



# Risk Assessment & Safety Management: Integrating Safety I & Safety II for Accident Prevention

# Introduction

- Rick Curtis
- Pronouns: he, him, his
- Land Acknowledgement – I am in New Jersey, the home of the Lenni Lenape people.
- Director, Princeton University Outdoor Action Program: 39 Years
- Founder: [www.IncidentAnalytix.com](http://www.IncidentAnalytix.com)
- Founder: [www.OutdoorEd.com](http://www.OutdoorEd.com)
- Author: [The Backpacker's Field Manual](#)

# Learning Objectives

- Learn how the **Safety I** framework and **Safety II** framework are complementary parts of an overall risk management plan
- Understand the **Systems Thinking Approach** to risk management
- Learn how a **Risk Management Information System (RMIS)** can provide rich data for implementing Safety I and Safety II principles
- Learn how to assess your program by building **AcciMaps** and **PreventiMaps**

# An Incident is either...

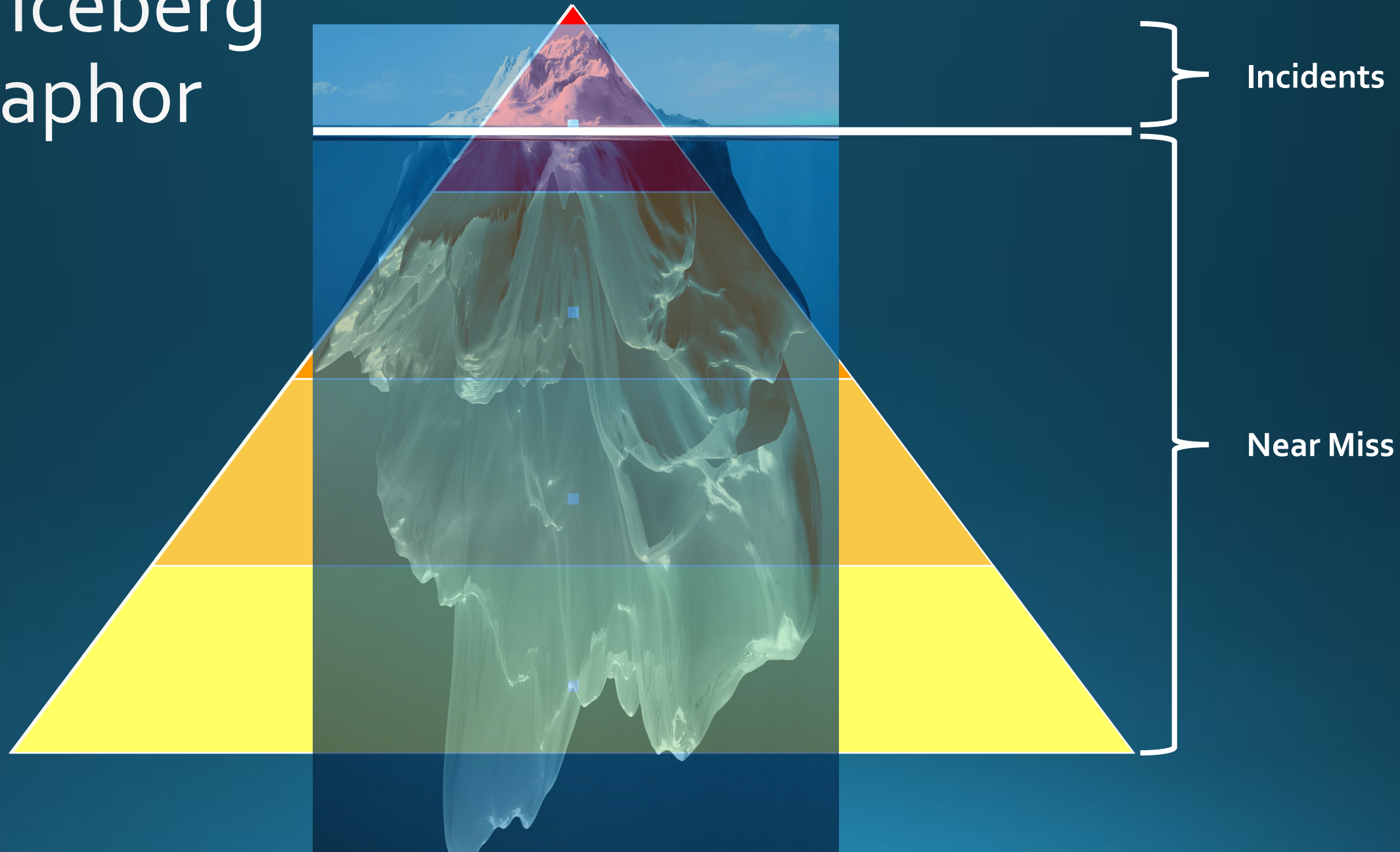
- Adverse Outcome
- Close Call/Near Miss



# Accident Pyramid



# The Iceberg Metaphor



Risk Level = Probability of Occurrence \*  
Potential Severity of Outcome

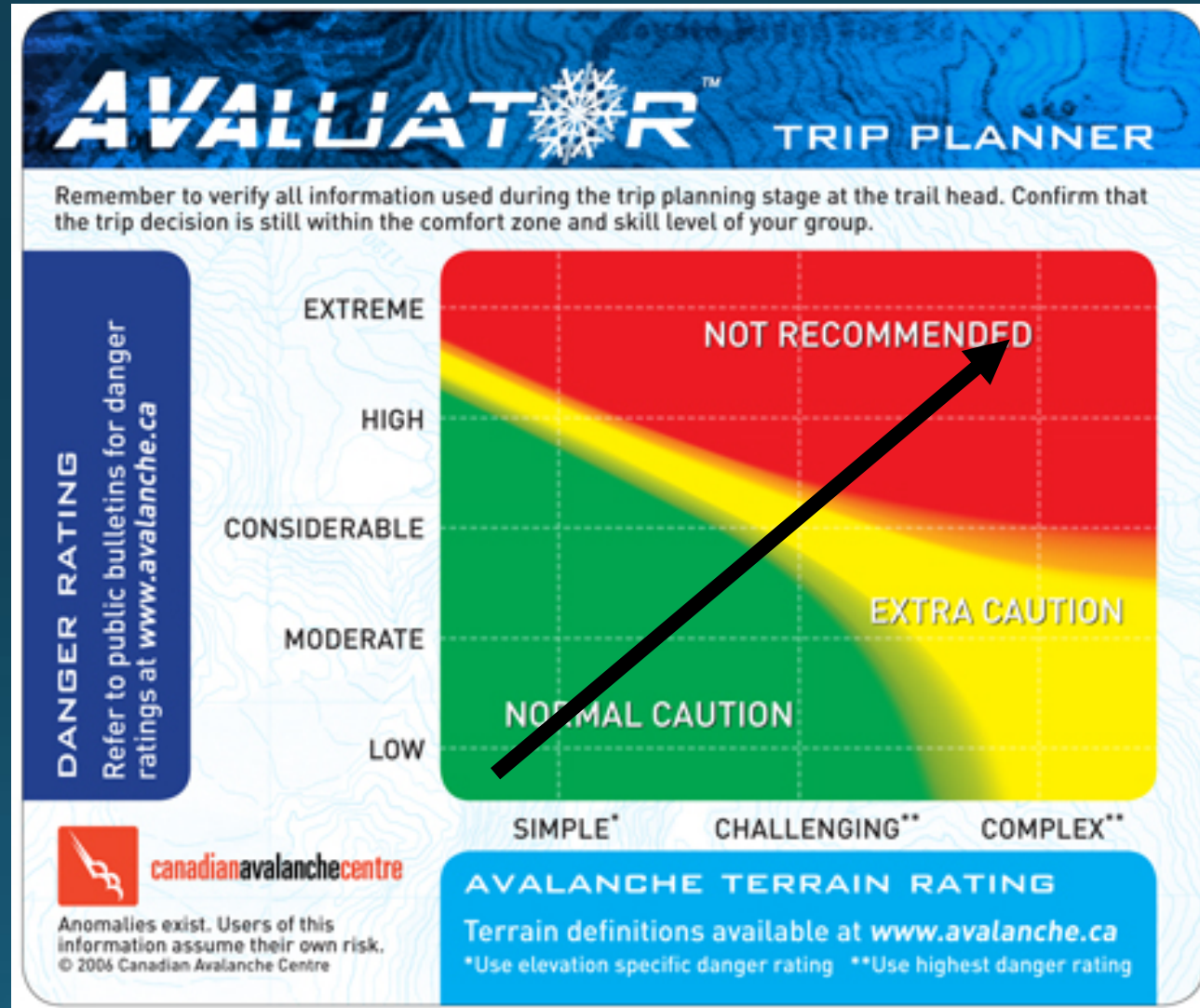
# Risk Calculator

# Risk Matrix (5x5)

Probability of Occurrence		Insignificant	Minor	Moderate	Major	Catostrophic
	Almost Certain	Lowest Risk	High Risk	Highest Risk	Highest Risk	Highest Risk
	Likely	Lowest Risk	Medium Risk	High Risk	Highest Risk	Highest Risk
	Possible	Lowest Risk	Low Risk	Medium Risk	High Risk	Highest Risk
	Unlikely	Lowest Risk	Low Risk	Medium Risk	Medium Risk	High Risk
	Rare	Lowest Risk	Lowest Risk	Low Risk	Low Risk	Medium Risk
Severity of Outcome/Consequences						

Based on NASA 5x5 Risk Matrix

# Avaluator Avalanche Risk Level Matrix



# How do we approach Risk?

## Paradigms

- Safety I
- Safety II

## Taxonomies of Causation

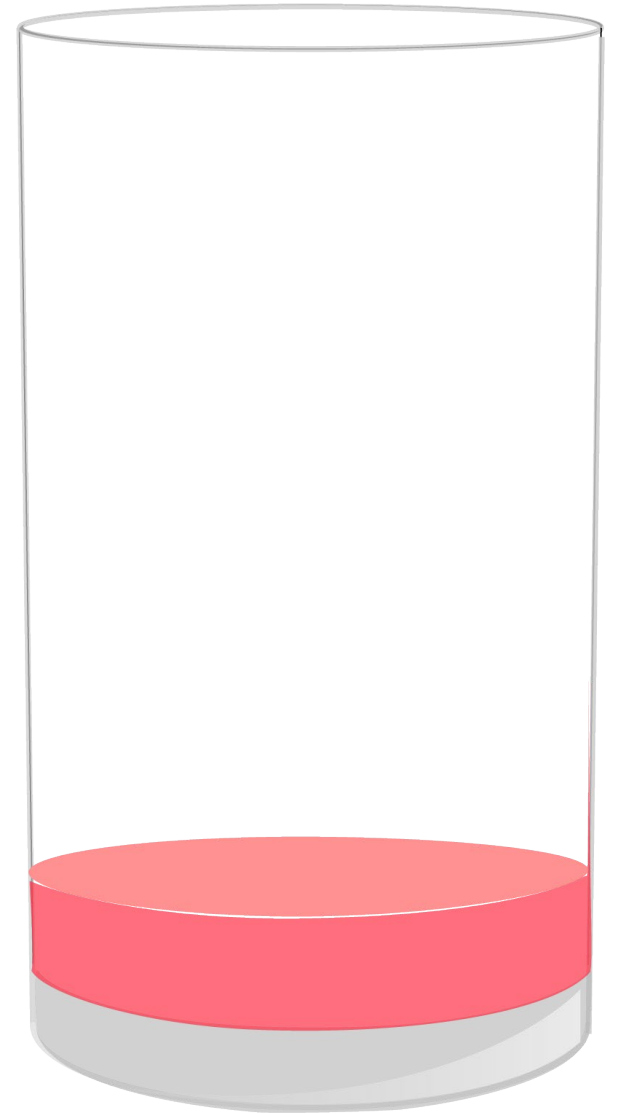
- The practice and science of classification of things or concepts

# Safety I

What's Going Wrong?

