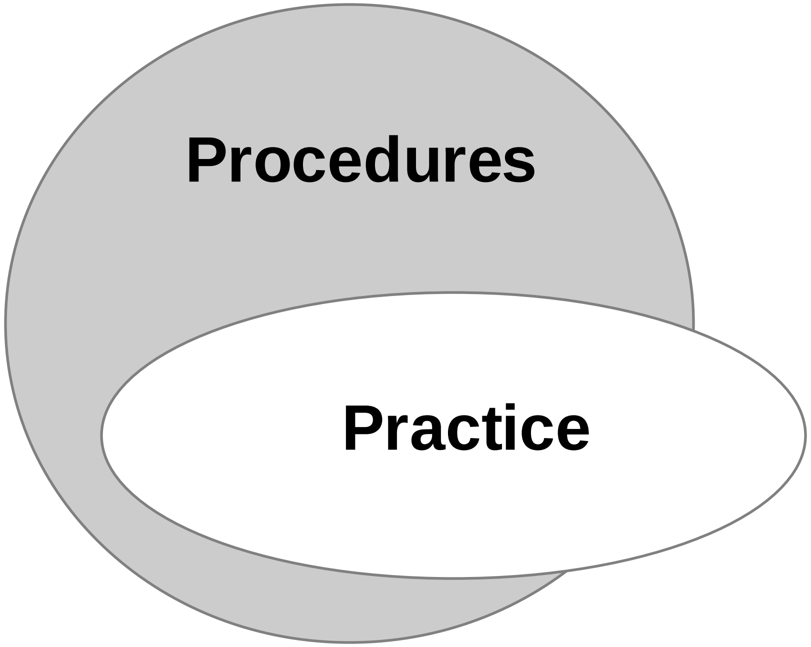
Immanuel Barshi, NASA Ames Research Center

