Applying Systems Thinking for Risk Management & Harm Mitigation: Understanding Safety-I and Safety-II

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Introduction

Rick Curtis

Pronouns: he, him, his

Land Acknowledgement

Director, Princeton University Outdoor Action Program

Founder: **www.IncidentAnalytix.com**

Founder: **www.OutdoorEd.com**

Author: **The Backpacker's Field Manual**

Introduce Yourself

- Name
- Pronouns
- Program Type
- What is your role
- Any goals you have

Format

- Presentation
- Small Group Work
- Sharing your Knowledge
- Questions - throughout
  - Parking Lot
- Discussion - throughout
  - Parking Lot

Always maintain your personal safety

Discussing and analyzing incidents and incident causation can be triggering for people.

Keep your own personal safety in mind at all times as well as the safety of others in the room.

If at any point you feel uncomfortable, take a safety break.

If you feel unsafe, let me know if there is anything I can modify in my presentation.

Guidelines

What is discussed here regarding specific incidents or personal stories stays in this room.

Real names should not be used except when they refer to situations that are clearly in the public domain (ex. Larry Nassar)

We are here to create safer programs, not to assign blame.

Learning Objectives

- Understand the **Systems Thinking Approach** to risk management
- Learn how the **Safety-I** framework and **Safety-II** framework are complementary parts of an overall risk management plan
- 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**

Concepts

Systems Thinking

Safety-I

Safety-II

Terminology

- **Safety Science** - concerned with finding and understanding the causes of adverse incidents and accidents and discovering ways to prevent them
- **Domains/Subdomains** – the industry/work setting where you operate (health care, aviation, outdoors – therapeutic adventure vs college outdoor program)

Terminology

- **Socio-technical System** – a system where there a many different components interacting to create the outcome/goals (people, technology, tools, transportation, environment, etc.)
- **Taxonomy** – the practice of classification of things or concepts. Related to the Domain.

Terminology

- **Incident/Event** – Something that occurred
  - **Accident –** an event with some adverse outcome
  - **Close Call** – an event with the possibility of an adverse outcome but none occurred