We are safe is there is as little as possible  
of this

Hollnagel, E. Hearn, R., Braithwaite, J. - *From Safety-I to  
Safety-II (A White Paper)*







# Safety I

	Safety I
Definition of Safety	As few things as possible go <b>wrong</b>
Safety Management Principle	<b>Reactive</b> , respond when something happens or is categorized as unacceptable risk
View of Human Factors	Humans are predominantly seen as a liability or hazard. They are a <b>problem</b> to be fixed.
Accident Investigation	Accidents are caused by <b>failures</b> and malfunctions. The purpose of an investigation is to identify the causes.

# Causation Taxonomies

- Potential Causes of Accidents in Outdoor Pursuits
  - Meyer (1979) revised by Williamson (1984 – 2013)
- Dynamics of Accidents Model
  - Hale (1982)
- Risk Management in a Dynamic Society
  - Rasmussen (1997)
- Risk Assessment & Safety Management Model (RASMM)
  - Curtis (2000)
- Causation in Led Outdoor Activities
  - Salmon et al (2014)

# Taxonomy: RASM Model

## Safety I & Safety II

### Safety I

- Equipment Factor Hazards
- Environmental Factor Hazards
- Human Factor Hazards

### Safety II

- Equipment Safety Factors
- Environmental Safety Factors
- Human Safety Factors

# An Accident in the making...

- Cast Away Scene 1



# Contributing Factors

## Equipment Hazards



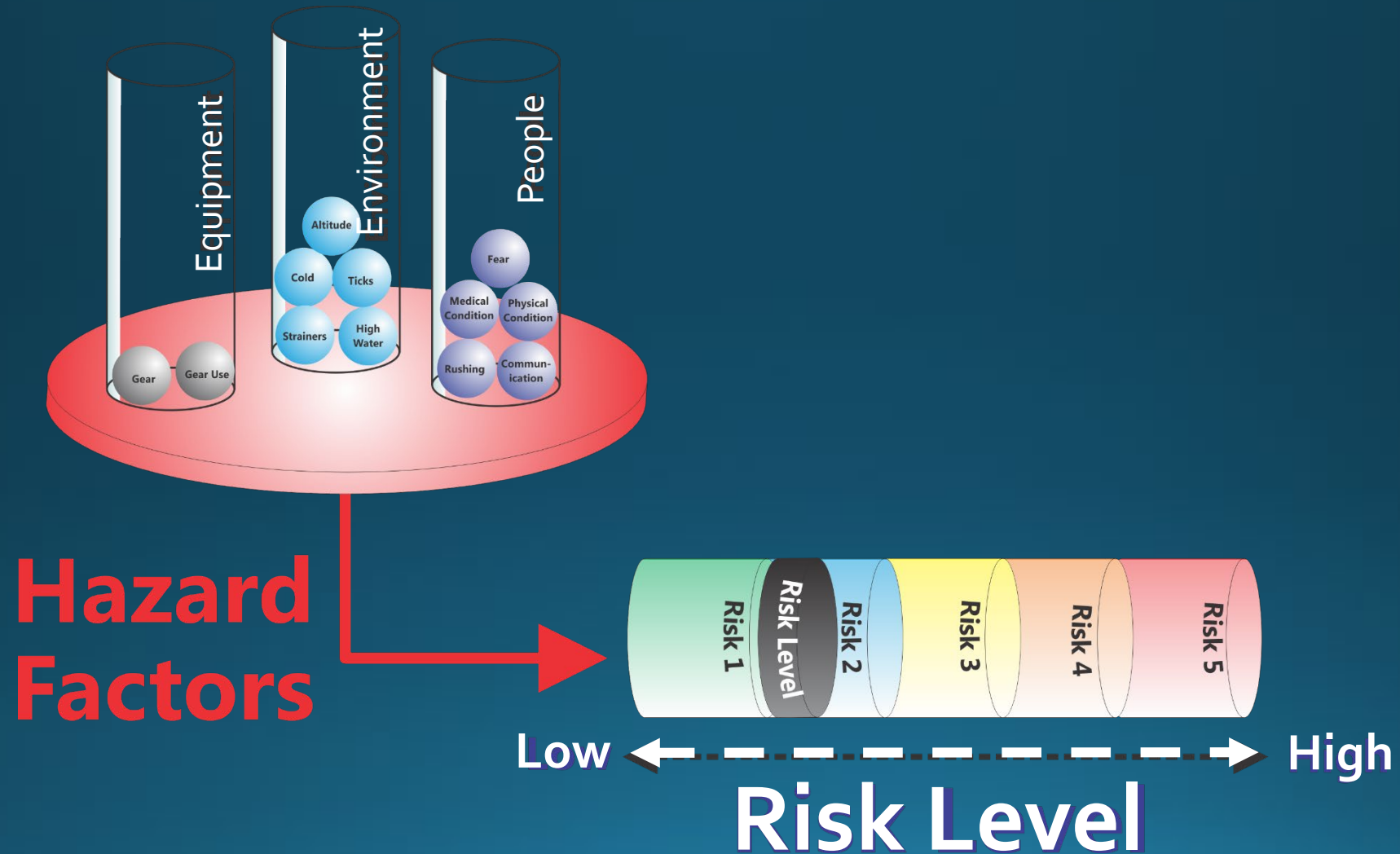
## Environment Hazards



## Human Factor Hazards



# Risk Assessment & Safety Management Model (RASMM) ©



# Safety II



<https://www.youtube.com/watch?v=gauR843rRNk>



## Safety Differently

**Increasing safety**  
**Reducing performance drag**

Professor Sidney Dekker, MA, MSc, PhD  
Safety Science Innovation Lab

[sidneydekker.com](http://sidneydekker.com)



0:00 / 26:48

CC AG

The image shows a video player interface. On the left, a white box contains the Griffith University logo, the title 'Safety Differently', two bullet points 'Increasing safety' and 'Reducing performance drag' in red, the speaker's name and credentials 'Professor Sidney Dekker, MA, MSc, PhD' and 'Safety Science Innovation Lab', and the website 'sidneydekker.com'. On the right, a man in a pink shirt is visible. At the bottom, a video control bar shows a progress bar at 0:00 / 26:48, a volume icon, and icons for closed captions (CC) and audio description (AG).

# Safety Differently

## Sidney Dekker



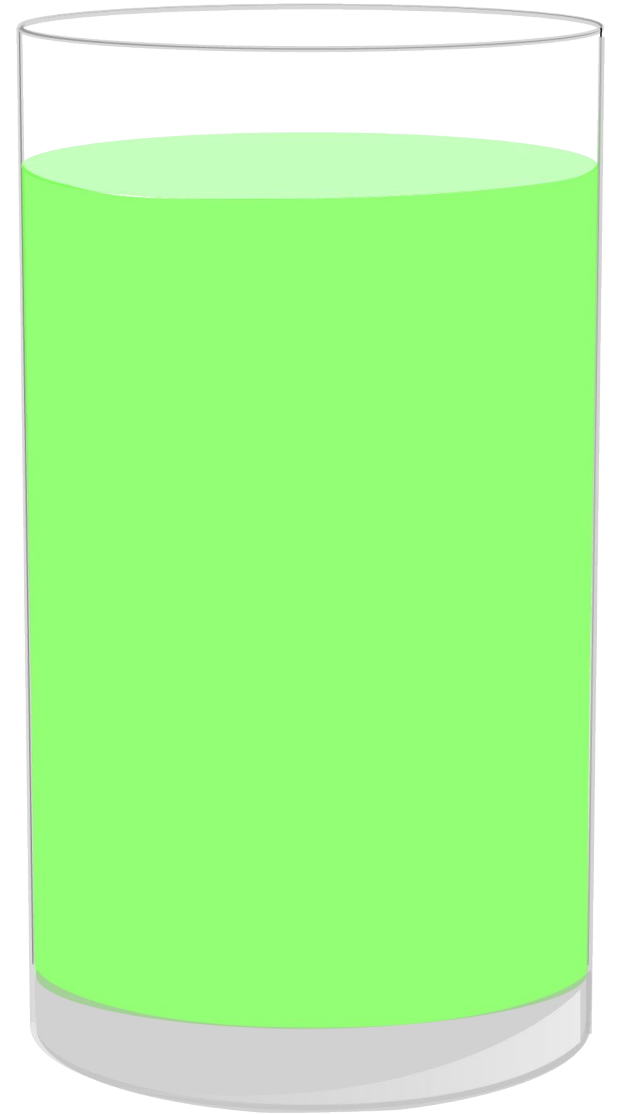
# Safety II

What's Going Well?

We are safe if there is as much as possible of this

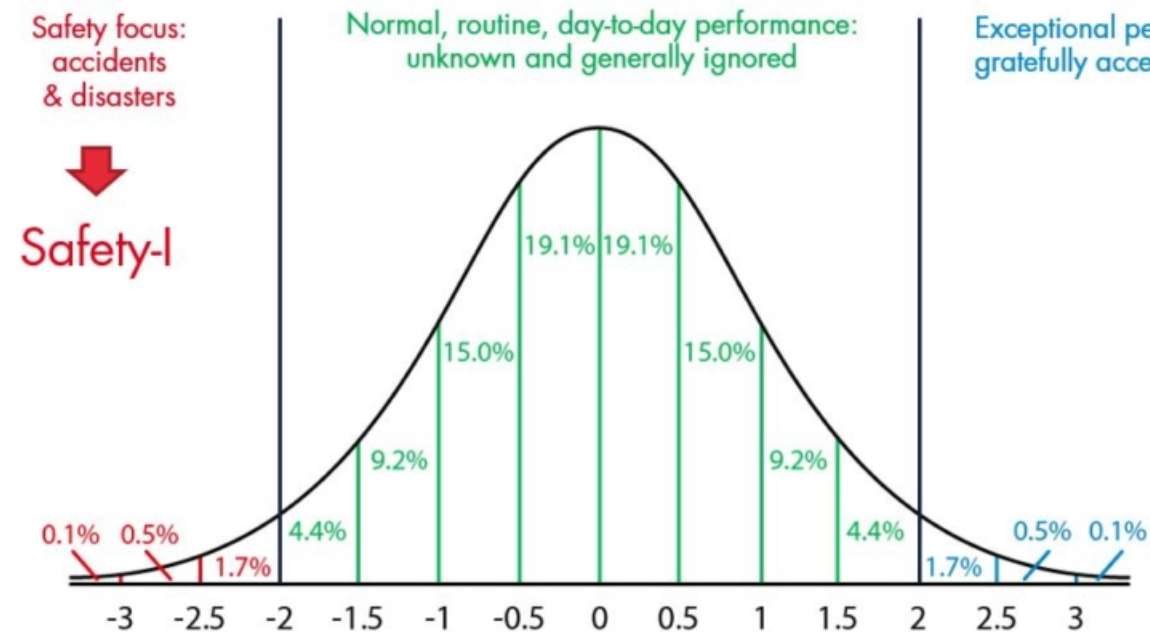
“Trying to understand safety by only looking at incidents is like trying to understand successful marriages by only looking at divorces.”

