Beyond decision making:
Accident reduction in avalanche terrain

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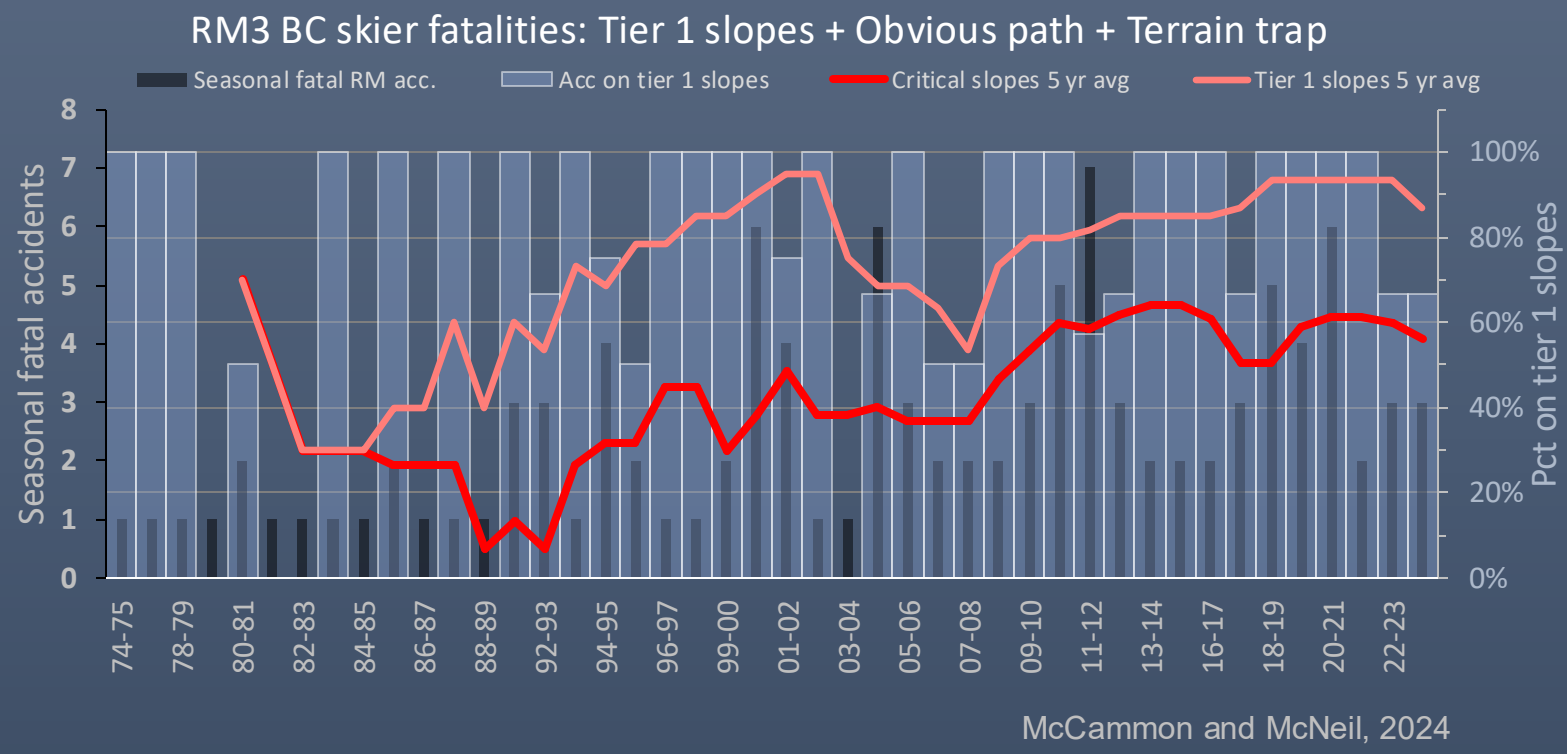
Wilderness Risk Management Workshop
29 September to October 2, 2025
Portland, ME

Problem 1: “Trained” victim errors are increasing



Skilled people getting killed in the very places they were trained to avoid.

Problem 2: Education about decision making is inconsistent

Avalanche Triangle
(Fredston & Fesler, 1984)

"Human Factor" in avalanche classes

- No curriculum consensus
- Data on effectiveness is inconclusive
- Anecdotal data suggests minimal impact
- Proxy data suggests counterproductivity

Dassler, Fjellaksel, McCammon, 2024

What’s not working and why

A fresh approach

How you can apply this information

Accident Models

Acts of God

(~1750 BC)

Today:

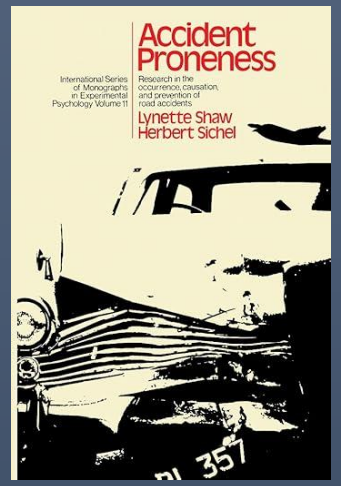
1st person accident reporting

Insurance policies

Consumer agreements

Proneness

(Greenwood and Woods, 1919)



Today:

3rd person accident reporting

Risk propensity (PSM)