Practice



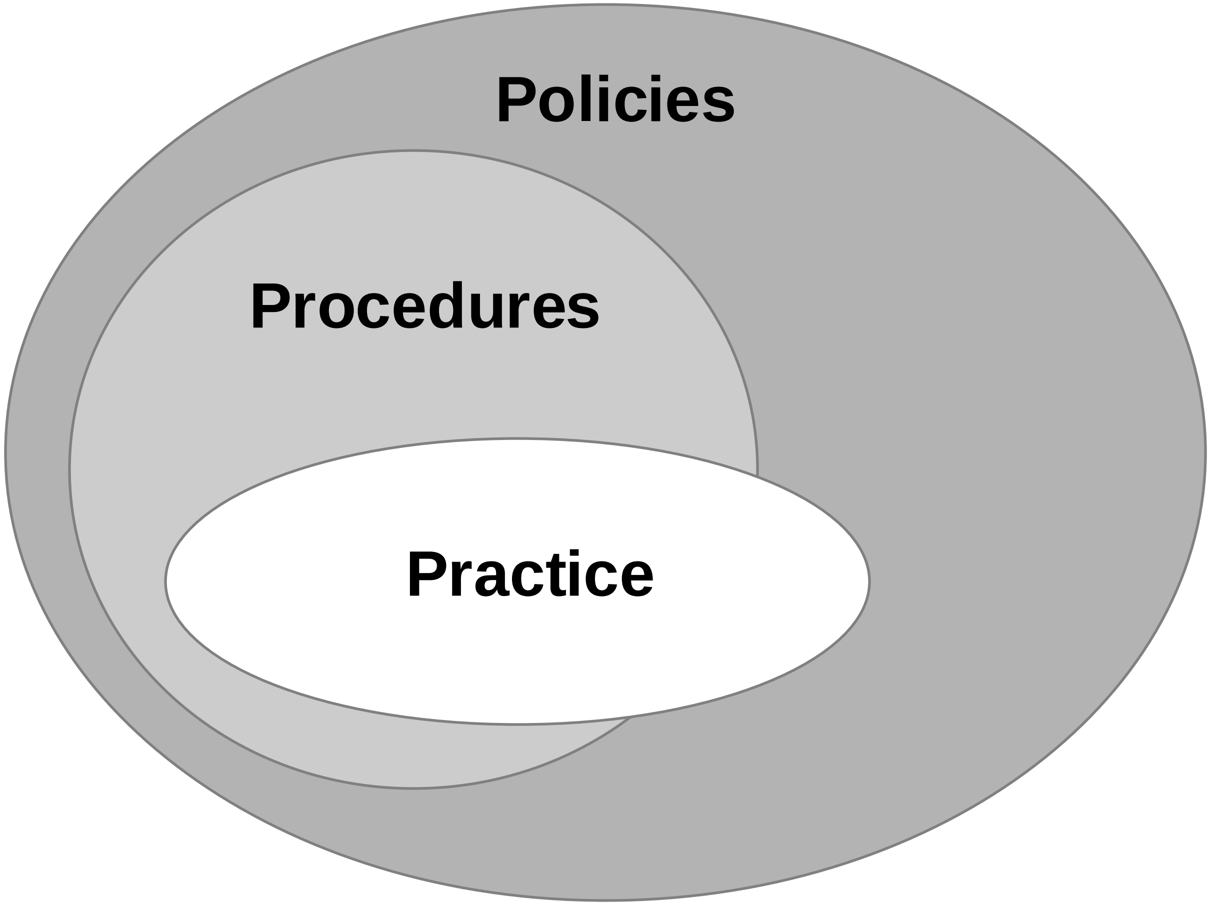
Procedures

Practice



Procedures

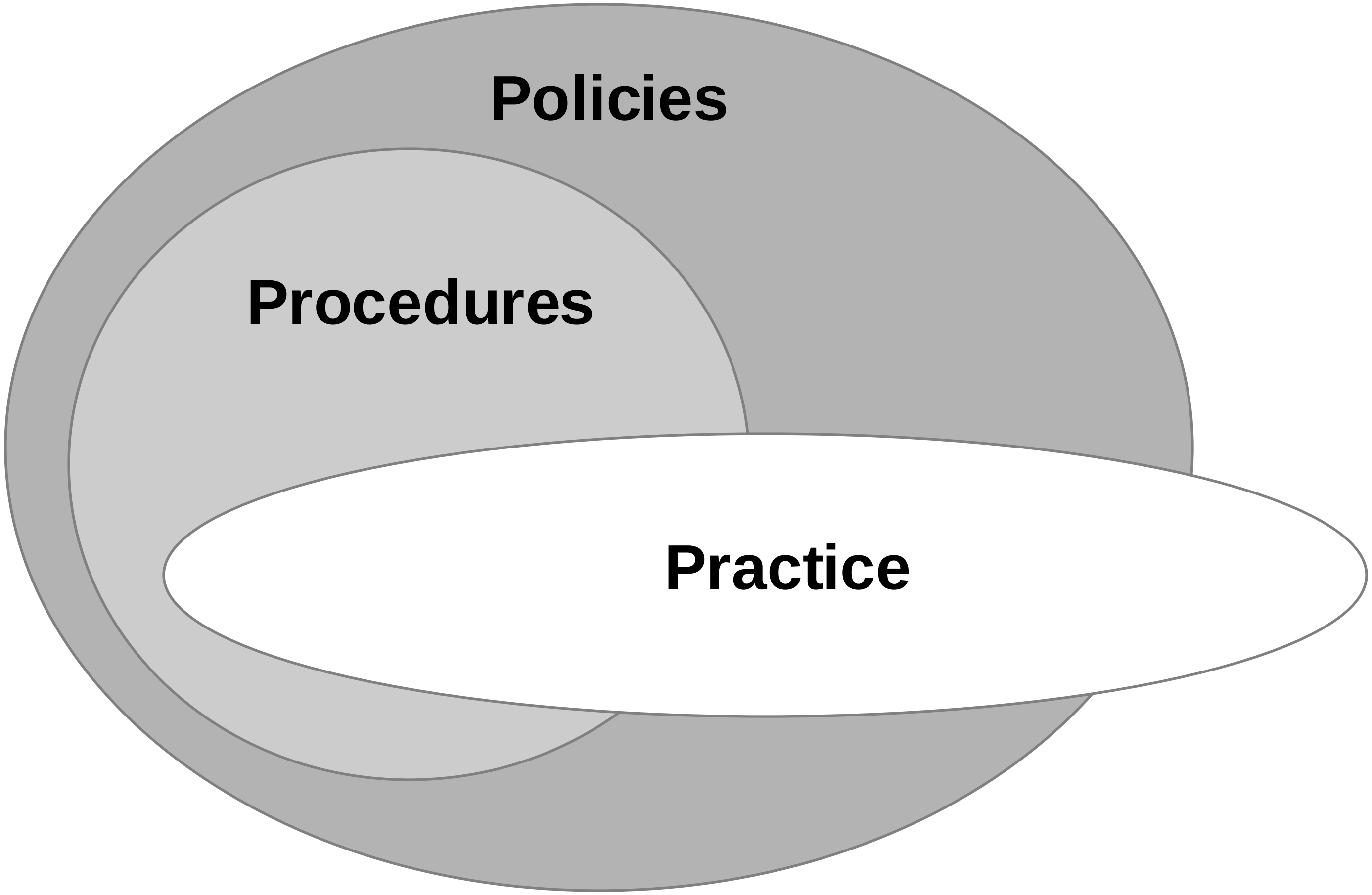
Practice



Policies

Procedures

Practice



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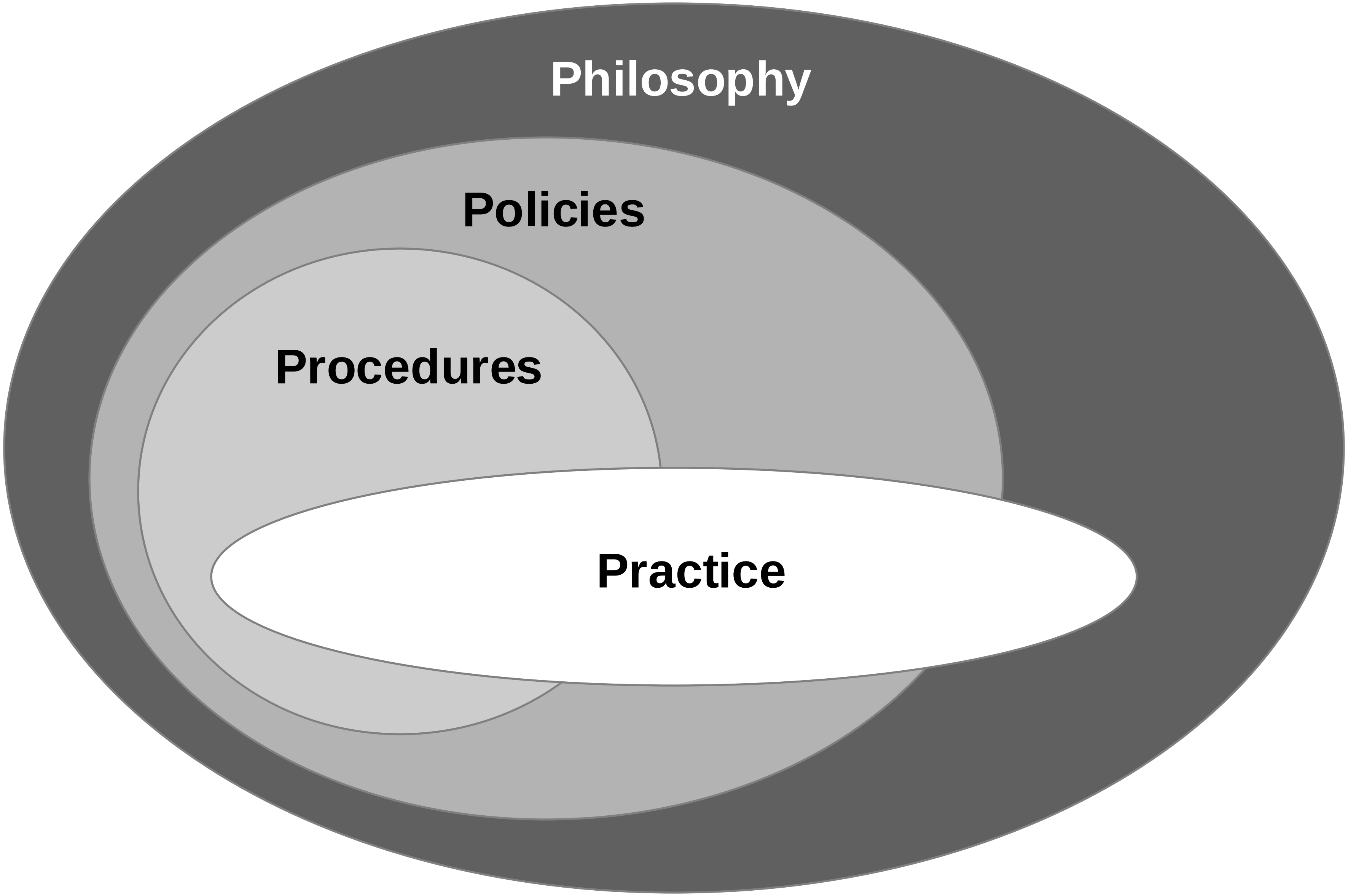
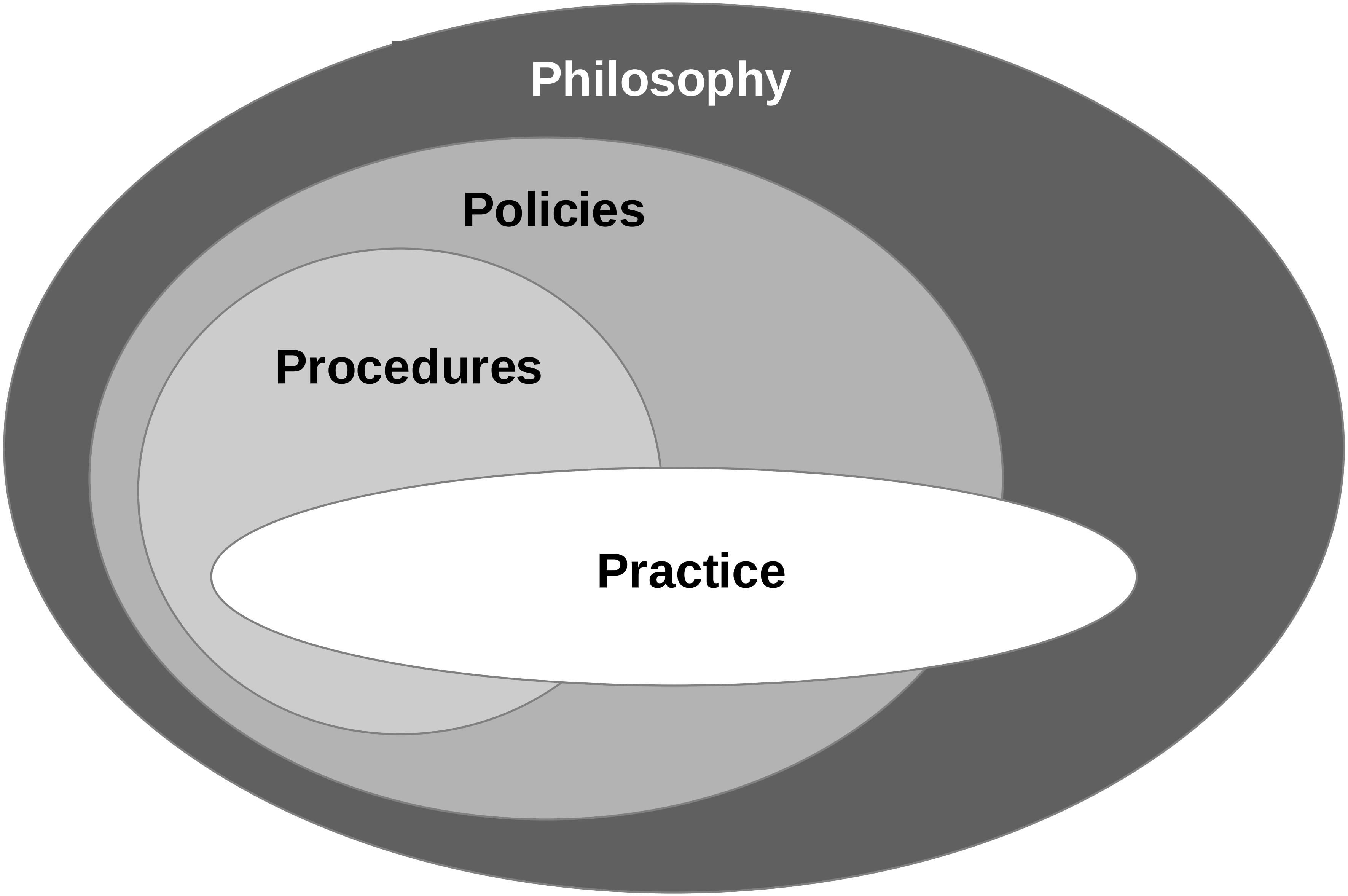