- Marit de Vos 2018



# Safety I & Safety II

## SAFETY-I TO SAFETY-II



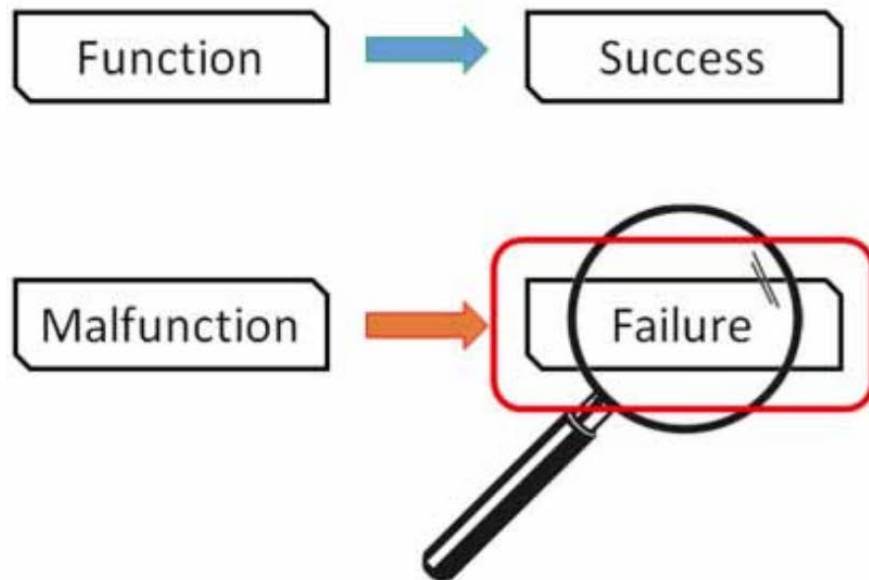
*Event probability and safety focus – Erik Hollnagel*

# Safety II

	Safety II
Definition of Safety	As many things as possible go <b>right</b>
Safety Management Principle	<b>Proactive</b> , continuously try to anticipate developments and events
View of Human Factors	Humans are seen as a <b>resource</b> necessary for system flexibility and resilience. They provide flexible solutions to many problems.
Accident Investigation	Things basically <b>happen in the same way</b> regardless of outcome (positive or negative). The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong.

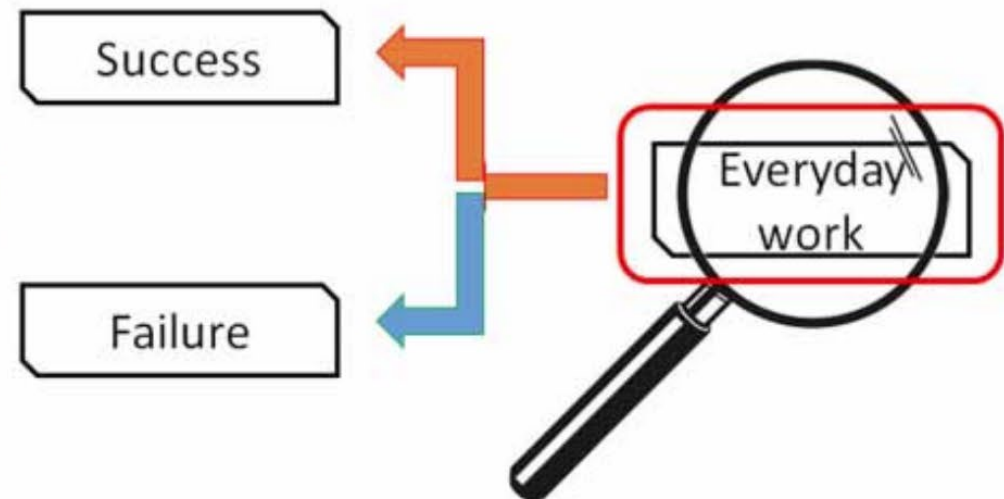
# Safety I vs Safety II

## SAFETY I APPROACH



VS

## SAFETY II APPROACH



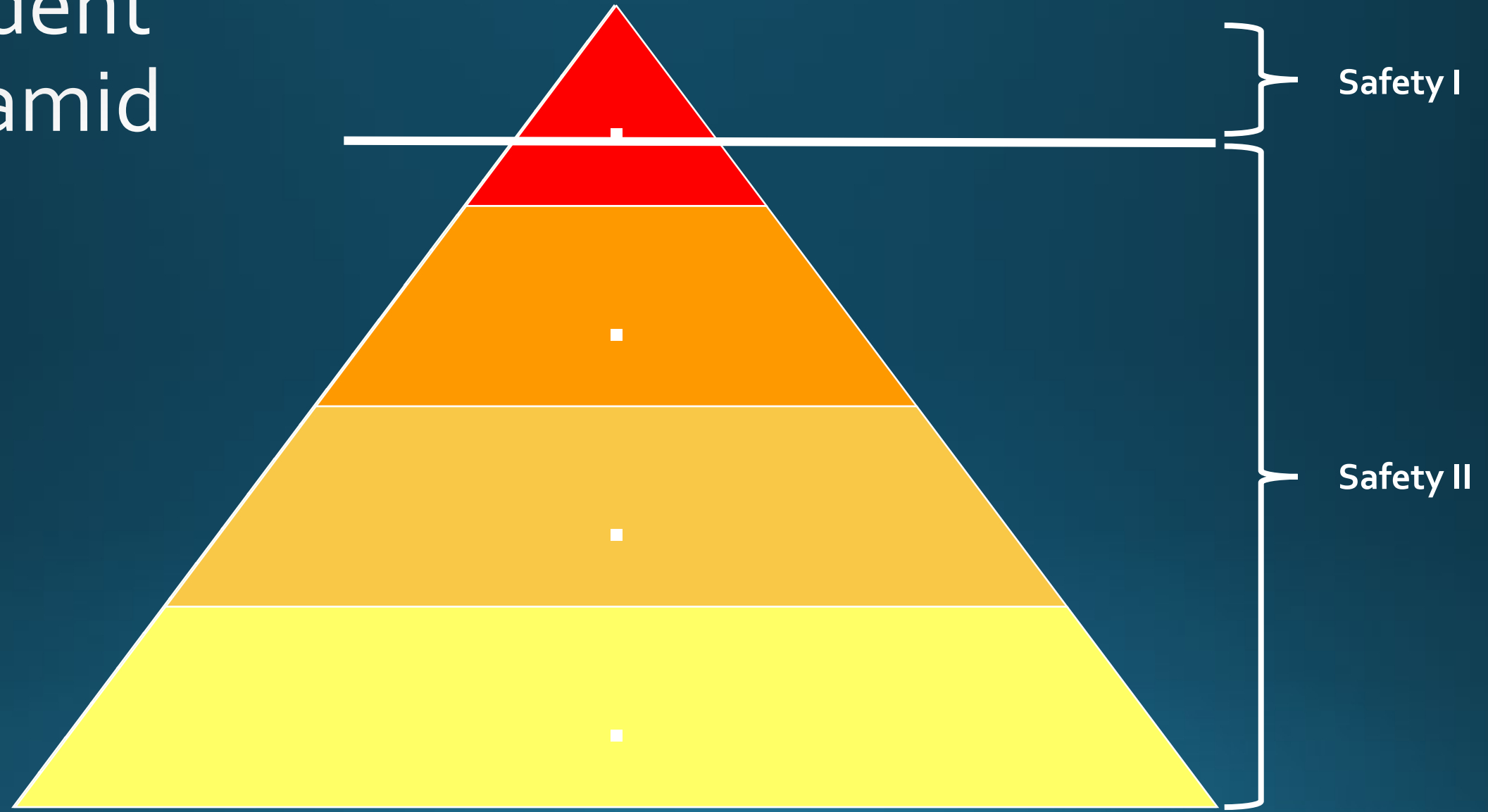


# Safety I vs Safety II

	Safety I	Safety II
Definition of Safety	As few things as possible go <b>wrong</b>	As many things as possible go <b>right</b>
Safety Management Principle	<b>Reactive</b> , respond when something happens or is categorized as unacceptable risk	<b>Proactive</b> , continuously try to anticipate developments and events
View of Human Factors	Humans are predominantly seen as a liability or hazard. They are a <b>problem</b> to be fixed.	Humans are seen as a <b>resource</b> necessary for system flexibility and resilience. They provide flexible solutions to many problems.
Accident Investigation	Accidents are caused by <b>failures and malfunctions</b> . The purpose of an investigation is to identify the causes.	Things basically <b>happen in the same way</b> regardless of outcome (positive or negative). The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong.