Deficit theory

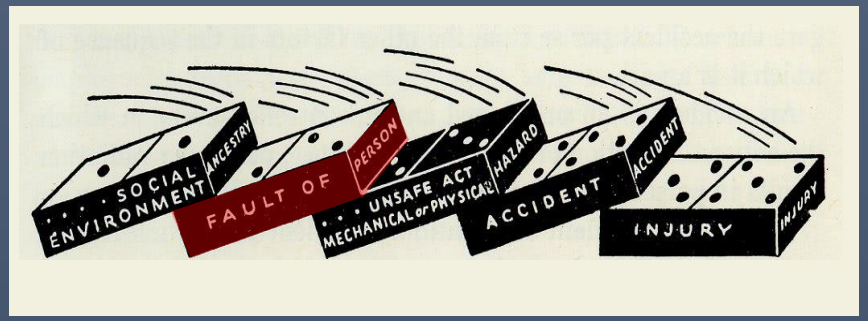
Sensation seeking

Accident Models (cont'd)

Domino Model

AKA Linear Sequential Model

(Heinrich, 1931)



Today:

Root cause of accidents

Event tree analysis

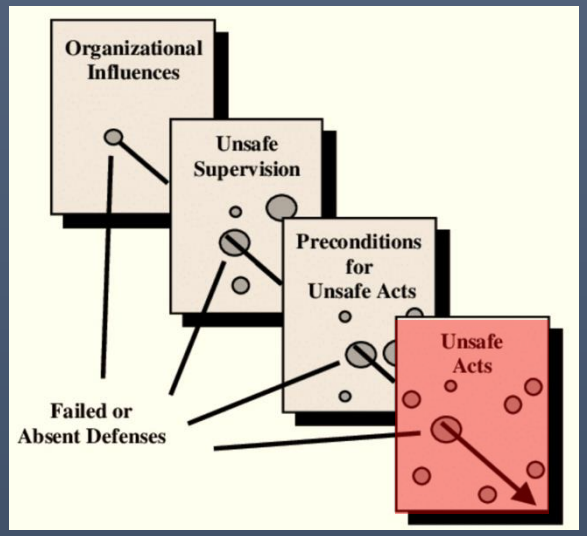
Reliability engineering

Risk analysis

"Swiss Cheese" Model

AKA Defense in Depth Model

(Reason, 1990)



Today:

Program avalanche safety

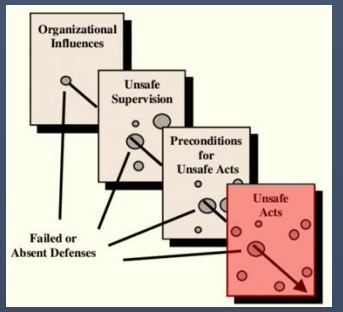
Aviation, computer security, healthcare, public health (COVID-19)

HFAC

The trouble with the human element

Proneness

Personal fault



Unsafe acts

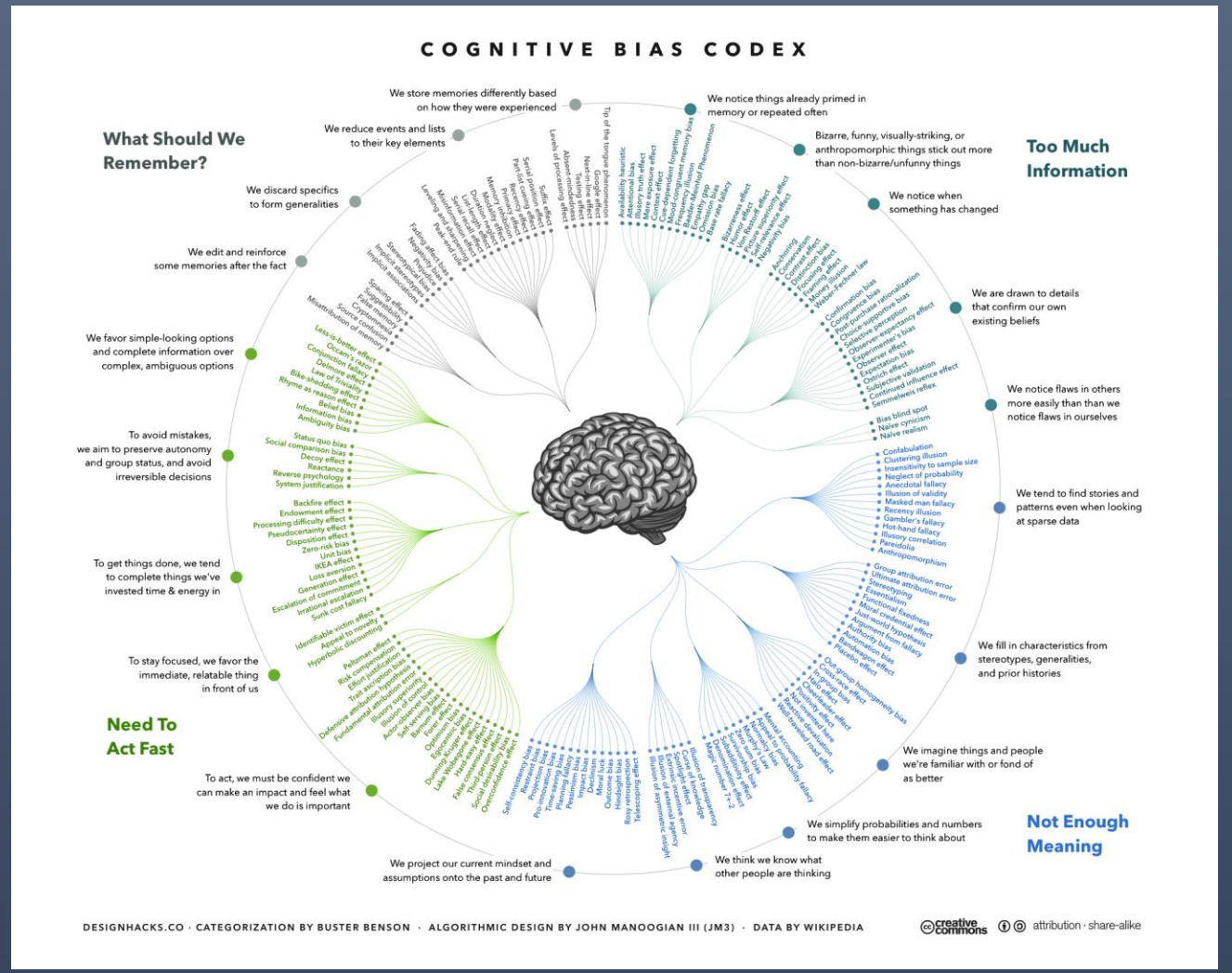
How do you fix it?