Philosophy
Policies
Procedures
Practice

The 4P’s



Philosophy

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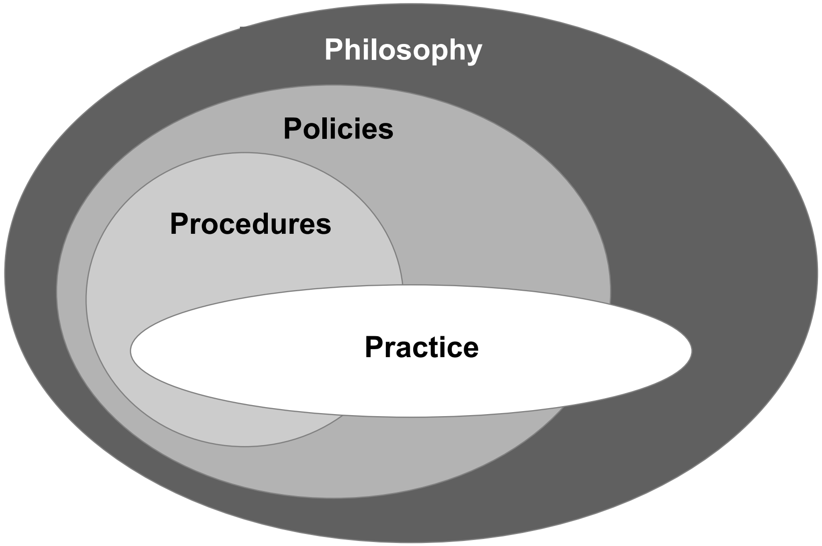
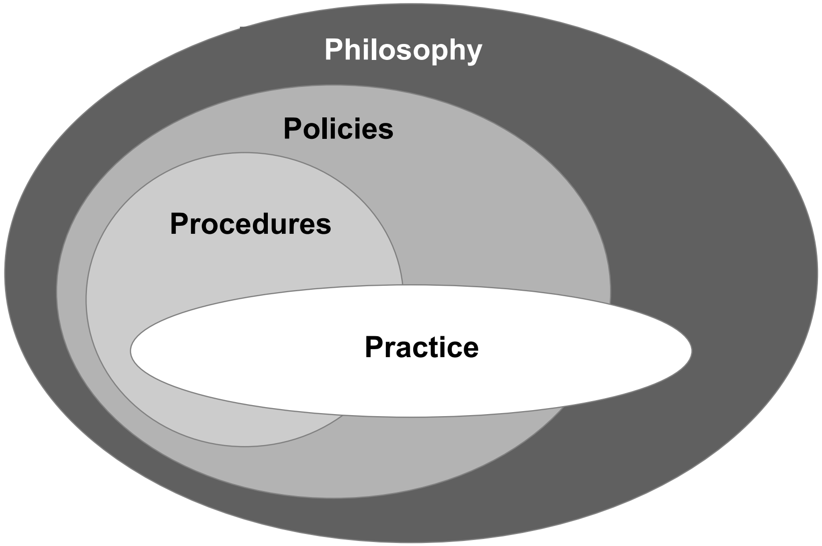
The 4P's



- Not a theoretical model.