# Incident Pyramid



# An Accident in the Making - 2

- Cast Away Scene 2



# Contributing Factors

## Equipment Hazards



## Environment Hazards



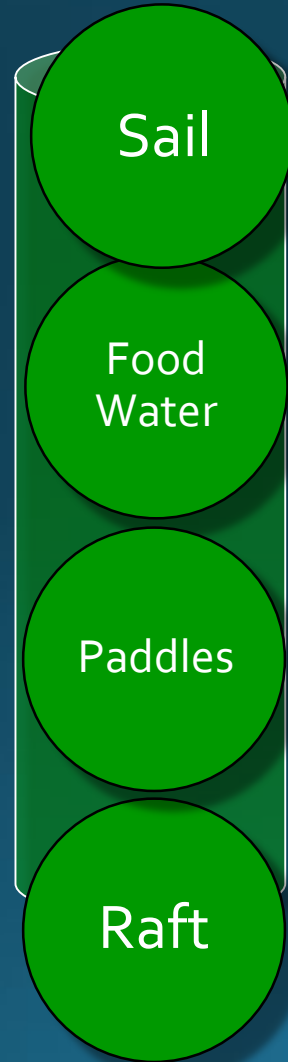
## Human Factor Hazards





# Mitigating Factors

## Equipment Resources



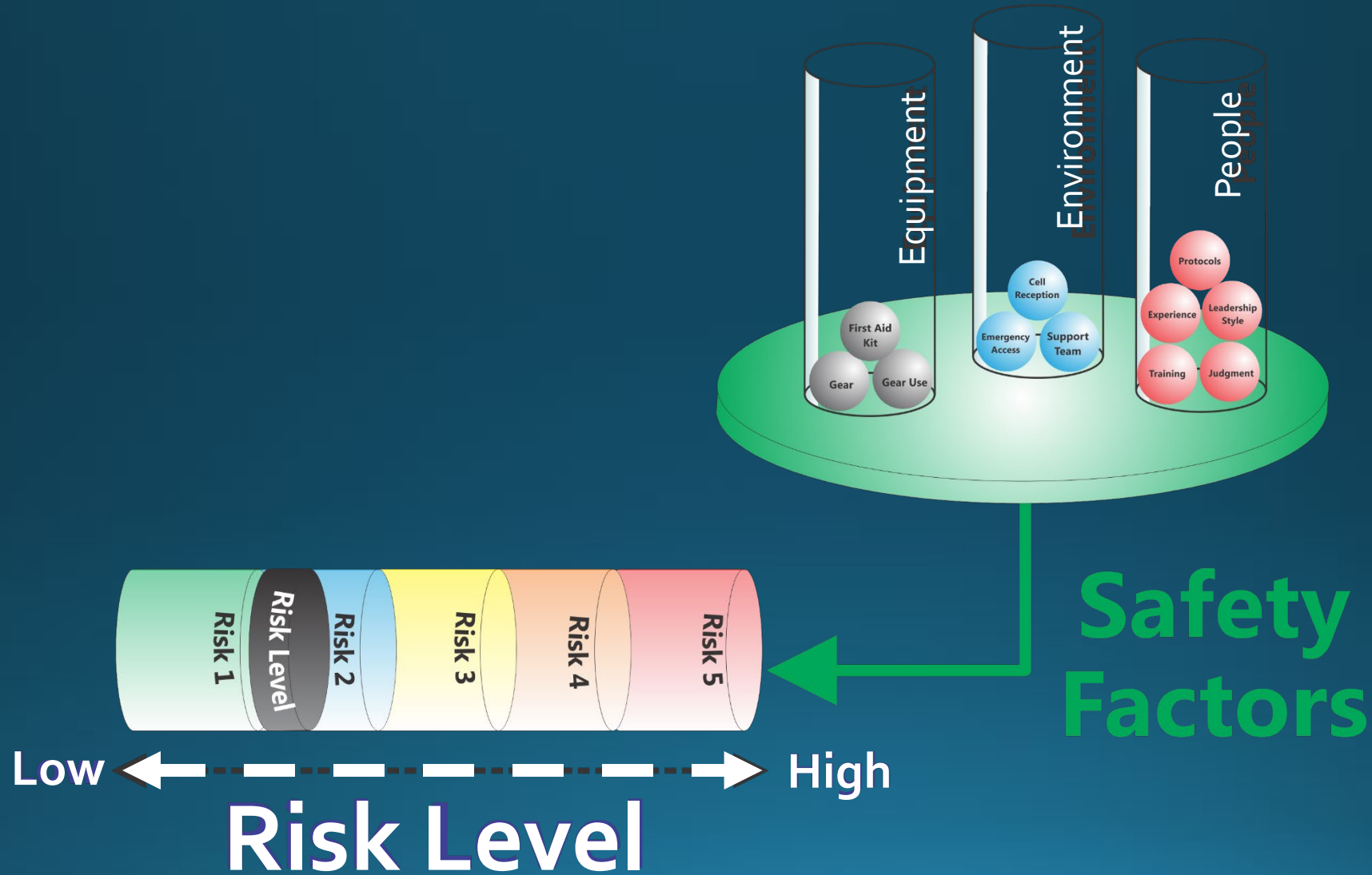
## Environment Resources



## Human Factor Resources

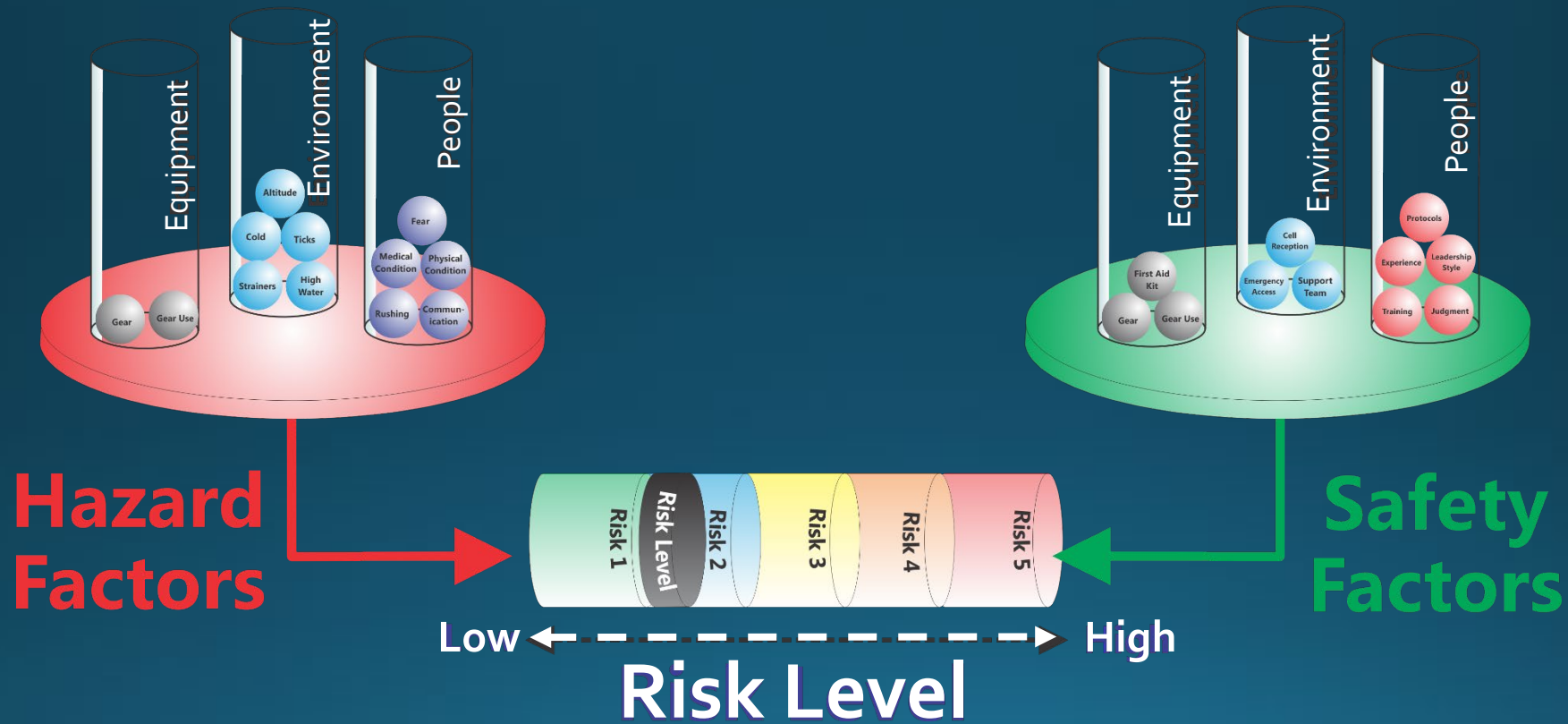


# Risk Assessment & Safety Management Model (RASMM) ©



# RASM – Safety I & Safety II

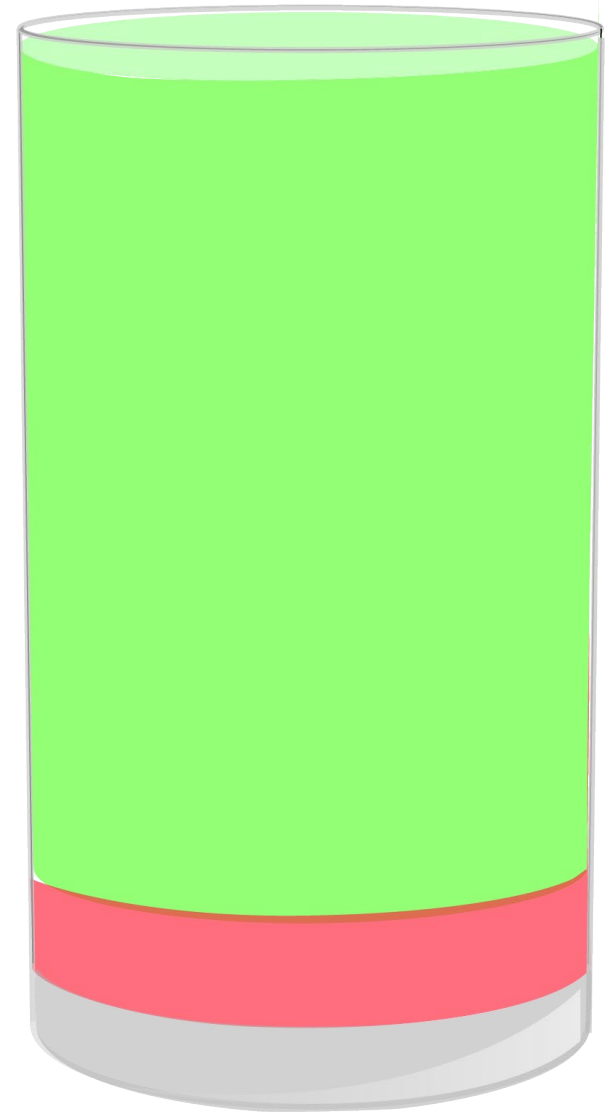
## The model can use different Taxonomies





# Safety I & Safety II

Covering the entire spectrum



# When do to use Safety I vs Safety II?

## Safety I – Simple Systems

- Systems are Decomposable – we can break things down into specific components and look for points of failure in each component
- Functionality is Bimodal – it either works or it is broken

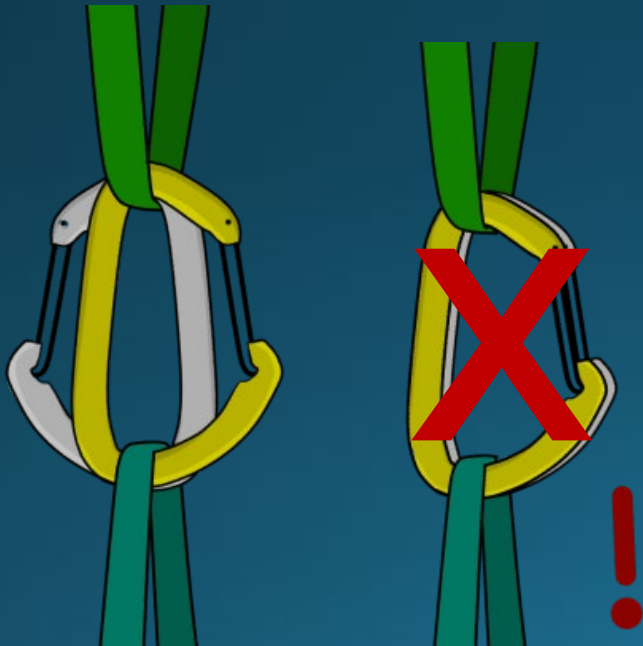
## Safety II – Complex Systems

- System success is based on relationships across many components, not just the components themselves
- Functionality is not simply bimodal

# When do to use Safety I vs Safety II?

## Safety I – Simple Systems

- Carabiners set as Opposite and Opposed – Simple, Bimodal



## Safety II – Complex Systems

- Making decisions about avalanche danger with many variables & low data confidence



# Professional vs Paraprofessional/Trainee

- The Safety II approach identifies employees as 'the sharp end of the system'
- Employees are resources because they are experts
- But what happens when they aren't?
  - Trainees or paraprofessionals