Recreationists won't:

- Adapt their environment
- Follow safety policies
- Be ticketed for not following rules

You can only shape their knowledge and provide skills.

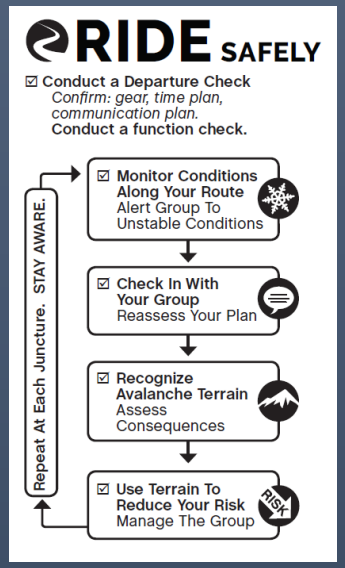
Strategy 1: Teach “better” decision making



~200+ known

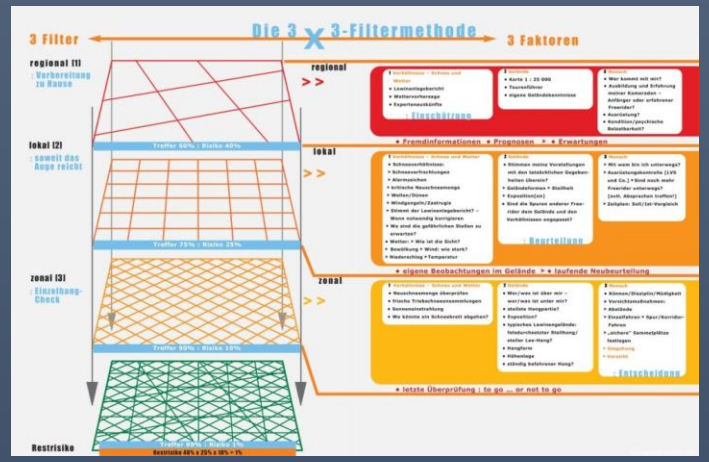
Strategy 2: Take human error out of decisions