The 4P’s



Philosophy

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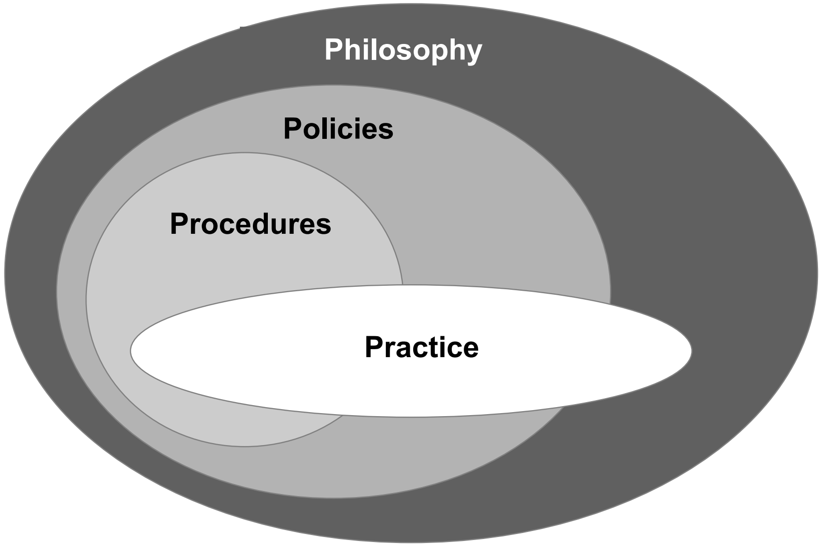
- Not a theoretical model.
- The result of observations.

The 4P’s



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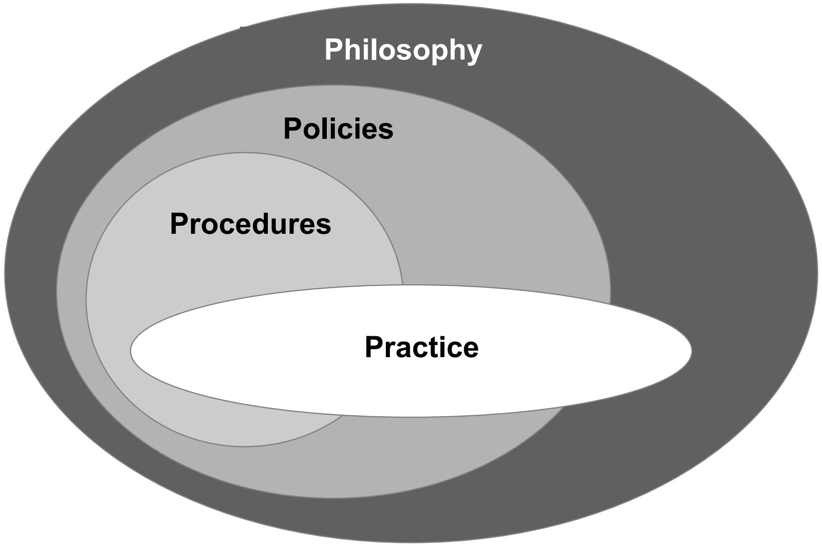
- The result of observations.
- That’s the way it’s out there right now.

The 4P's



Philosophy

Policies

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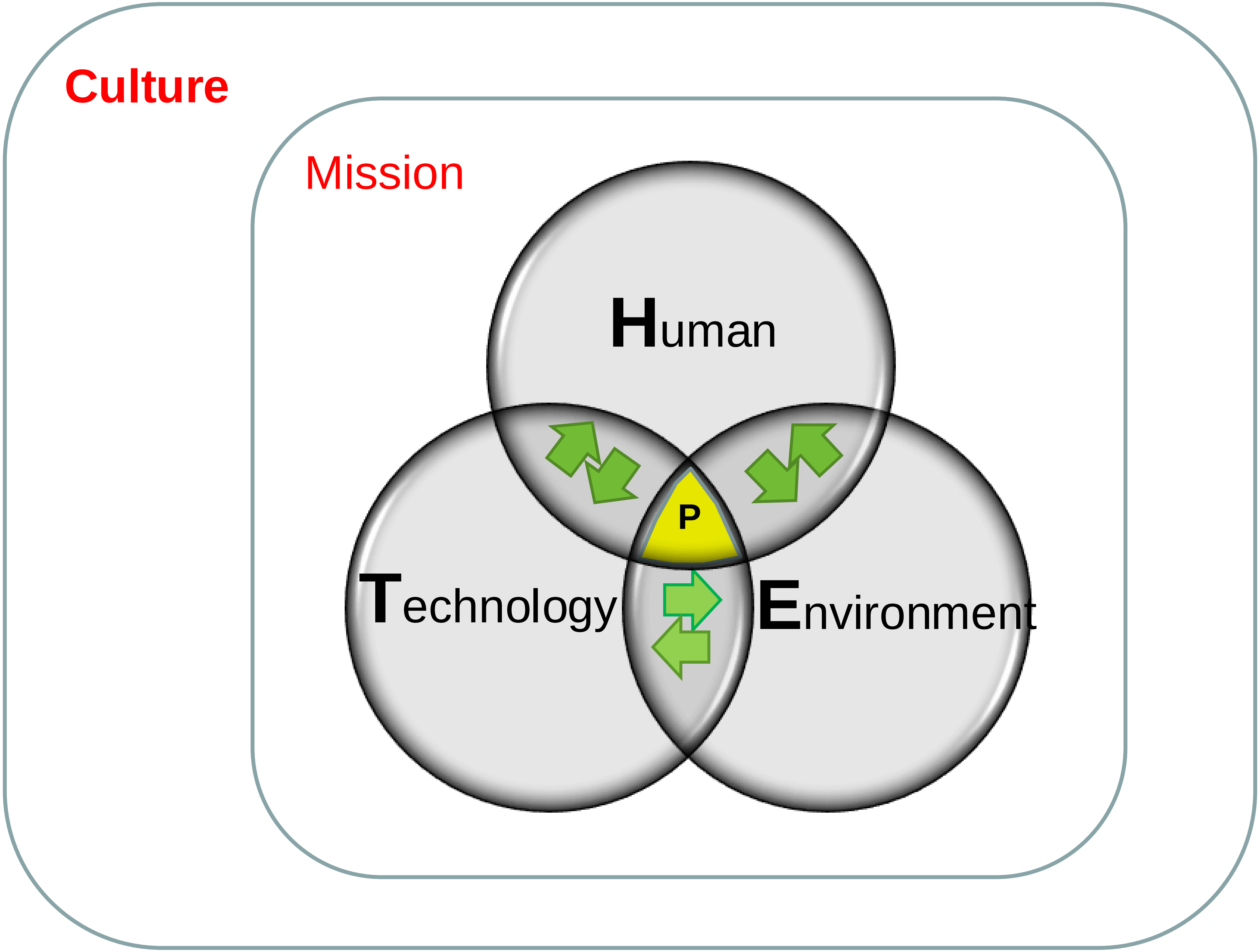
- Not a theoretical model.
- The result of observations.
- That's the way it's out there right now.
- The question is whether you want to make it explicit or not.