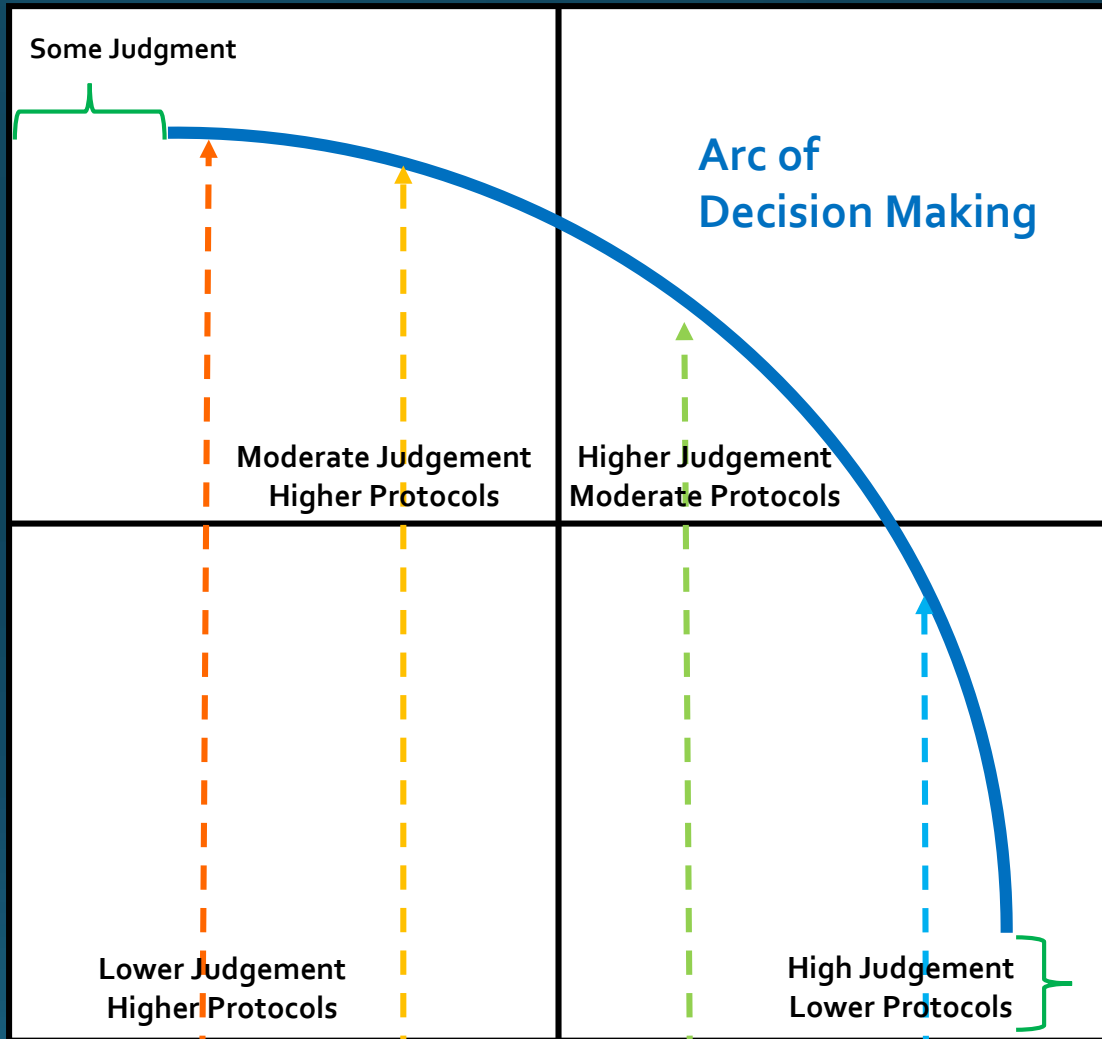


# Protocols/Rules vs Judgment/Experience

- Intern
- Resident
- Attending Physician

Paraprofessional

Protocols Control Decisions



Judgment Controls Decisions

Some Protocols

Professional



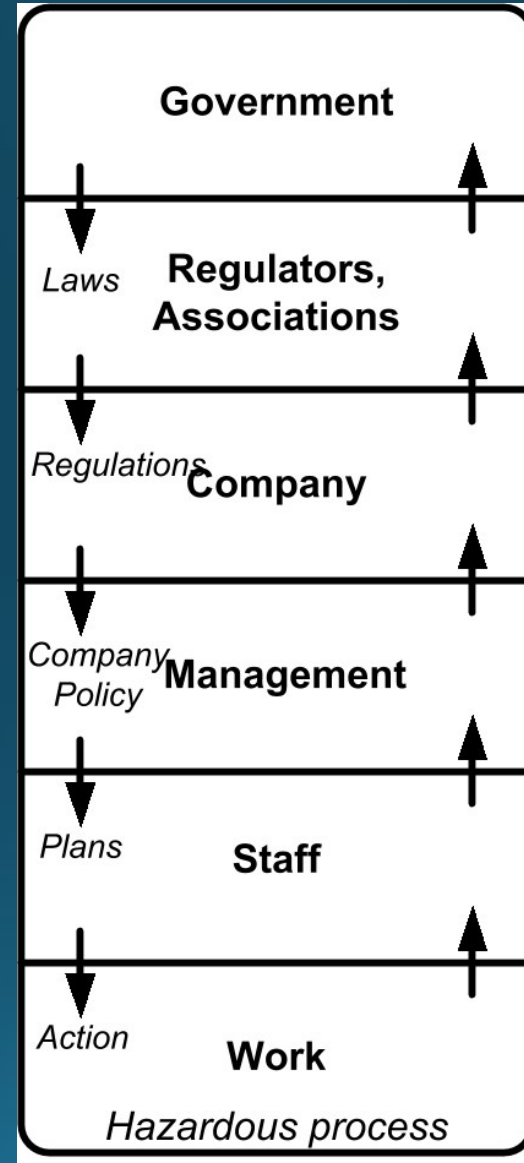
Staff Experience Level



Break

# Systems Thinking

- Risk Management in a Dynamic Society, Safety Science, 1997, Jens Rasmussen
  - Safety I + Safety II



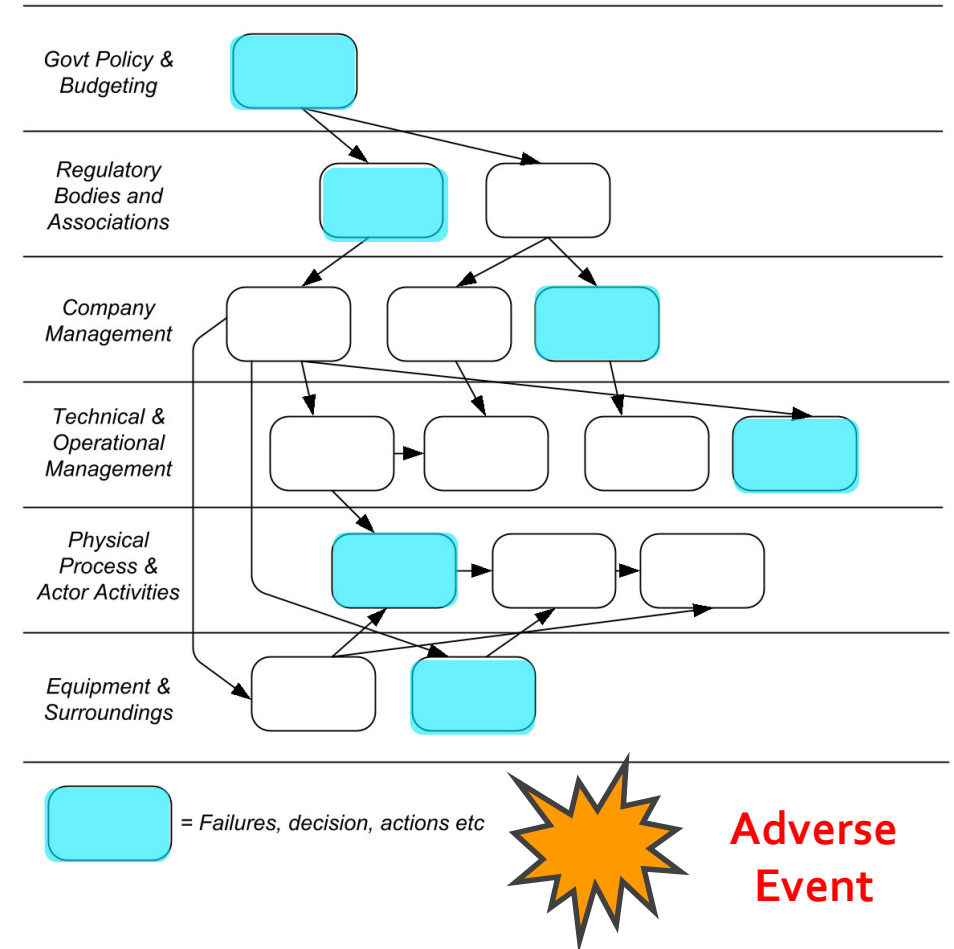
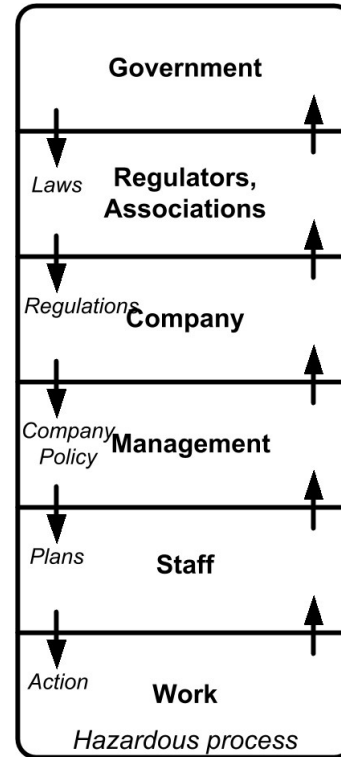
# Systems Thinking<sup>1</sup>

- “Behavior and safety is impacted by the decisions and actions of everyone in the system, not just frontline workers alone.”
- “Near misses and adverse events are caused by multiple, interacting, contributing factors, not just a single bad decision or action.”
- “Effective countermeasures focus on systemic changes rather than individuals.”

1. UPLOADS Project, <https://uploadsproject.org>

# AcciMaps

- Map of a Sociotechnical system
- Negative Outcome is at bottom
- Higher Levels show factors contributing directly or indirectly to the negative outcome



# Mangatepopo Tragedy - NZ

- 6 students and a teacher drown in a canyoning accident in April 2008







# Mangatepopo Low Head Dam/Spillway



# Building an AcciMap

1. Create a blank AcciMap with the Taxonomy headings on the left sidebar in hierarchical order
2. Identify the outcome(s) and enter at the bottom
3. Identify Causal Factors on a sticky note
4. Enter the Causal Factors at each Taxonomy Level
5. Identify and Relationships between Factors
  - Had A not occurred, B would (probably) not have occurred
    - AND
  - B is a direct result of A (no other factor in between, otherwise link A to C and C to B)
6. Check causal logic
7. Formulate Safety Recommendations
  - What is In Scope?
  - What is Out of Scope



# Build an AcciMap from your Incident (15 min)

- Download the AcciMap Template
  - [GOOGLE DRIVE LINK](#)
- Enter Contributing Factors at the appropriate Taxonomy Level
  - You may have a Systems Approach list of things, you may have things at the 'sharp end', either is fine for this exercise
- Draw Relationships

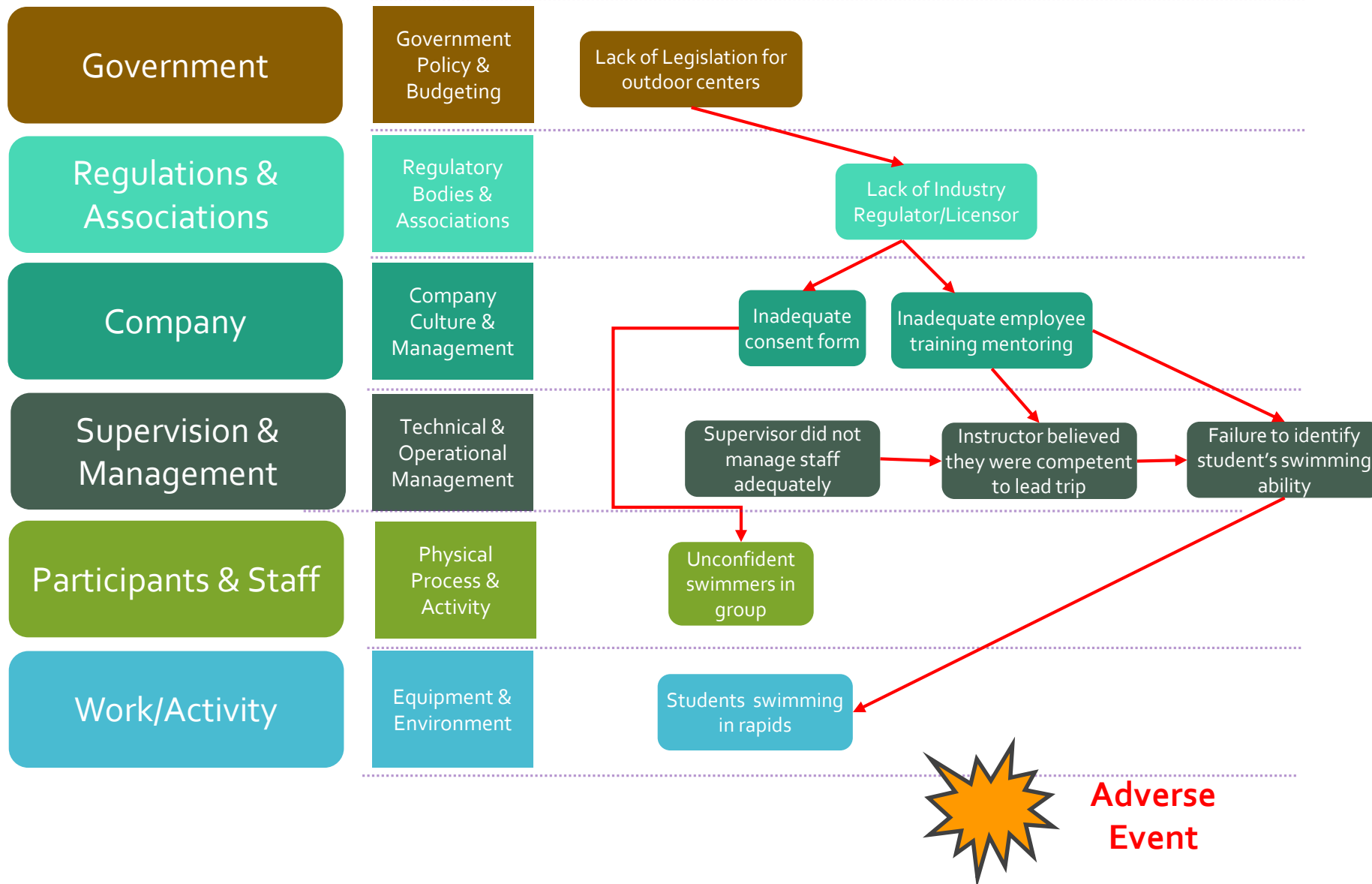


# Causation in Led Outdoor Activities Taxonomy

- Government Departments
- Regulatory Bodies & Associations
- Local area government, parents and schools,  
Organization management, planning & budgeting
- Supervisory and management decisions & actions
- Decisions & actions of leaders, participants, and other actors at scene
- Equipment, environment and meteorological conditions