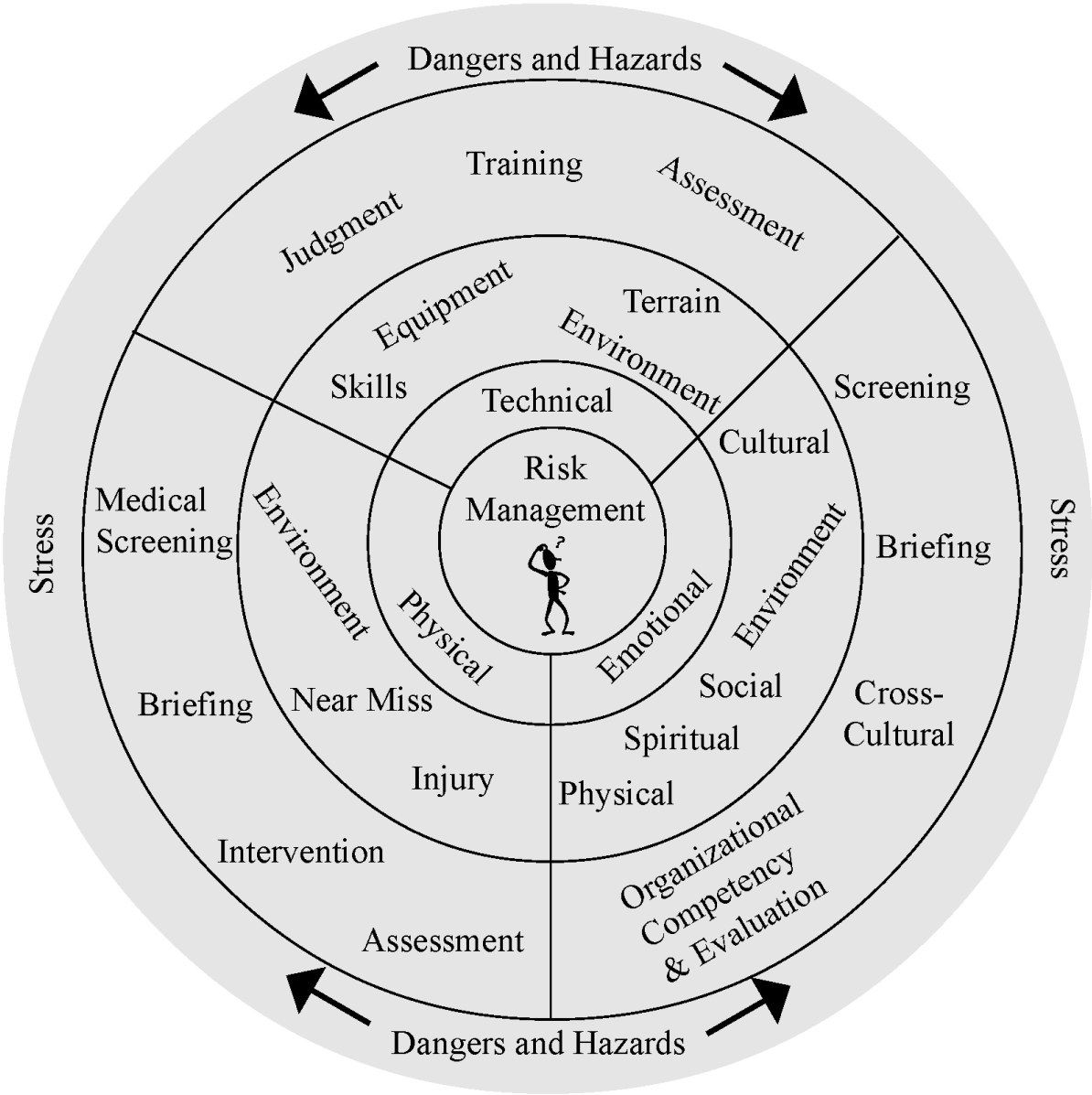
Diversity & Inclusion Risks

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

Remembering our colleague Nina Roberts

https://give.sfsu.edu/roberts

Humanistic Model of Risk Management
WRMC Proceedings 1997

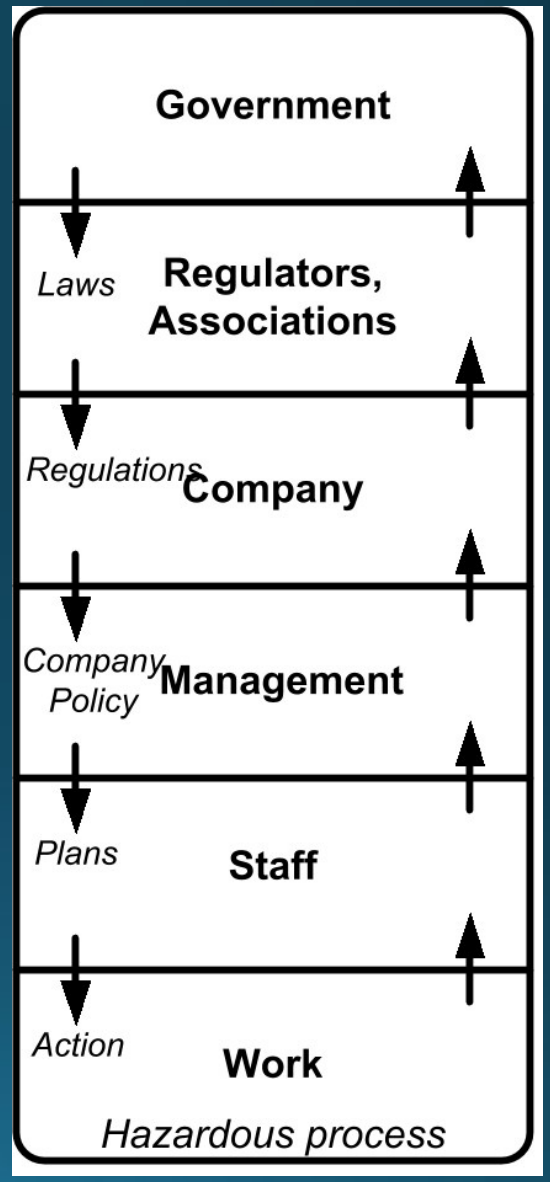


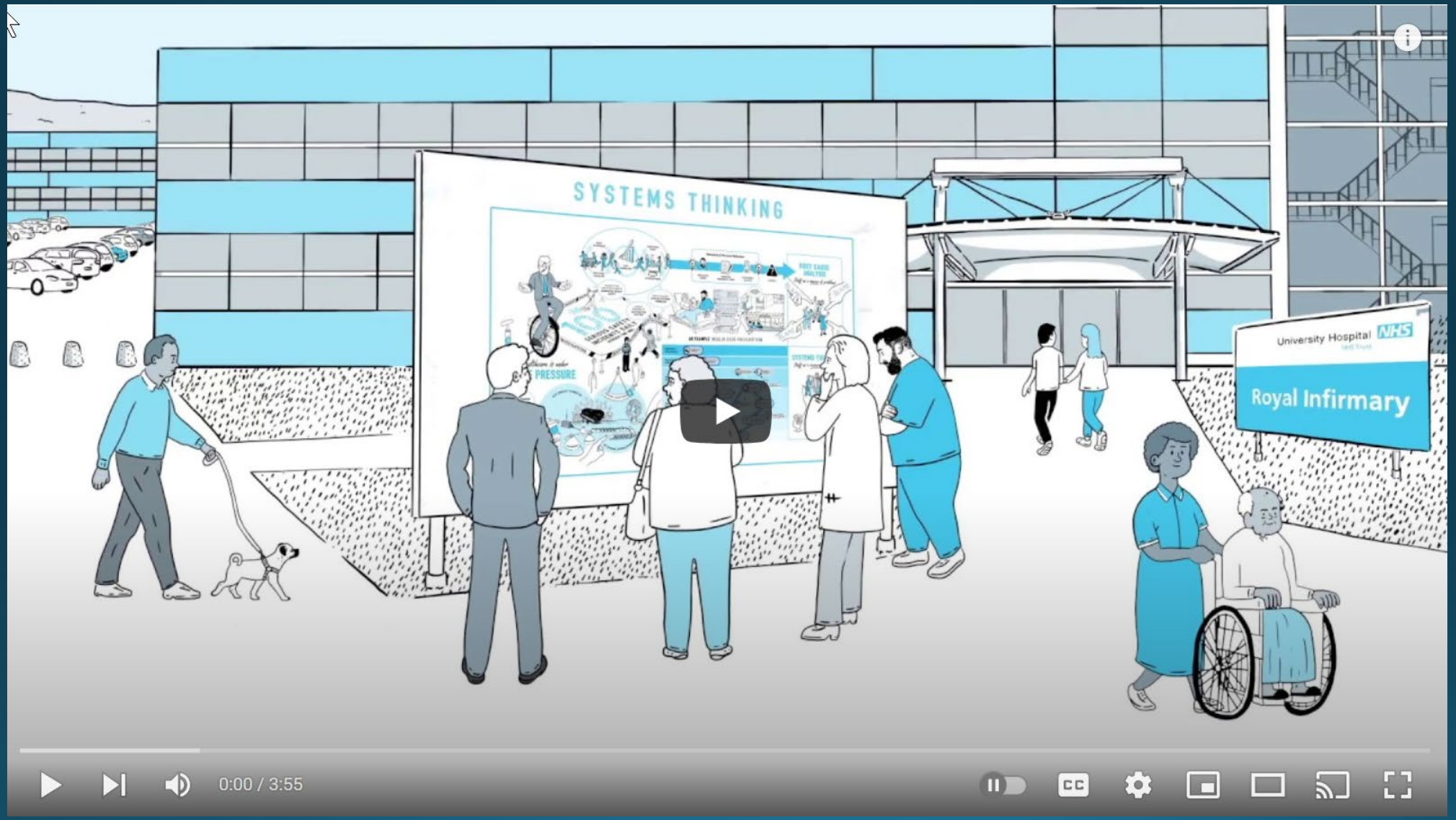