Checklists



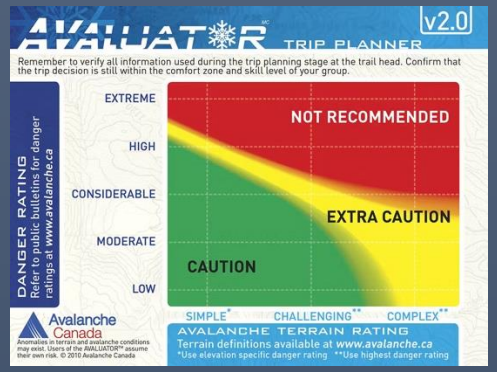
AIARE, 2019

Knowledge aids



Munter, 1997

Risk diagnostics



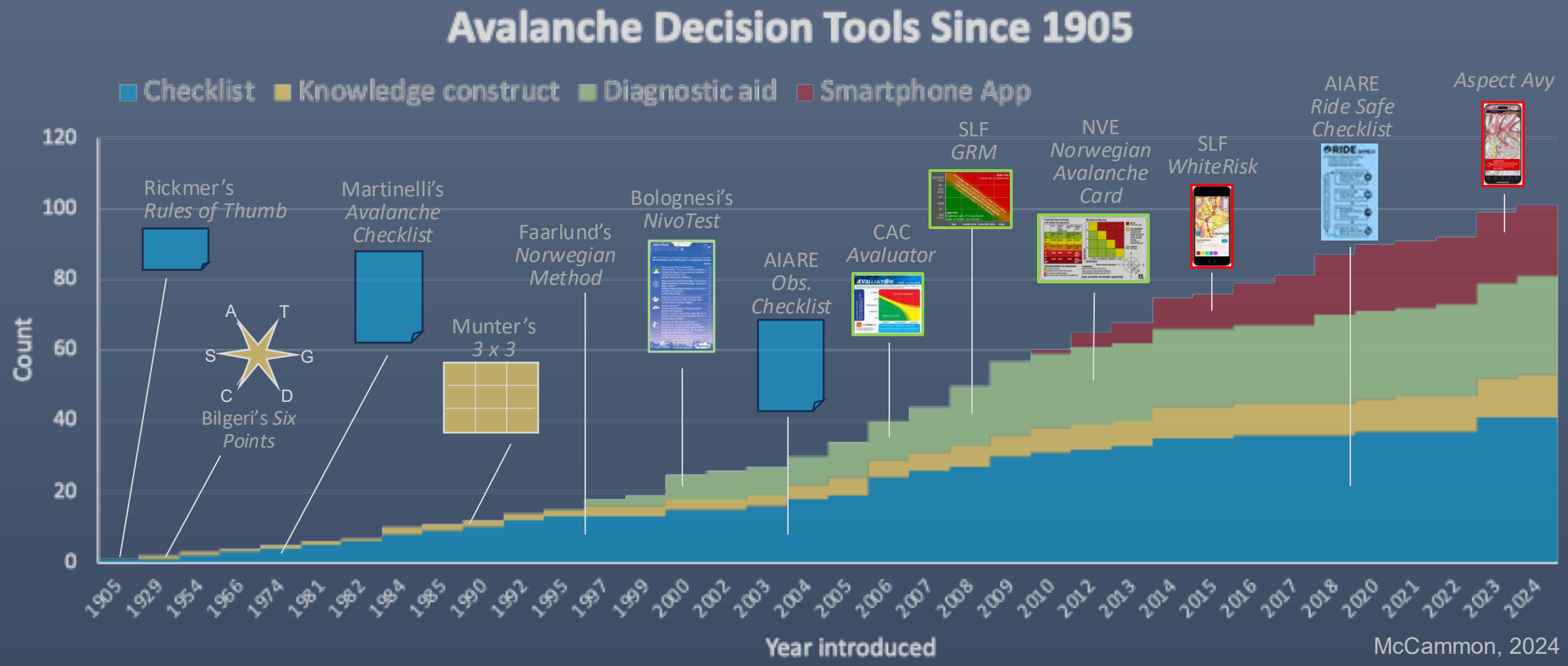
McCammon & Haegeli, 2006

Apps

Aspect Avy, 2023

Are these are effective?

Strategy 2: Take human error out of decisions



McCammon, 2024

Effectiveness rarely evaluated. Methods don't endure.

Failures not studied so we can't improve.

Why didn't they make a better decision?

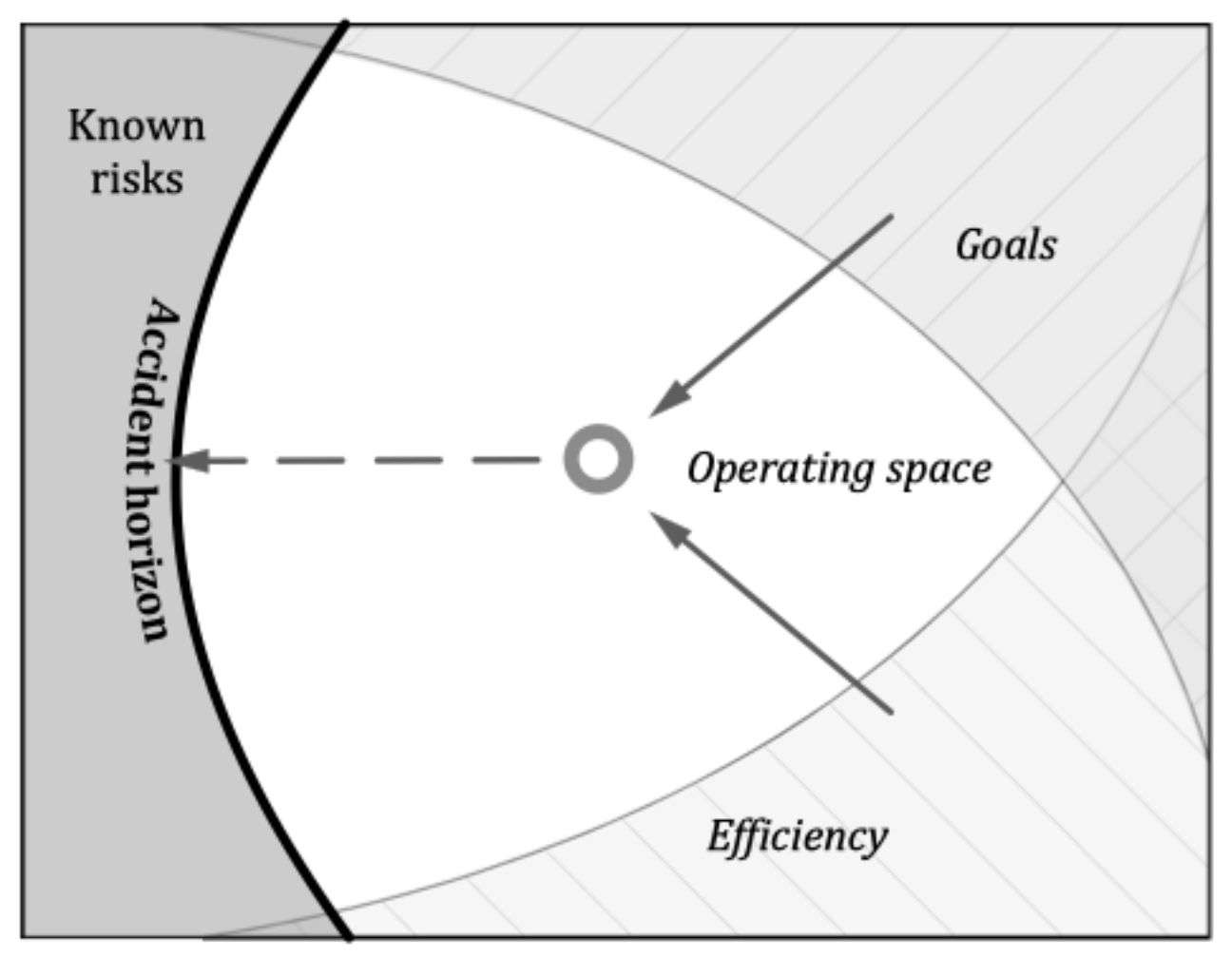
Wrong question?