THE Model

- Human error has been implicated in up to 80% of accidents in civil and military aviation[1]

Learn more: Holbrook, J. (2021). Exploring methods to collect and analyze data on human contributions to aviation safety. In *Proceedings of the 2021 International Symposium on Aviation Psychology.* *https://aviation-psychology.org/wp-content/uploads/2021/05/ISAP_2021_Proceedings_FINAL.pdf*

- Human error has been implicated in up to 80% of accidents in civil and military aviation[1]

Attributed to Human Intervention	Outcome		
	Not Accident	Accident	
No	?	20%	?
Yes	?	**80%**	?
	?	?	?

- Human error has been implicated in up to 80% of accidents in civil and military aviation[1]

- Pilots intervene to manage aircraft malfunctions on 20% of normal flights[2]

		Outcome		
		Not Accident	Accident	
Attributed to Human Intervention	No	80%	20%	?
	Yes	**20%**	**80%**	?
		?	?	?

- Human error has been implicated in up to 80% of accidents in civil and military aviation[1]

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- World-wide jet data from 2007-2016[3]
  - 244 million departures
  - 388 accidents

Attributed to Human Intervention	**Outcome**		
	Not Accident	Accident	
No	80%	20%	?
Yes	**20%**	**80%**	?
	243,999,612	**388**	**244,000,000**

(1) Weigmann & Shappell, 2003; (2) PARC/CAST, 2013; (3) Boeing, 2017

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Attributed to Human Intervention	Outcome		
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No	195,199,690	78	195,199,768
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Pilots *Produce* Safety Far More Often than They *Reduce* It

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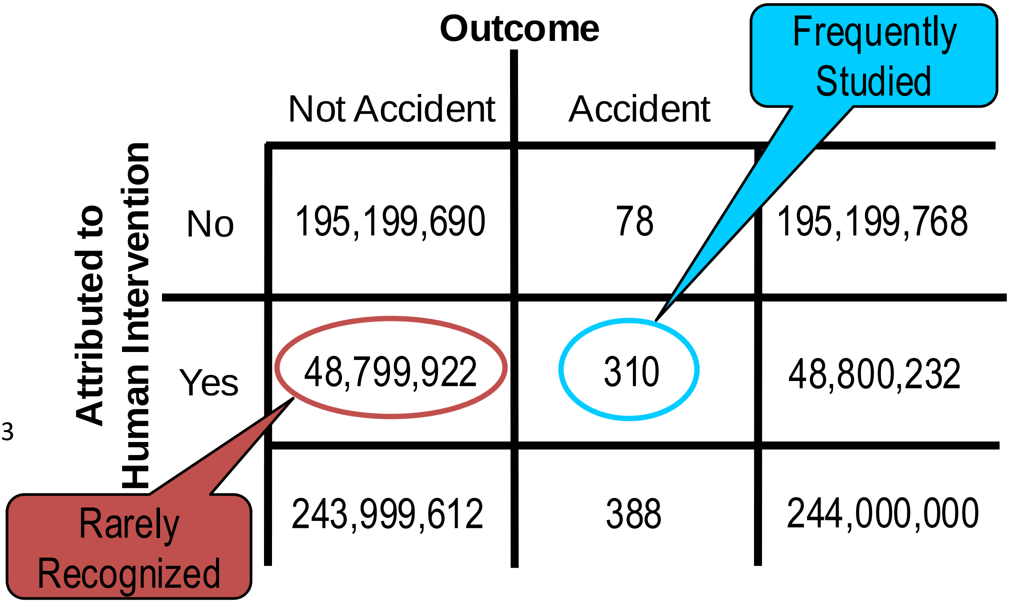

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Frequently Studied

Rarely Recognized

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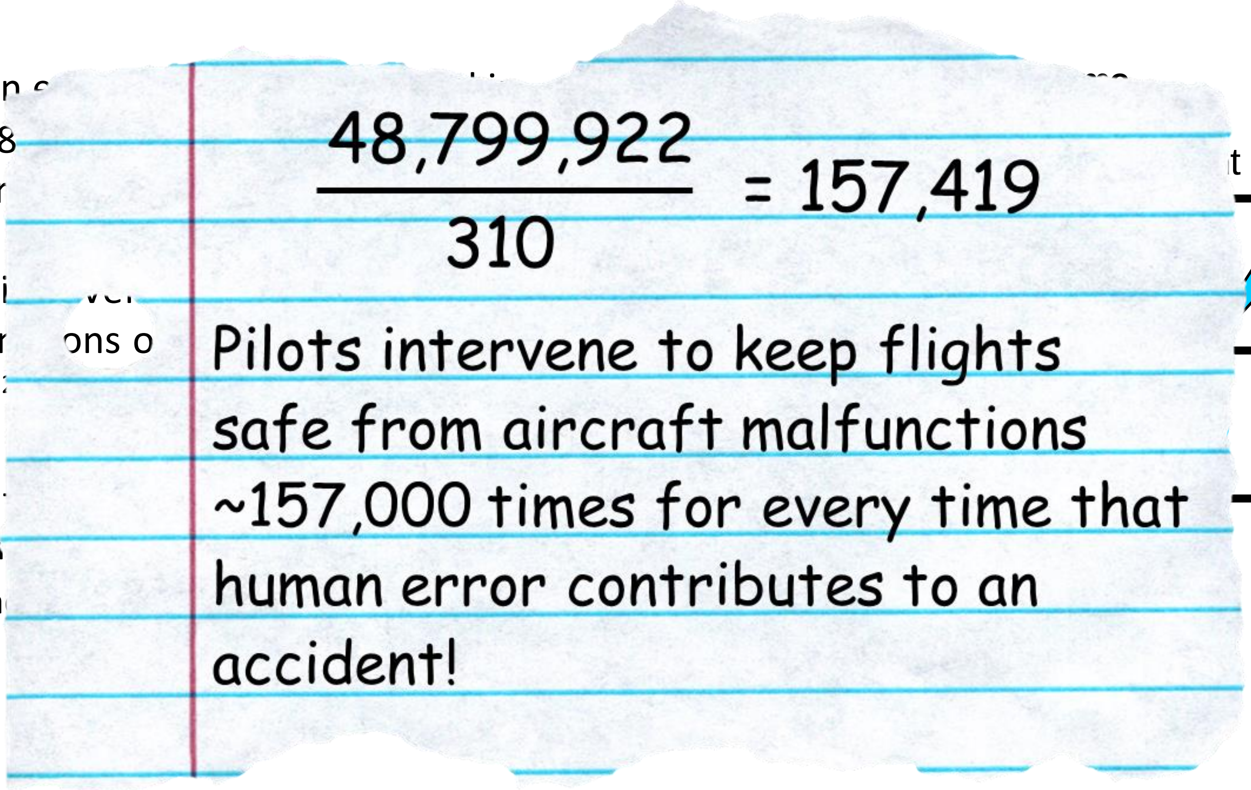

$$\frac{48{,}799{,}922}{310} = 157{,}419$$

Pilots intervene to keep flights safe from aircraft malfunctions ~157,000 times for every time that human error contributes to an accident!