Concepts

Systems Thinking

Systems Thinking

Risk Management in a Dynamic Society
Jens Rasmussen, Safety Science, 1997





SystemsThinking - A New Direction in Healthcare Incident Investigation

Systems Thinking

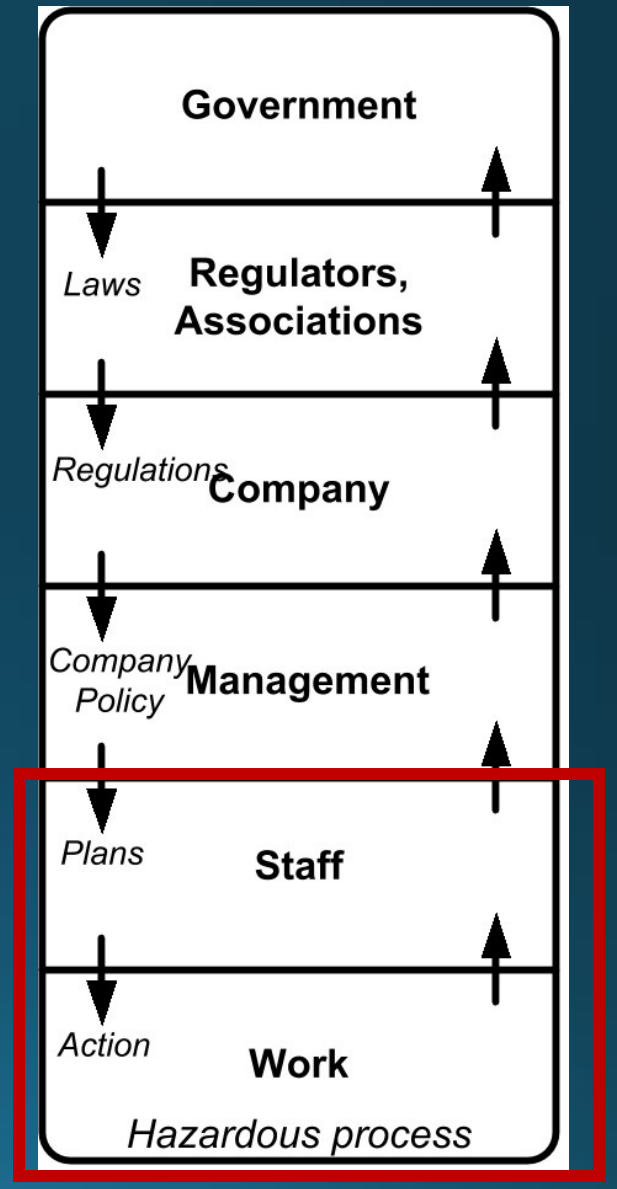
- Near misses and adverse events are caused by multiple, interacting, contributing factors, not just a single bad decision or action.
- Behavior and safety is impacted by the decisions and actions of everyone in the system, not just individuals.
- Effective countermeasures focus on systemic changes rather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