# Building & Discussion

# Mangatepopo River Accident, NZ from Salmon et al



# Creating AcciMaps - Excel

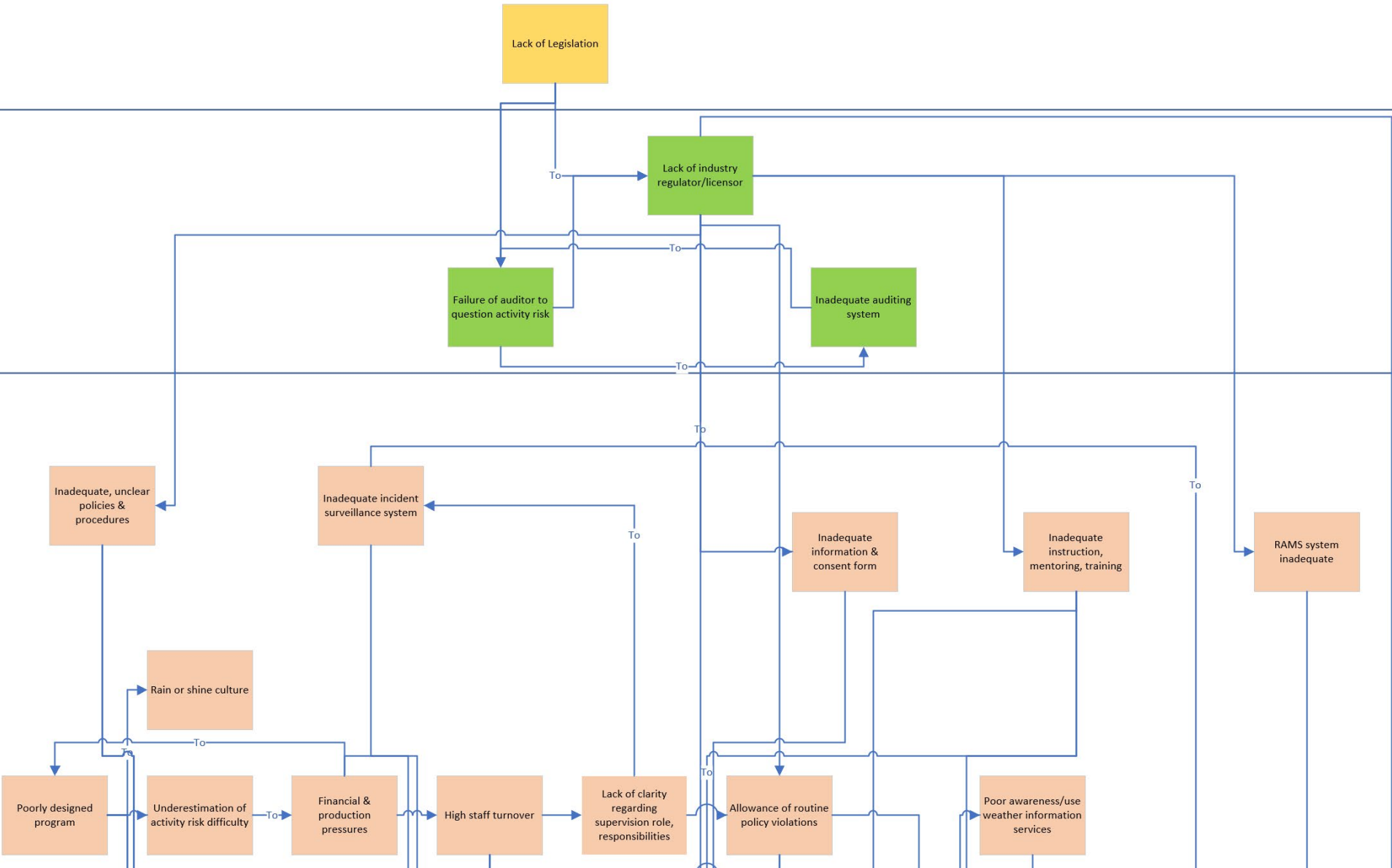
Contributing Factor Taxonomy	Contributing Factor	Relates To
Government Policy & Budgeting	Lack of Legislation	B1,B2,B3
Regulatory Bodies & Associations	Lack of industry regulator/licensor	C4,C5,C7,C9,C12,E1
Regulatory Bodies & Associations	Inadequate auditing system	B3
Regulatory Bodies & Associations	Failure of auditor to question activity risk	E2
Local Area Government Planning & Budgeting, Company Management	Financial & production pressures	C3,C10
Local Area Government Planning & Budgeting, Company Management	Rain or shine culture	
Local Area Government Planning & Budgeting, Company Management	Poorly designed program	C2,C6,D7,E1
Local Area Government Planning & Budgeting, Company Management	Inadequate information & consent form	E3
Local Area Government Planning & Budgeting, Company Management	Inadequate instruction, mentoring, training	D1,D8,E7
Local Area Government Planning & Budgeting, Company Management	Underestimation of activity risk difficulty	E1
Technical & Operational Management	Instructor lack of experience/competence	E8,E9,E16
Technical & Operational Management	Supervisor's return from leave poorly handled	D6
Technical & Operational Management	Failure to check maps on weather fax	D8,E1
Technical & Operational Management	Failure to check for subsequent weather forecasts	D8,E2
Technical & Operational Management	Instructor belief in competence to lead trip	
Technical & Operational Management	Failure of staff to question/prevent trip	E2,E10
Physical Processes & Actor Activities	Failure to assess/appreciate hazards	E2,E4,E8,E9
Physical Processes & Actor Activities	initiation of trip activity	
Physical Processes & Actor Activities	Unconfident swimmers in group	E6,E8,E13
Physical Processes & Actor Activities	Decision to undertake full gorge trip	
Physical Processes & Actor Activities	Failure to assess conditions	E8
Physical Processes & Actor Activities	Slow progress of group	E8
Physical Processes & Actor Activities	Failure to use halfway ledge/last high water escape	E8
Physical Processes & Actor Activities	Group stranded on ledge	
Physical Processes & Actor Activities	Decision to leave ledge	
Physical Processes & Actor Activities	Communication device failures	E9,E11,E12
Physical Processes & Actor Activities	Inadequate /inappropriate plan & instructions	E12,E13,E14

Contributing Factor

Government  
Policy &  
Budgeting

Regulatory Bodies & Associations

I Area Government Planning & Budgeting, Company Management



# Determining Scope

- Based on the Taxonomy you selected for your analysis, determine what things are:
  - In Scope
  - Out of Scope

# In Scope Prioritization

- Risk Mitigation Impact (RMI)
  - What will get you the greatest impact with the least amount of resources?
  - What is the single most important factor to address that would have a significant impact regardless of resources?
  - If it is resource intense, how will you make the case for getting those resources?
  - Who are your stakeholders to help you?



# Scope Assessment

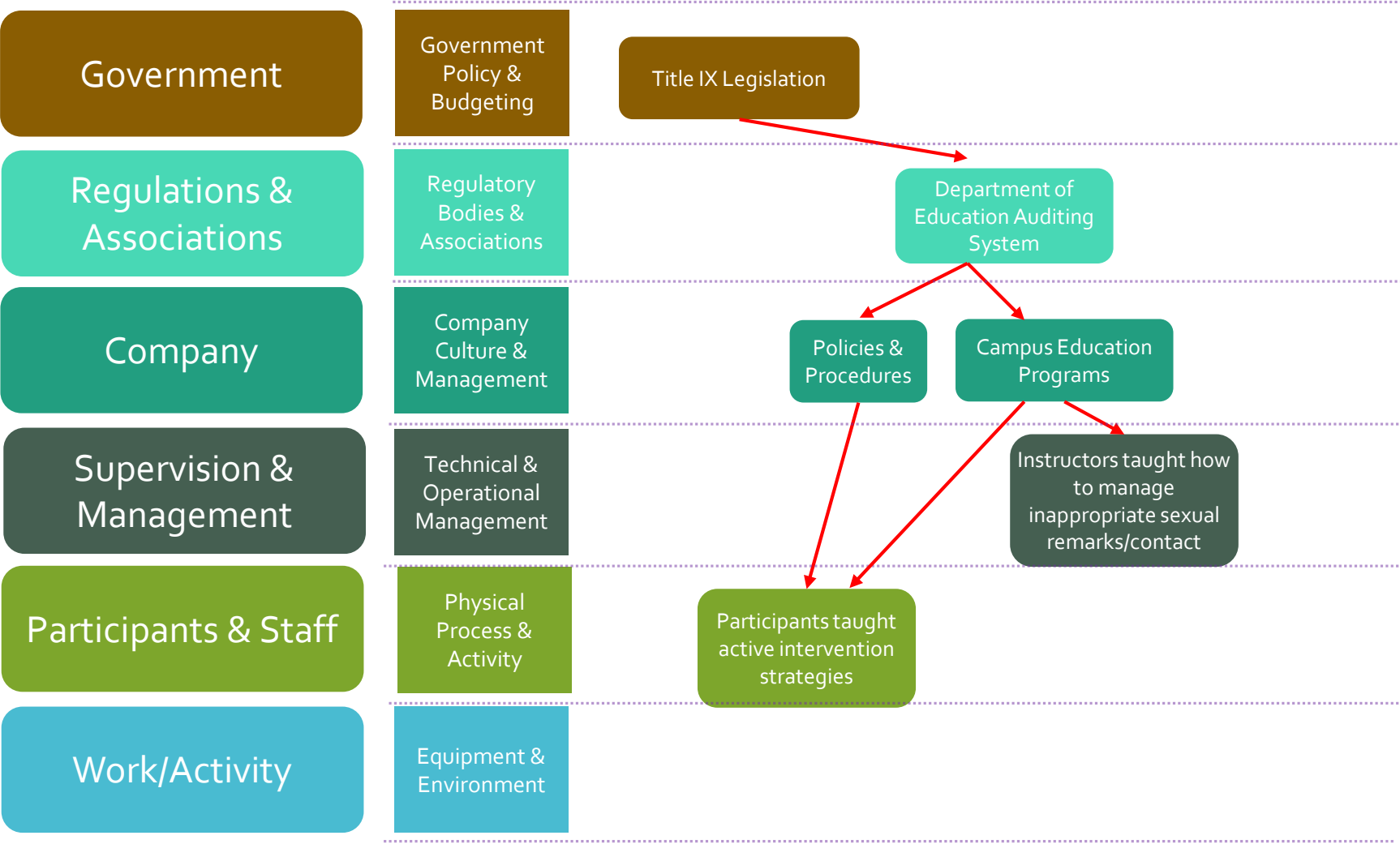
# Safety II = PreventiMaps

- Safety I = AcciMaps (hazard analysis)  
“What went wrong?”