Instead:

Why did that action make sense in that moment?

Drift into Failure

Rasmussen (1997)



Goals escalate
+
Efficiency pressure

= Drift

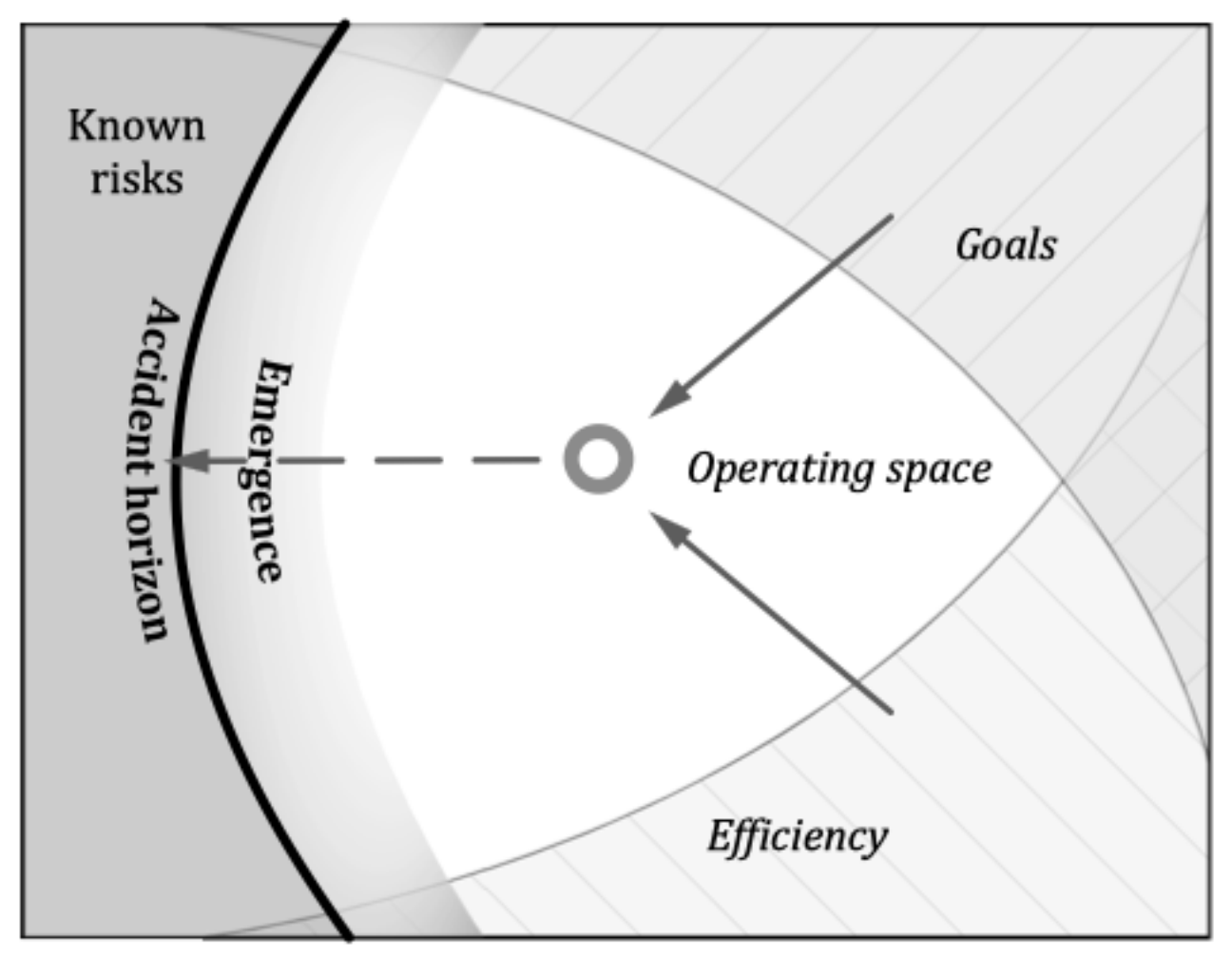
"Arriving at the edge of chaos is the logical endpoint for drift.