UPLOADS Project, https://uploadsproject.org

Systems Thinking

Risk Management in a Dynamic Society
Jens Rasmussen, Safety Science, 1997

Traditional Accident Analysis focuses here



Concepts

Systems Thinking

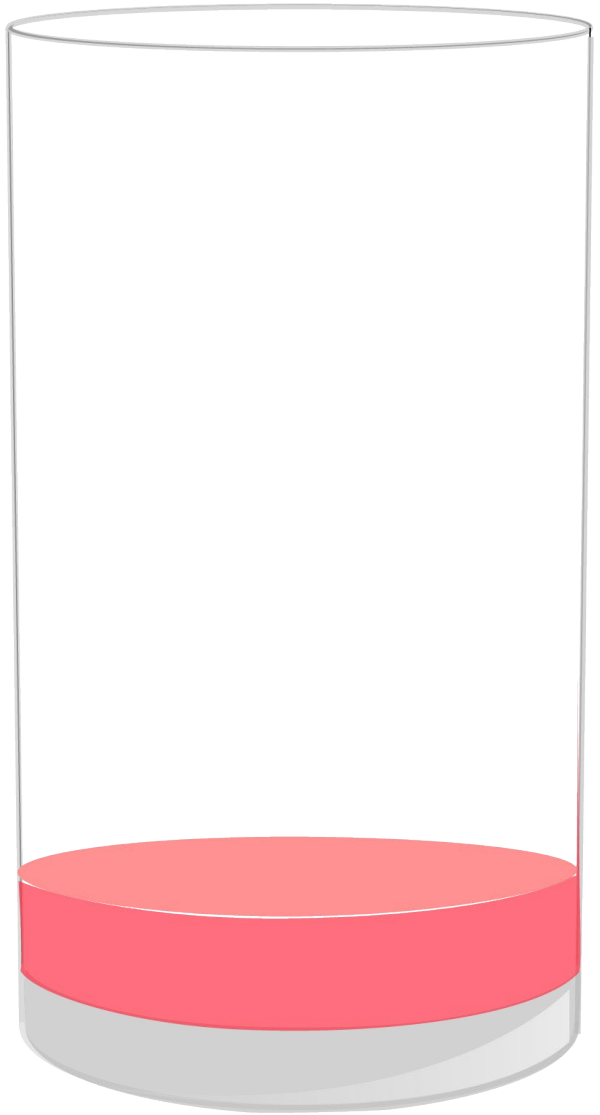
Safety-I

Safety-I

What's Going Wrong?

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

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



Safety-I

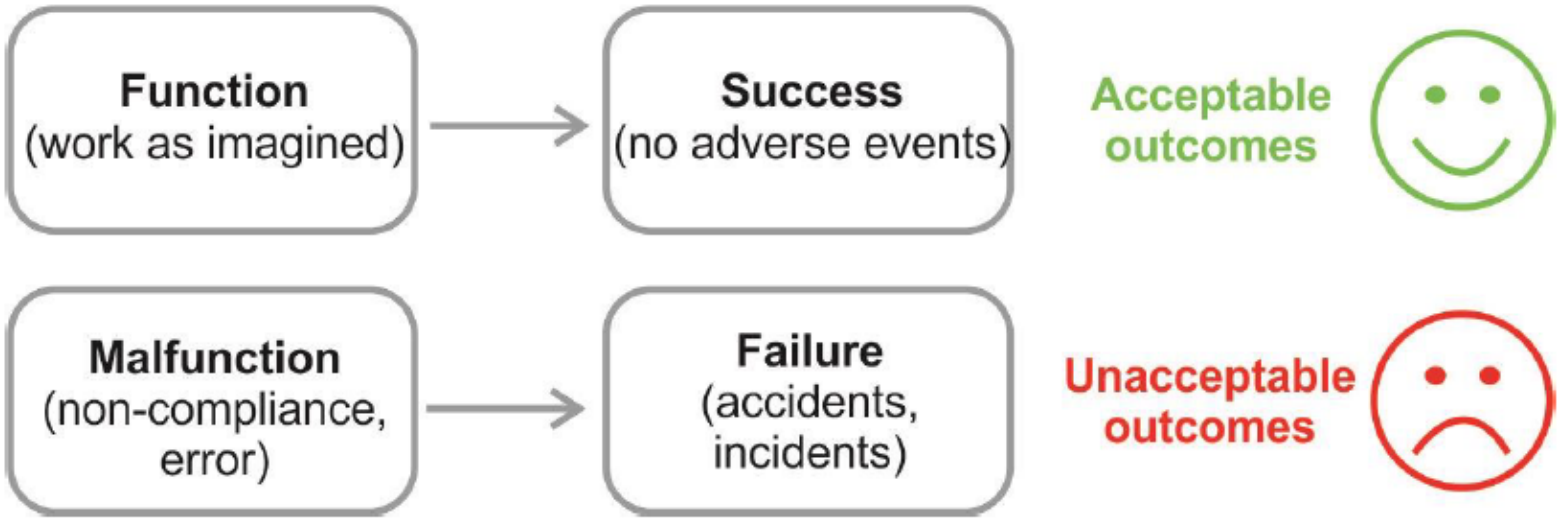


Figure 2: Safety-I assumes that things that go right and things that go wrong happen in different ways

- 1. Hollnagel, E. Wears, R., Braithwaite, J. - EUROCONTROL (2013). *From Safety-I to Safety-II (A White Paper)*. Brussels.