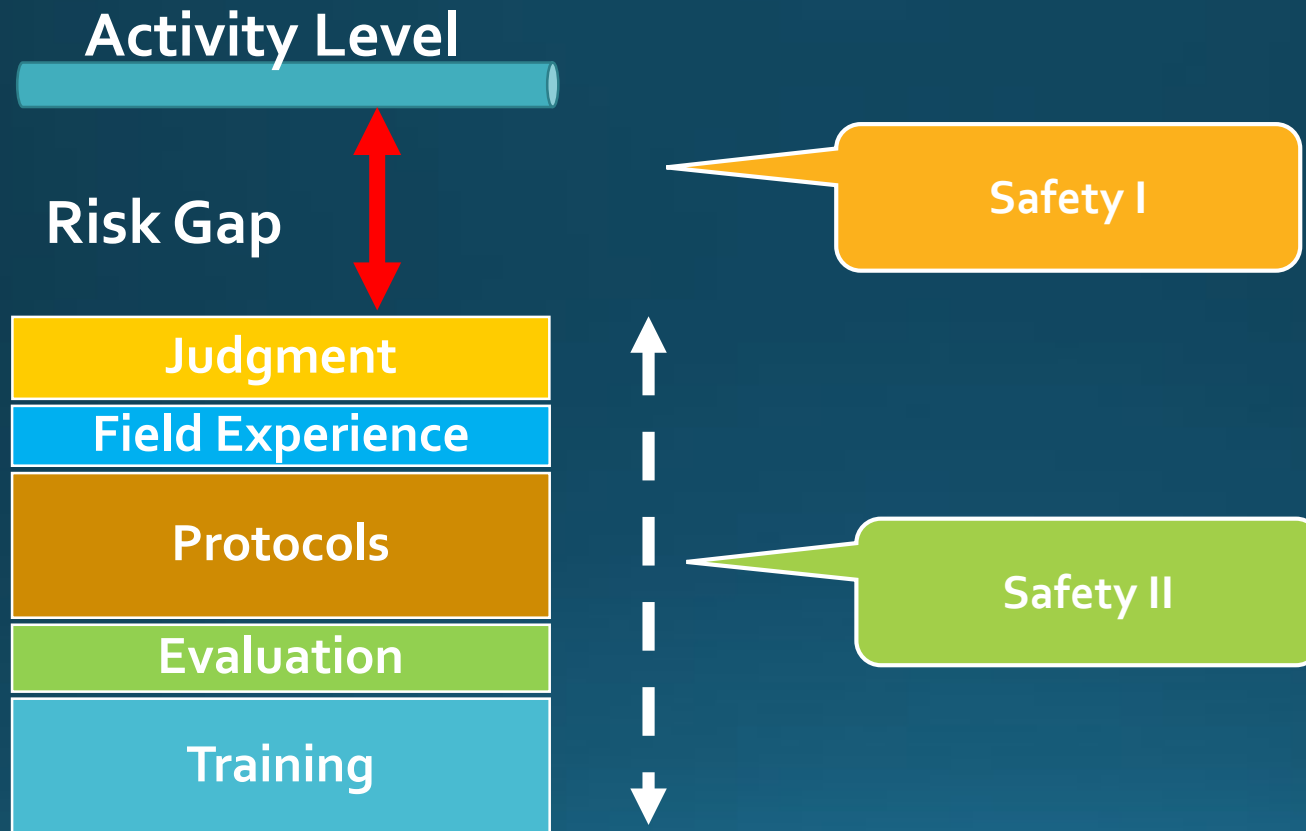
then

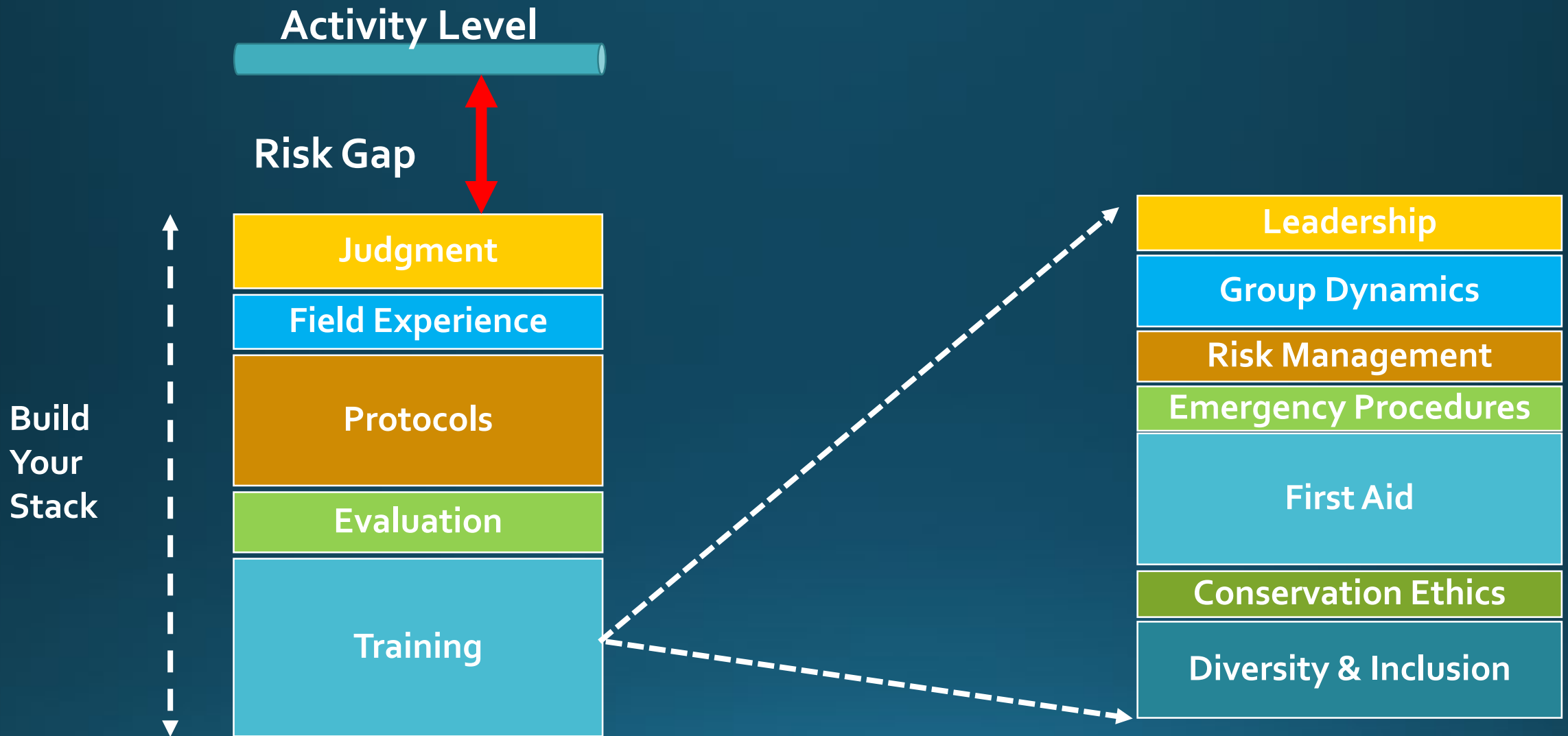
- Safety II = PreventiMaps (mitigation analysis)  
“What went right?”

# Title IX Implementation on Campus



# PreventiMaps: Managing the Risk Gap







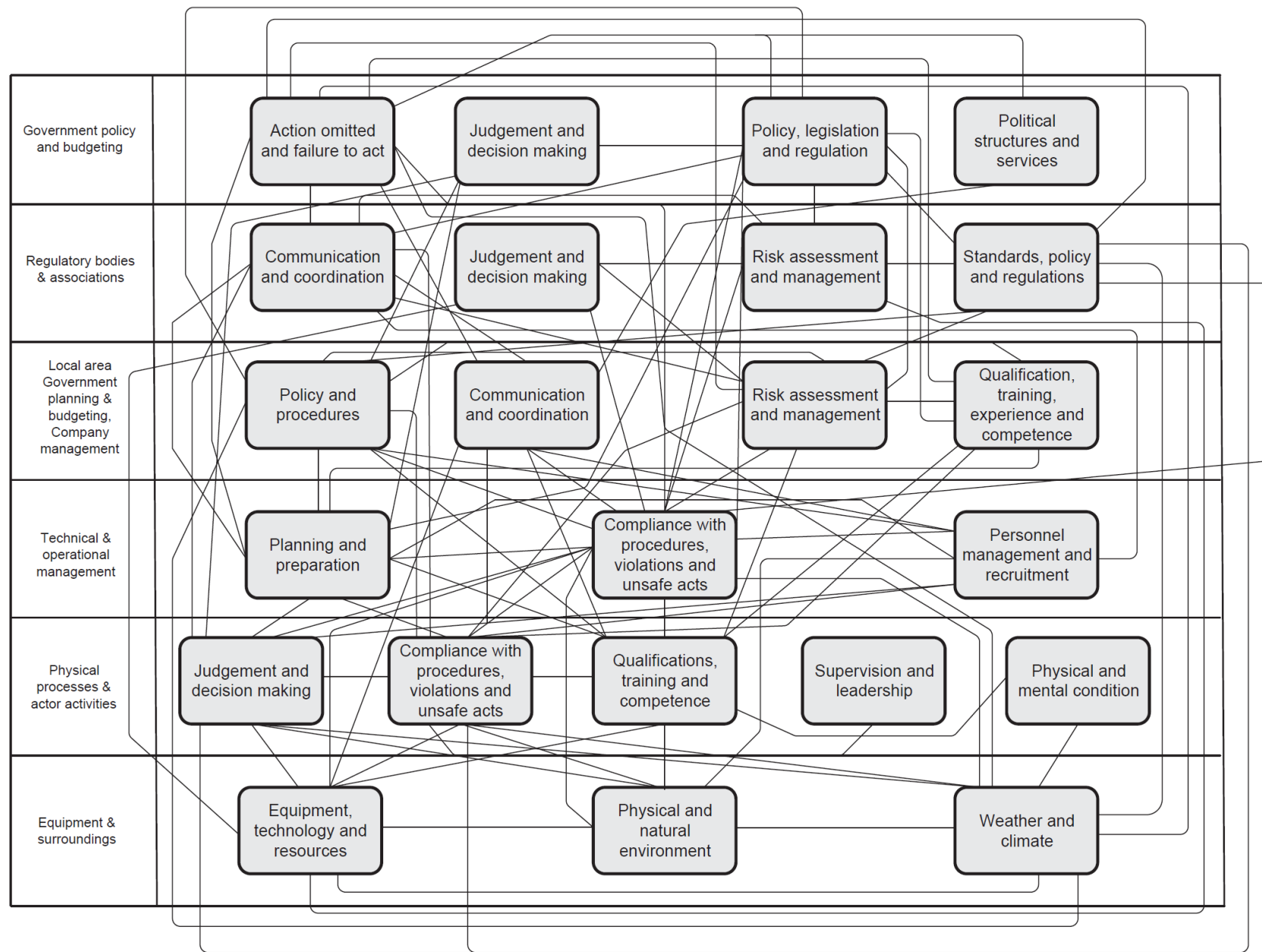
# Meta-analysis of AcciMap Causal Factors