At this edge, systems have tuned themselves to the point of maximum capability.".

Sidney Dekker

Drift into Failure

Rasmussen (1997)
Hollnagel (2017)



Goals escalate
+
Efficiency pressure

= Drift

"When avalanche accidents are investigated, it's not just one or two clues that were overlooked, but three, four or or five clues."

Fredston & Fesler, 1994

Emergence: Complex, often transient interactions between system elements

Known vs Emergent Risks

	Known Risks	Emergent risks
Causes	Known and understood	Poorly or not understood
Core components	Known and defined	Ambiguous
Evolution	Slow-changing	Volatile
Signals	Clear and often quantified	Weak or ambiguous
Forecasting	Possible	Unavailable
Historical data	Well-established	Poor or absent
Exposure	Mostly choice driven	Mostly random
Management	Monitor & control known variables	Identify and adapt

Emergent risk examples: The “Uns”

- UNspoken: someone saw the risk but it was not shared
- UNheard: a concern was voiced but dismissed
- UNclear: a risk was noticed, taken for something else
- UNtimely: mitigation was taken was too late
- UNseen: risk not noticed due to distractions
- UNcaring: rights of others not respected

Mooney, L. 2025. High Reliability in Action, Dark Space Press
Weick, K. & Sutcliffe,K. 2001. Managing the Unexpected: Assuring high performance in an age of complexity. Whitepaper

How you can use this:
Take aways from Resilience Engineering

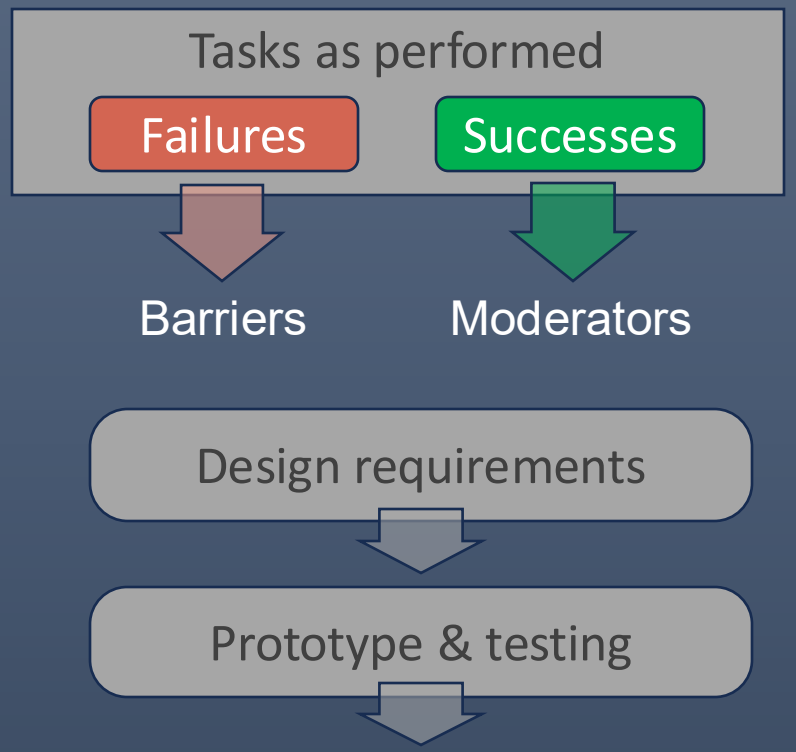
1. What must go right?
   Systems – people - communication

2. “Furrowed Brow” Test
   Identify deviations from expectations

3. Adaptation = *Informed* risk taking
   Probing – intention – action

3. Debrief to improve
   Gaps in expectations vs events?

Project Flow



Working title:
"Human Factor Trouble-Shooting Guide"

Methods

✓ Jobs Theory
- Interviews
- Segmentation analysis

✓ Product Engrg
- Systems design
- Useability

Resilience Engineering Principles

- Emergence
- Equivalence
- Approximate adjustment
- Functional resonance

ISSW WHISTLER 2026

Collaborators

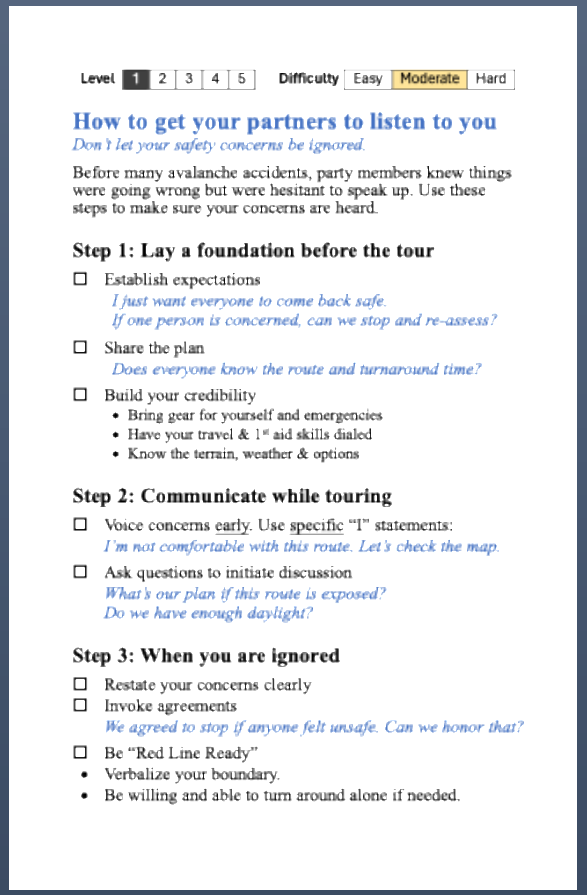
Dr. Sara Boilen	Sweetgrass Psychological
Brooke Maushund	Avalanche Forecaster
Dr. Jerry Isaak	Thompson Rivers University
Meghan Allsop	America Avalanche Association
Dr. Forest Wagner	University of Alaska
Kevin Grove	Central Oregon Community College
Katie Choate	Sperling Center for Research and Innovation