Frequently Studied

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Revisiting Our Assumptions on Human Performance

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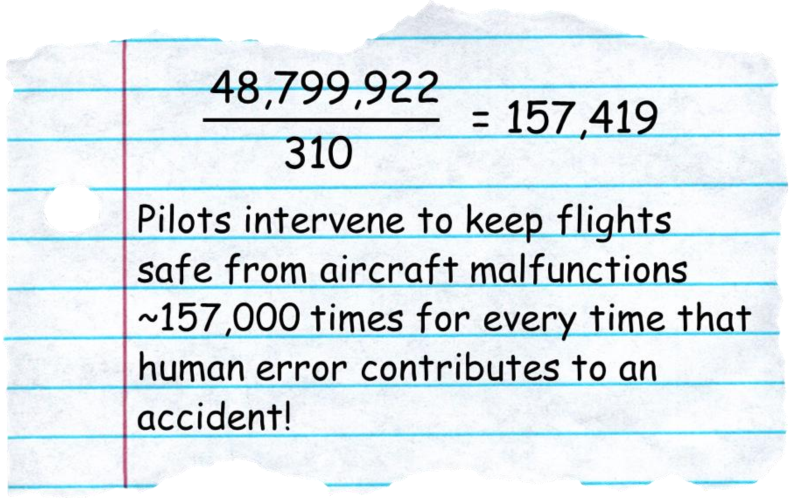
Pilots intervene in various ways on 100% of flights!

Revisiting Our Assumptions on Human Performance



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This is a *conservative* estimate!

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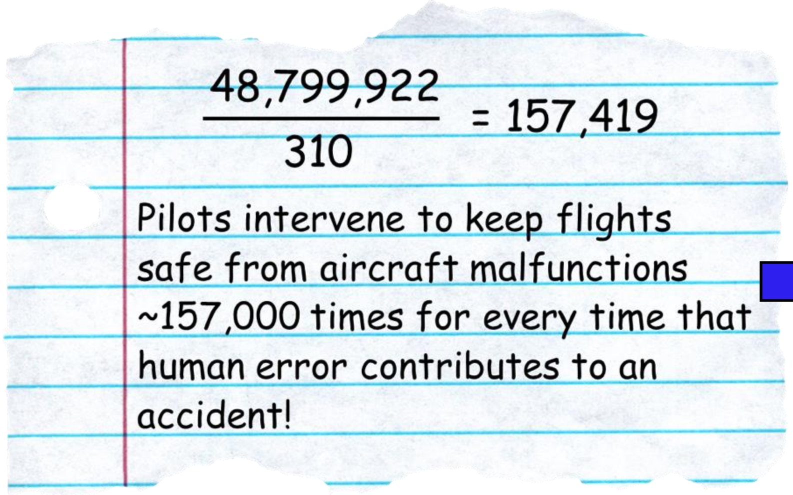

$$\frac{48,799,922}{310} = 157,419$$

Pilots intervene to keep flights safe from aircraft malfunctions ~157,000 times for every time that human error contributes to an accident!

(All non-accidents)

$$\frac{243,999,612}{388} = 628,865$$

(All accidents)

Human capabilities keep flights safe more than **628,865** times for every time that a human limitation contributes to an accident!

This is a *conservative* estimate!

This estimate is more indicative of operational realities!

Consequences of Focusing on Human Error

- Designs intended to “protect” the system from “error-prone” humans can design *out* the capability for humans to effectively intervene/adapt, which is a far more common behavior than error.

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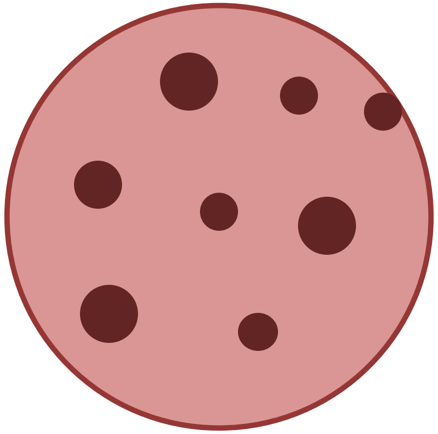
- Designs intended to "protect" the system from "error-prone" humans can design *out* the capability for humans to effectively intervene/adapt, which is a far more common behavior than error.
- Automation levels are only increasing
  - Until automation designers acknowledge and consider that operators can intervene to *cause* safety, every increase in automation adds to the risk of
    - Isolating the operator from the system
    - Limiting the operator's adaptive capacity and capability

Absence of evidence ≠ evidence of absence

A Debatable Claim: *“To fast-forward to the safest possible operational state for vertical takeoff and landing vehicles, network operators will be interested in the path that realizes full autonomy as quickly as possible.” (Uber, 2016)* 🤔

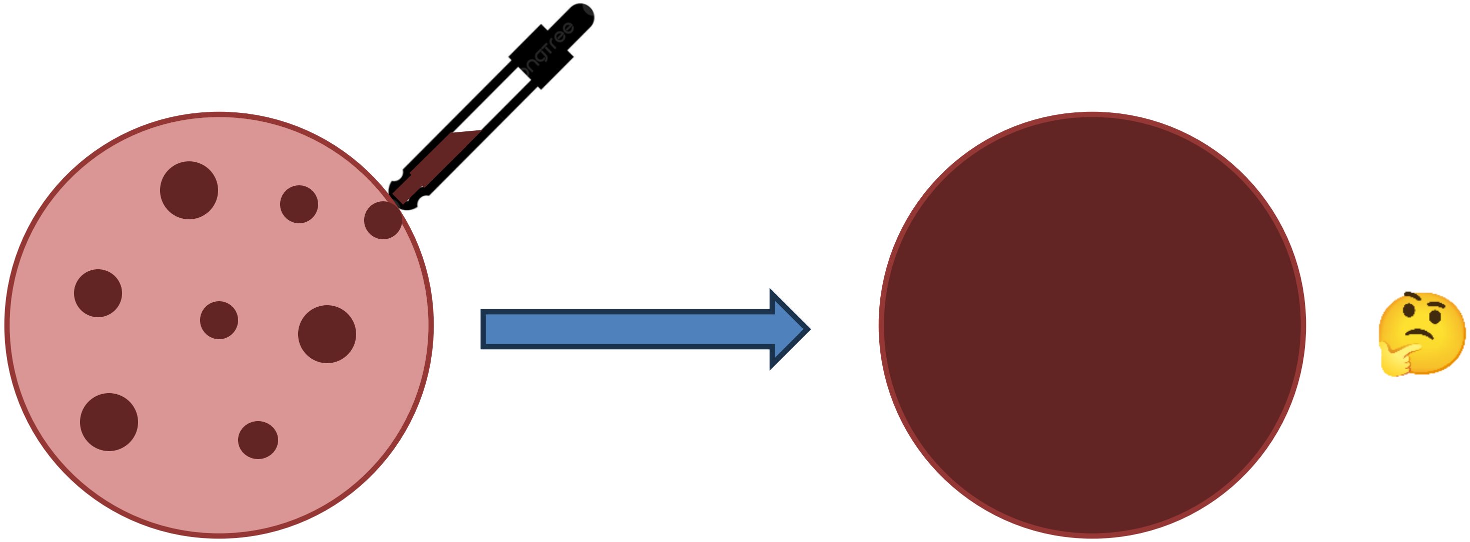
- When we characterize safety only in terms of errors and failures, we ignore the vast majority of human impacts on the system.
- When policy decisions are based only on failure data, they are based on a non-representative sample.