Taxonomy	Contributory Factors	Percent	
Equipment, Environment & Surroundings	Physical & Natural Environment Factors	32.6%	In Scope
Equipment, Environment & Surroundings	Equipment, Technology & Resources	30.8%	In Scope
Equipment, Environment & Surroundings	Weather & Climate	15.1%	Out of Scope (in the field)
Physical processes & Actor Activities	Judgement & Decision Making	20.2%	In Scope
Physical processes & Actor Activities	Compliance with Procedures, Violations & Unsafe Acts	20%	In Scope
Physical processes & Actor Activities	Qualification, Experience & Competence	15%	In Scope



# Meta Analysis of AcciMap Causal Factors

Taxonomy	Contributory Factors	Percent	
Equipment, Environment & Surroundings	Physical & Natural Environment Factors	32.6%	May be In Scope or Out of Scope
Equipment, Environment & Surroundings	Equipment, Technology & Resources	30.8%	In Scope
Equipment, Environment & Surroundings	Weather & Climate	15.1%	Out of Scope (in the field)
Physical processes & Actor Activities	Judgement & Decision Making	20.2%	In Scope
Physical processes & Actor Activities	Compliance with Procedures, Violations & Unsafe Acts	20%	In Scope
Physical processes & Actor Activities	Qualification, Experience & Competence	15%	In Scope







# Top 3 Contributory Factors/Taxonomy Level

<b>Government Policy &amp; Budgeting</b>	Policy, legislation & regulation	Action omitted, failure to act	<b>Judgment &amp; decision making</b>
<b>Regulatory Bodies &amp; Associations</b>	Standards, policy & regulation	Communication & coordination	<b>Judgment &amp; decision making</b>
<b>Local Area Government planning &amp; Budgeting, Company Management</b>	Risk assessment & management	<b>Qualification, experience, training &amp; competence</b>	Policy & procedures
<b>Technical &amp; Operational Management</b>	Planning & preparation	<b>Compliance violations &amp; unsafe acts</b>	Personnel management & recruitment
<b>Physical Processes &amp; Actor Activities</b>	<b>Judgment &amp; decision making</b>	<b>Compliance violations &amp; unsafe acts</b>	<b>Qualification, experience, training &amp; competence</b>
<b>Equipment &amp; Surroundings</b>	Physical & natural environment	Equipment, technology & resources	Weather & climate



# What is a Risk Management Information System?

Database System for collecting and analyzing Incident and Close Call Data that allows you to apply Safety I & Safety II principles of causal analysis to inform your risk management process.

# Developing an RMIS

**Review your  
Incidents**

**1**

**Develop a  
Database**

**3**

**Train staff on  
Submitting data**

**5**

**Implement  
Change**

**7**

**Decide what  
Data to Track**

**2**

**Determine  
Taxonomy**

**4**

**Build Analytics**

**6**

# What Data to Track?

- Start with an assessment of past incidents
  - What are most common?
  - What are the most severe?
  - What incidents are commonly associated with that activity, population, etc. (even if it hasn't happened to you)
  - What has never happened (or you never heard about it) but you need to prepare for?

# RMIS Data



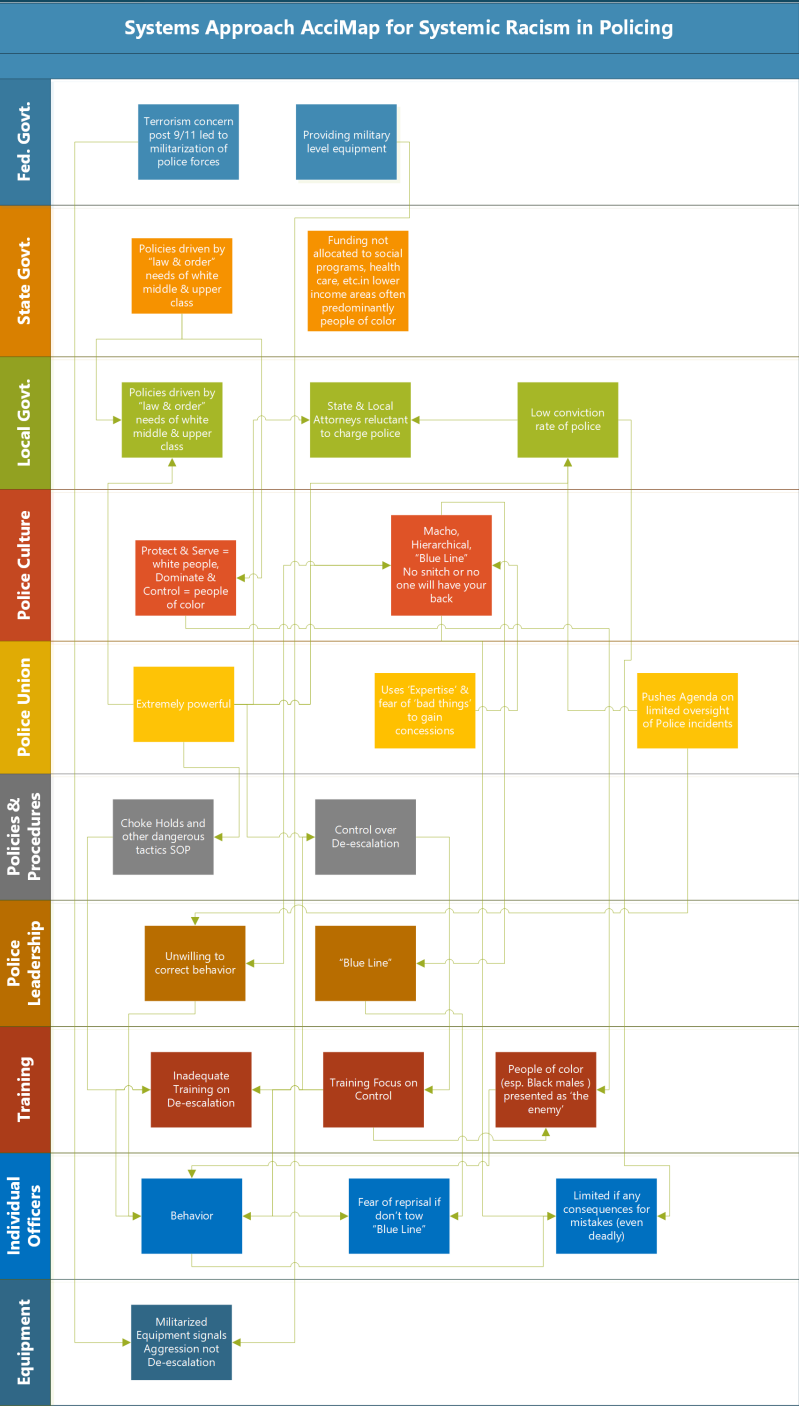
# IncidentAnalytix Demo

# Implementing Culture Change – Safety I & Safety II

## Diversity & Inclusion Risks

- **Physical Safety** is only one dimension on the Risk Management spectrum
- **Emotional Safety** is equally important and Hazards can be equally life threatening
  - Teens committing suicide after bullying
  - LGBTQ individuals being harassed
- Talk to your staff about where there are Emotional/Interpersonal Hazards, Assess the Risk Level, and establish the necessary guidelines, structures, protocols, culture to manage the risk





# Concept Review

- Safety I
- Safety II
- Taxonomy of Causation
- Systems Thinking
- Collecting Incident and Close Call Data
- Building AcciMaps
  - Identifying In Scope vs Out of Scope
  - Determining RMI for In Scope
- Building PreventiMaps
- Implementing Data Driven Organizational Change

# Take Aways

- Develop your Incident Data Management Plan
  1. Review your Incidents
  2. Decide What to Track
  3. Develop a Database
  4. Determine Taxonomy
  5. Train your Staff in collecting/submitting data
  6. Build your Analytics
  7. Implement Program Changes based on actionable data

## Key Resources

- Risk Management in a Dynamic Society: A modeling problem – Jens Rasmussen (1997) - <https://orbit.dtu.dk/ws/files/158016663/SAFESCI.pdf>
- From Safety-I to Safety-II: A White Paper – Hollnagel E; Wears RL; Braithwaite J. (2015) - <https://www.england.nhs.uk/signuptosafety/wp-content/uploads/sites/16/2015/10/safety-1-safety-2-white-papr.pdf>
- Translating Systems Thinking Into Practice: A Guide to Developing Incident Reporting Systems – Goode, Salmon, Lenne, Finch – Available at Amazon Books
- <https://www.IncidentAnalytix.com>
- Contact: Rick Curtis – [staff@incidentanalytix.com](mailto:staff@incidentanalytix.com)

# Videos & Articles

- 1.5.5 Safety I vs Safety II - <https://www.youtube.com/watch?v=WMoLVvgNrhM>
- Doing Safety Differently – Sydney Dekker: <https://www.youtube.com/watch?v=6gREMV6j2A4>
- Safety II & Safety II – Erik Hoffnagel: <https://vimeo.com/channels/1366431/89492241>
- Perceiving what cannot be seen” - the practical side of Safety - II - Erik Hollnagel: <https://vimeo.com/159498494>
- A story of Safety II – Jeffrey Braithwaite: <https://www.youtube.com/watch?v=gauR843rRNk>
- Safety Differently | The Movie: <https://www.youtube.com/watch?v=moh4QN4IAPg>
- Sidney Dekker — Safety Differently Lecture: <https://www.youtube.com/watch?v=oMtLSofNDZs>
- Sidney Dekker — Just Culture short course 1: <https://www.youtube.com/watch?v=PVWjgqDANWA>
- The New View of Safety with Todd Conklin: <https://www.youtube.com/watch?v=loYUQlWiRgc>
- Dr. Todd Conklin speech "Risk Analysis is Fixed in Time - But Hazards Ebb and Flow: <https://www.youtube.com/watch?v=X211fU398o8>

# Videos & Articles

- Guidelines for AcciMap Analysis: [https://openresearch-repository.anu.edu.au/bitstream/1885/20987/2/01\\_Branford\\_Guidelines\\_for\\_ACCIMAP\\_2009.pdf](https://openresearch-repository.anu.edu.au/bitstream/1885/20987/2/01_Branford_Guidelines_for_ACCIMAP_2009.pdf)
- Webinar: An Introduction to “New Safety” (HOP, Safety II, and Safety Differently): <https://www.youtube.com/watch?v=zqZVGaFlhyw>
- FAA Safety Management Systems (SMS) Fundamentals: Policy: <https://www.youtube.com/watch?v=j8NoPZx5YwM>
- FAA Safety Management Systems (SMS) Fundamentals: Safety Risk Management Component: <https://www.youtube.com/watch?v=b6dwxQ3oEAE>
- Mangatepopo canyoning tragedy a decade on: 'I know they would be loving every minute of life': [https://www.nzherald.co.nz/nz/news/article.cfm?c\\_id=1&objectid=12032068](https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12032068)
- In a Flash TV Movie: <https://www.tvnz.co.nz/shows/in-a-flash/episodes/s1-e1>
- BBC NASA Challenger Disaster: <https://www.youtube.com/watch?v=reM5fTo-6PI>
- Challenger Disaster Governmental Report: <https://www.govinfo.gov/content/pkg/GPO-CRPT-99hrpt1016/pdf/GPO-CRPT-99hrpt1016.pdf>
- A Review of Accident Modelling Approaches for Complex Critical Sociotechnical Systems: <https://www.semanticscholar.org/paper/A-Review-of-Accident-Modelling-Approaches-for-Qureshi/c3a597212068c27be45d84dec76e86baabd4cf90>

# Final Thoughts

The biggest mistake  
about a mistake  
is not learning from it.

# Resources

[www.OutdoorEd.com](http://www.OutdoorEd.com)  
[www.IncidentAnalytix.com](http://www.IncidentAnalytix.com)