A problem well stated is half solved.

Charles Kettering, American Engineer

Backup

Example: 1 page how-to for an emergent risk



Level 1 2 3 4 5 Difficulty Easy Moderate Hard

How to get your partners to listen to you

Don't let your safety concerns be ignored.

Before many avalanche accidents, party members knew things were going wrong but were hesitant to speak up. Use these steps to make sure your concerns are heard.

Step 1: Lay a foundation before the tour

☐ Establish expectations
I just want everyone to come back safe.
If one person is concerned, can we stop and re-assess?

☐ Share the plan
Does everyone know the route and turnaround time?

☐ Build your credibility
- Bring gear for yourself and emergencies
- Have your travel & 1st aid skills dialed
- Know the terrain, weather & options

Step 2: Communicate while touring

☐ Voice concerns early. Use specific "I" statements:
I'm not comfortable with this route. Let's check the map.

☐ Ask questions to initiate discussion
What's our plan if this route is exposed?
Do we have enough daylight?

Step 3: When you are ignored

☐ Restate your concerns clearly
☐ Invoke agreements
We agreed to stop if anyone felt unsafe. Can we honor that?

☐ Be "Red Line Ready"
- Verbalize your boundary.
- Be willing and able to turn around alone if needed.

4 x 7 Booklet format

One of many possible implementations

Key design issues:

- Evidence-based
- High usability
- Pilot test & iterate with user input

References:
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Forgey, W. 2006, *WMS Practice Guidelines for Wilderness Emergency Care*, Falcon
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Resilience Safety Engineering

Resilience = Sustained adaptation

Robust risk management

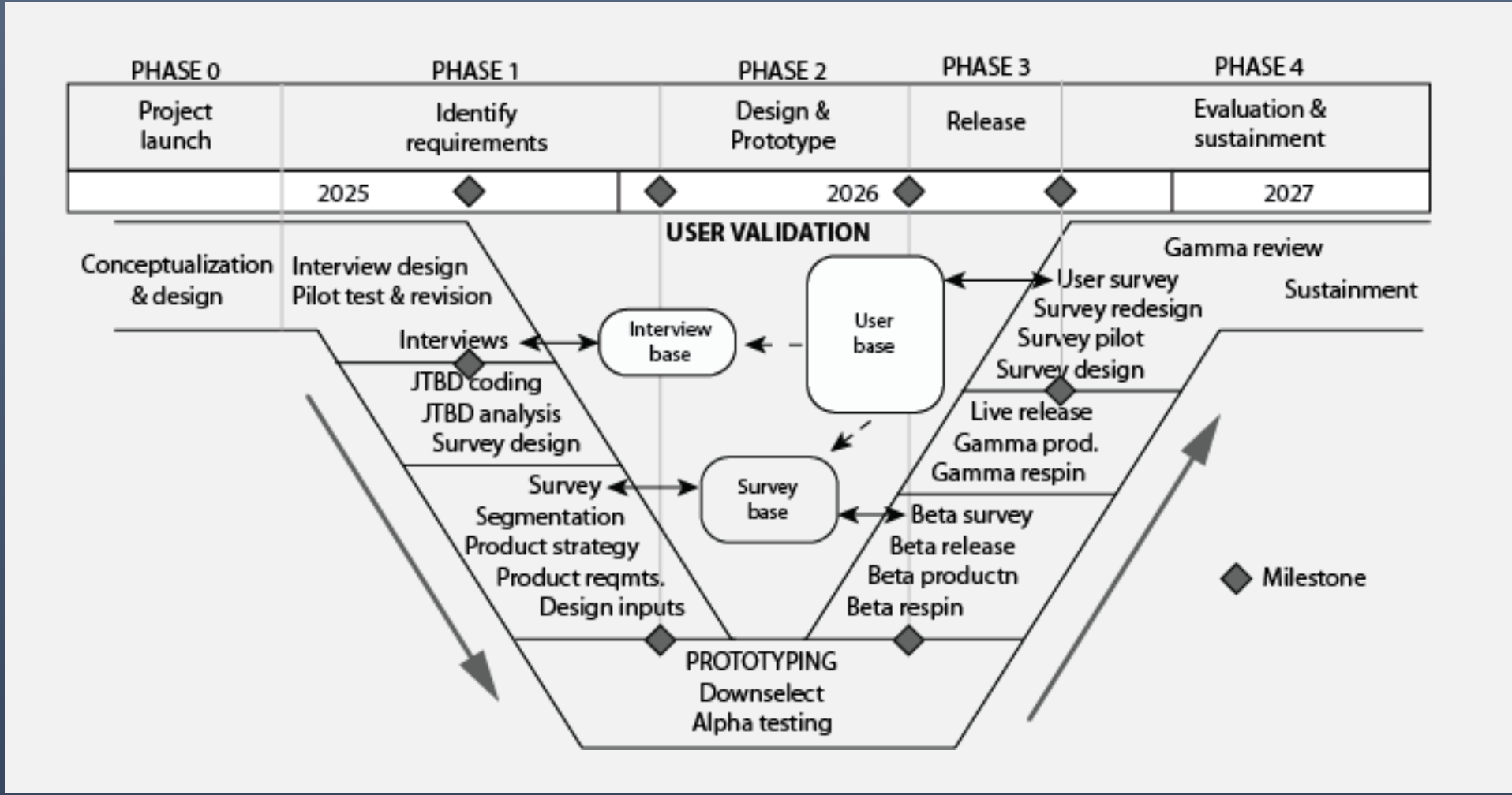
- Known risks
- Protective + reactive
- Risk matrices, checklists
- Monitoring