Food for Thought



Suppose we want to understand chocolate chip cookies, because they are desirable, and we want to have more.

Food for Thought



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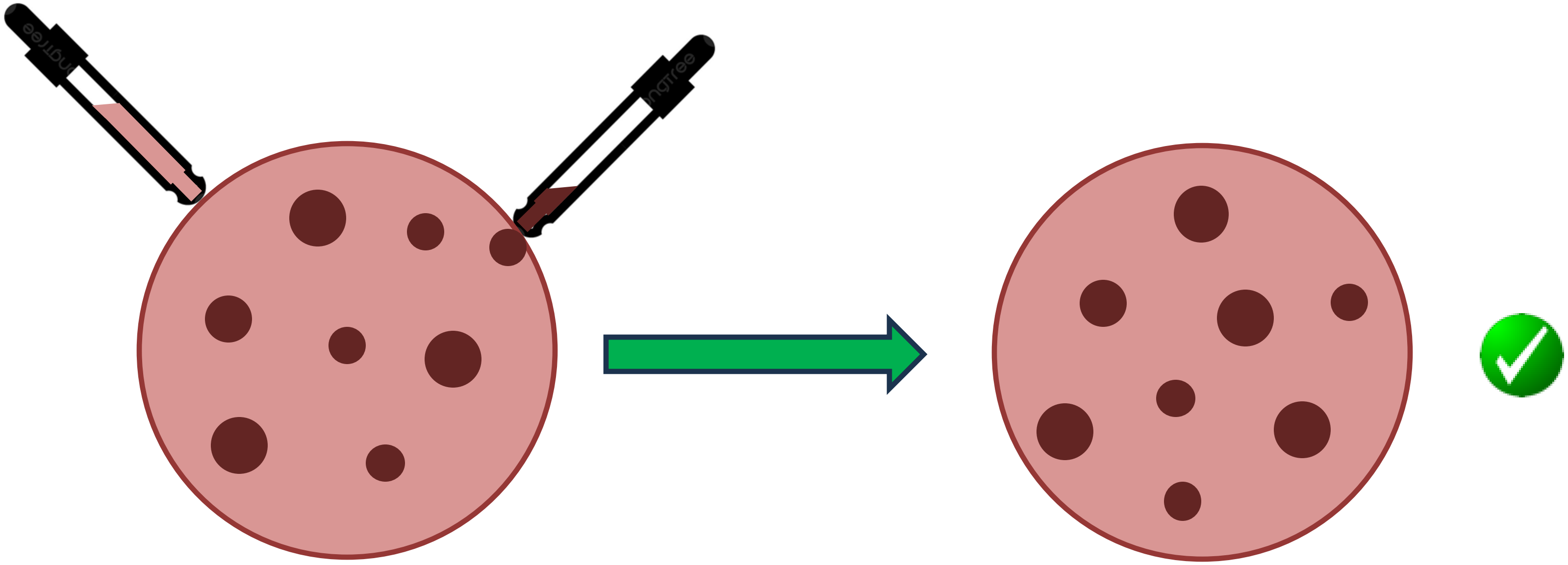

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An operational example

Suppose we want to understand ***safety***,
because it is desirable, and we want to have more.

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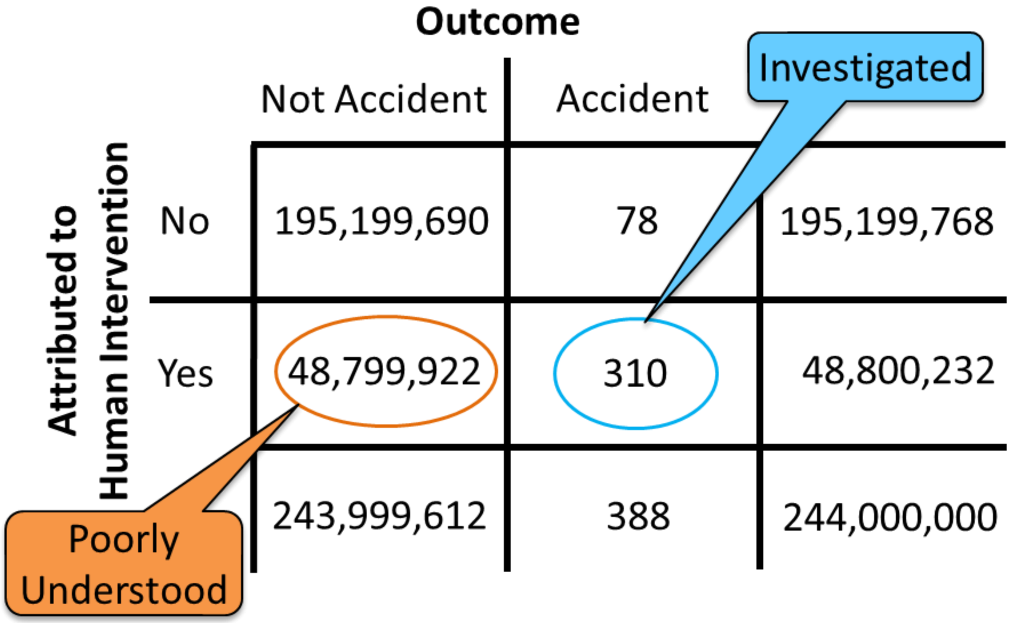

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Consequences for you

- How do you see the focus on human error in your work?

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- How do you see the focus on human error in your work?
- How would you change the narrative about the role of the human in operations?
- What activities can you initiate that would support that change?

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).
- That’s what “resilience” is all about.

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.

How to "Change the Narrative…"

…that people are the safety problem

- Designs intended to "protect" the system from "error-prone" humans can design-out the capability for the human to effectively intervene/adapt, which is a far more common behavior.

- Designs intended to replace humans often fail to acknowledge or understand the capabilities that humans routinely contribute to safety, and therefore fail (or don't have the data/knowledge) to design that into the system.