Resilient risk management

- Emergent risks
- Proactive
- 4 elements
  - Anticipate known KRIs
  - Recognize emergence
  - Adapt
  - Learn

Hollnagel, E. Woods, D. and Leveson, N. (2006)

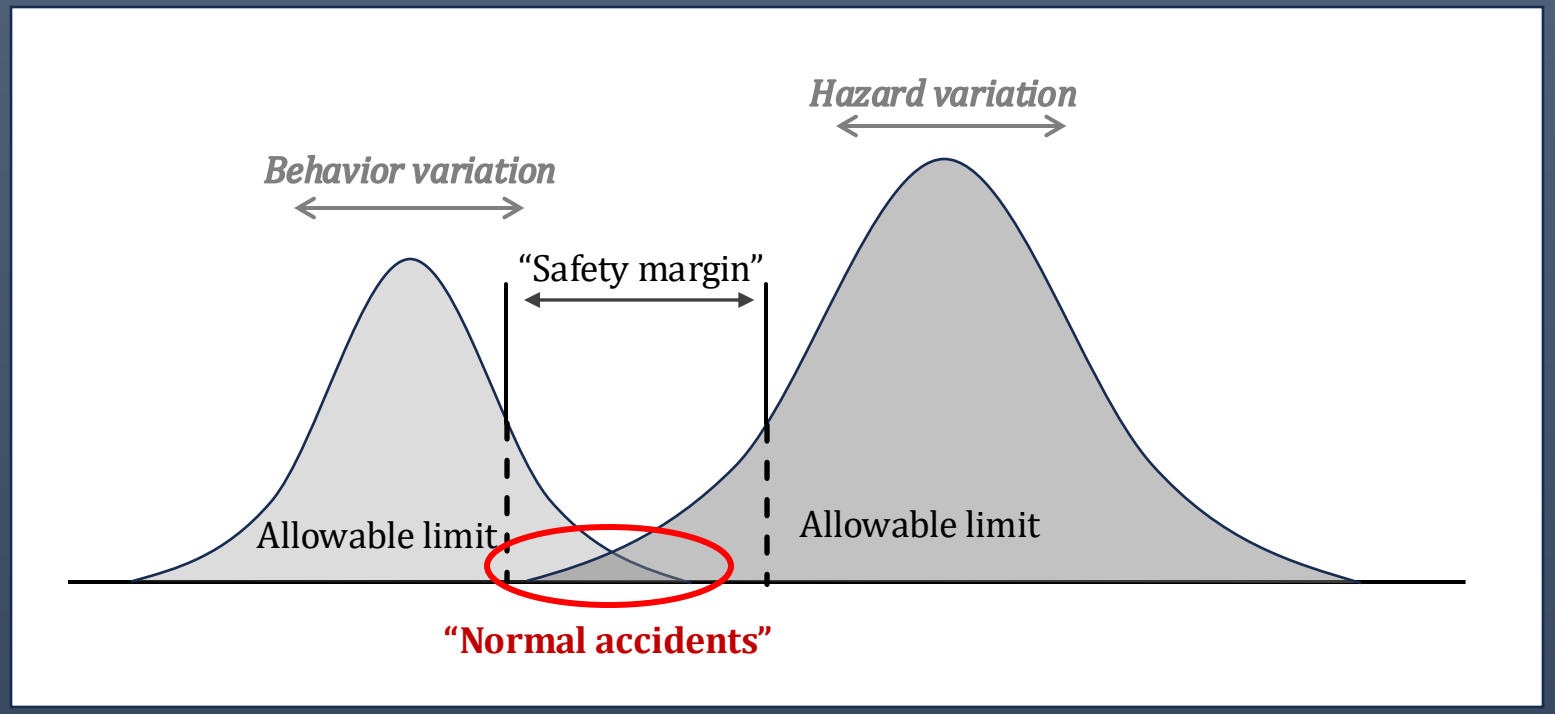
Project overview



Modern accident models

Systemic Variation Model

(Perrow,1984)



System variables:

- Complex
- Numerous
- Dynamic
- Coupled

"Most high-risk systems have characteristics that make accidents inevitable, even normal."
Charles Perrow

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