- Designs that leverage a "safety pilot" who will only intervene to "save the day" in rare failure events fail to consider how our cognitive systems work and how they evolved to work. Such designs are setting up the operator to fail.

How to "Change the Narrative…"

…that people are the safety problem

PROPOSED SOLUTION

- In today's industry, *data talks*
- When the only data that are available are about human failure, then data-driven designs only consider that humans fail
- To change the narrative, we need new data and new ways to examine data
  - Specifically, data on how (and the processes by which) humans *contribute* to safety

IMPACTS

- Safer system designs
- Increased organizational awareness
- Improved operational learning/training
- System safety that is robust and resilient to future changes

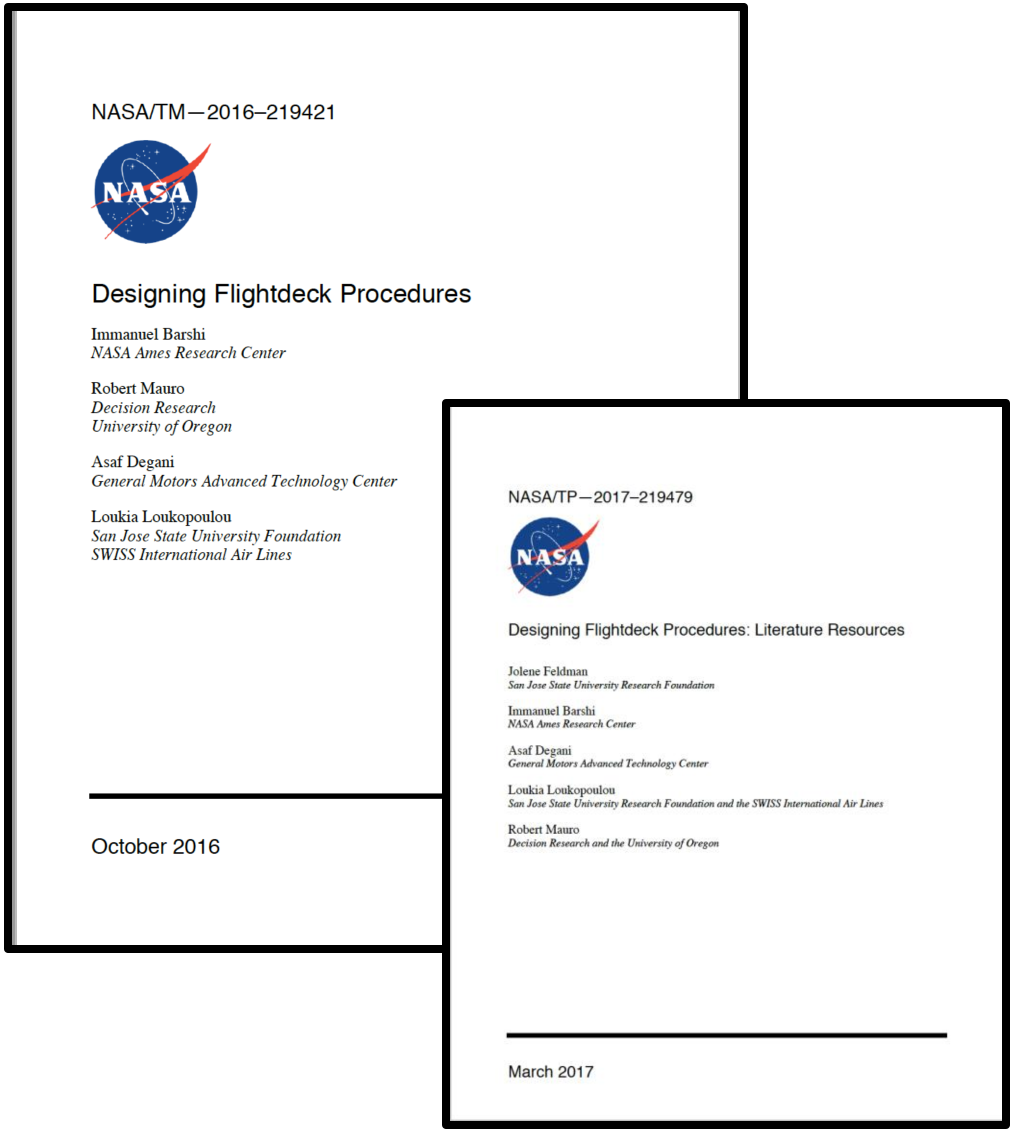
Consequences for you

- How do you see the focus on human error in your work?
- How would you change the narrative about the role of the human in operations?
- What activities can you initiate that would support that change?
- What data would you suggest collecting to help change the narrative?
- How would you collect and analyze such data?
- What will you do differently now?

Regardless of how much automation or autonomy is built into a system,

**all systems are being built
by people for people.**

People will continue to be at the center of all that we do.



NASA/TM—2016–219421

Designing Flightdeck Procedures

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General Motors Advanced Technology Center

Loukia Loukopoulou
San Jose State University Foundation
SWISS International Air Lines

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NASA/TP—2017–219479

Designing Flightdeck Procedures: Literature Resources

Jolene Feldman
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San Jose State University Research Foundation and the SWISS International Air Lines

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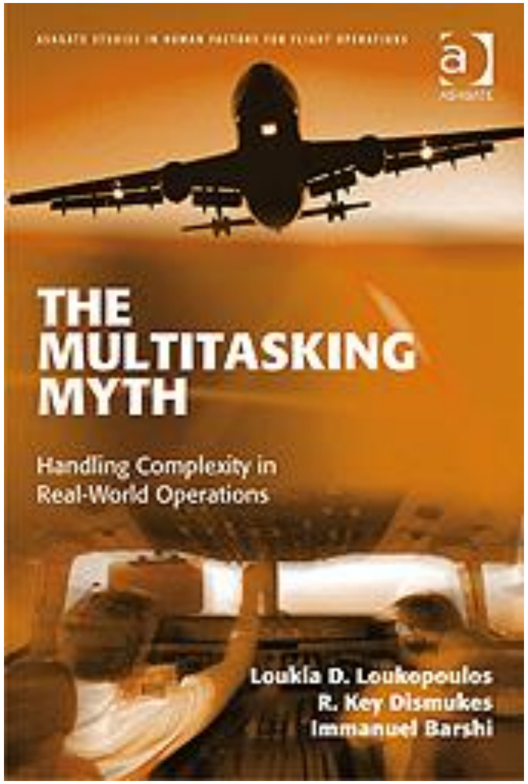

ASHGATE STUDIES IN HUMAN FACTORS FOR FLIGHT OPERATIONS

ASHGATE

THE MULTITASKING MYTH

Handling Complexity in Real-World Operations

Loukia D. Loukopoulos
R. Key Dismukes
Immanuel Barshi

Or contact me:

Immanuel.Barshi@nasa.gov

Thank you!

Human Systems
integration division

Immanuel.Barshi@nasa.gov