	Safety-I
Definition of Safety	As few things as possible go wrong
Safety Management Principle	Reactive, 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 problem to be fixed.
Accident Investigation	Accidents are cause by failures and malfunctions. The purpose of an investigation is to identify the causes.

Safety-I

- 1. Hollnagel, E. Wears, R., Braithwaite, J. - EUROCONTROL (2013). *From Safety-I to Safety-II (A White Paper)*. Brussels.

Concepts

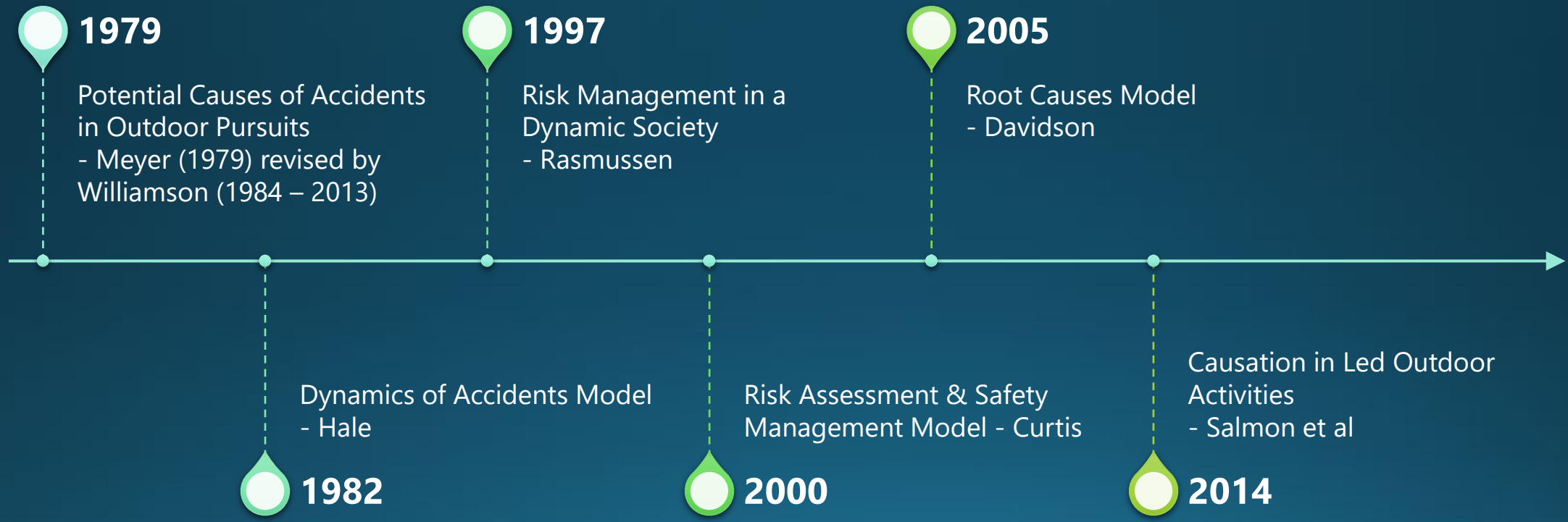
Systems Thinking

Safety-I

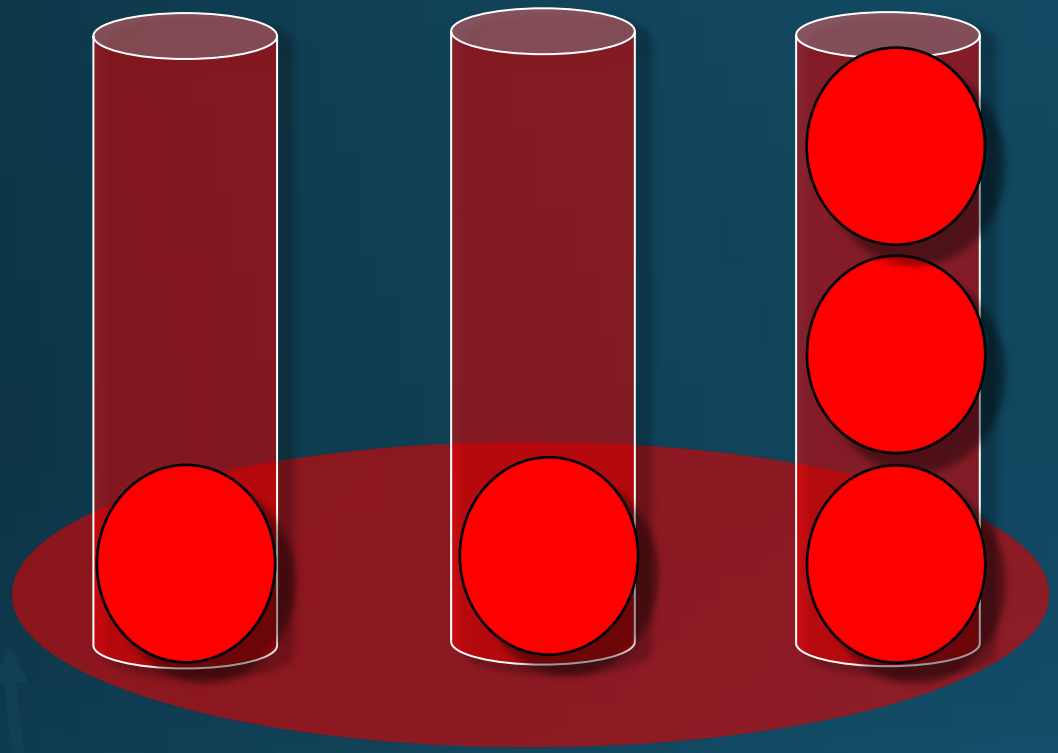
Contributing Factors

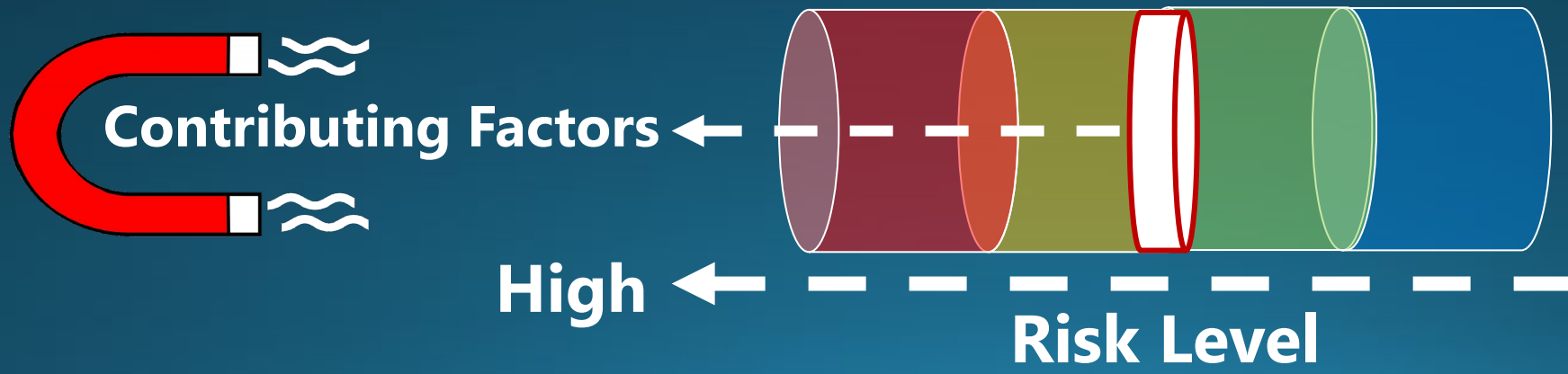
Taxonomy

Causation Taxonomies for Outdoor Industry

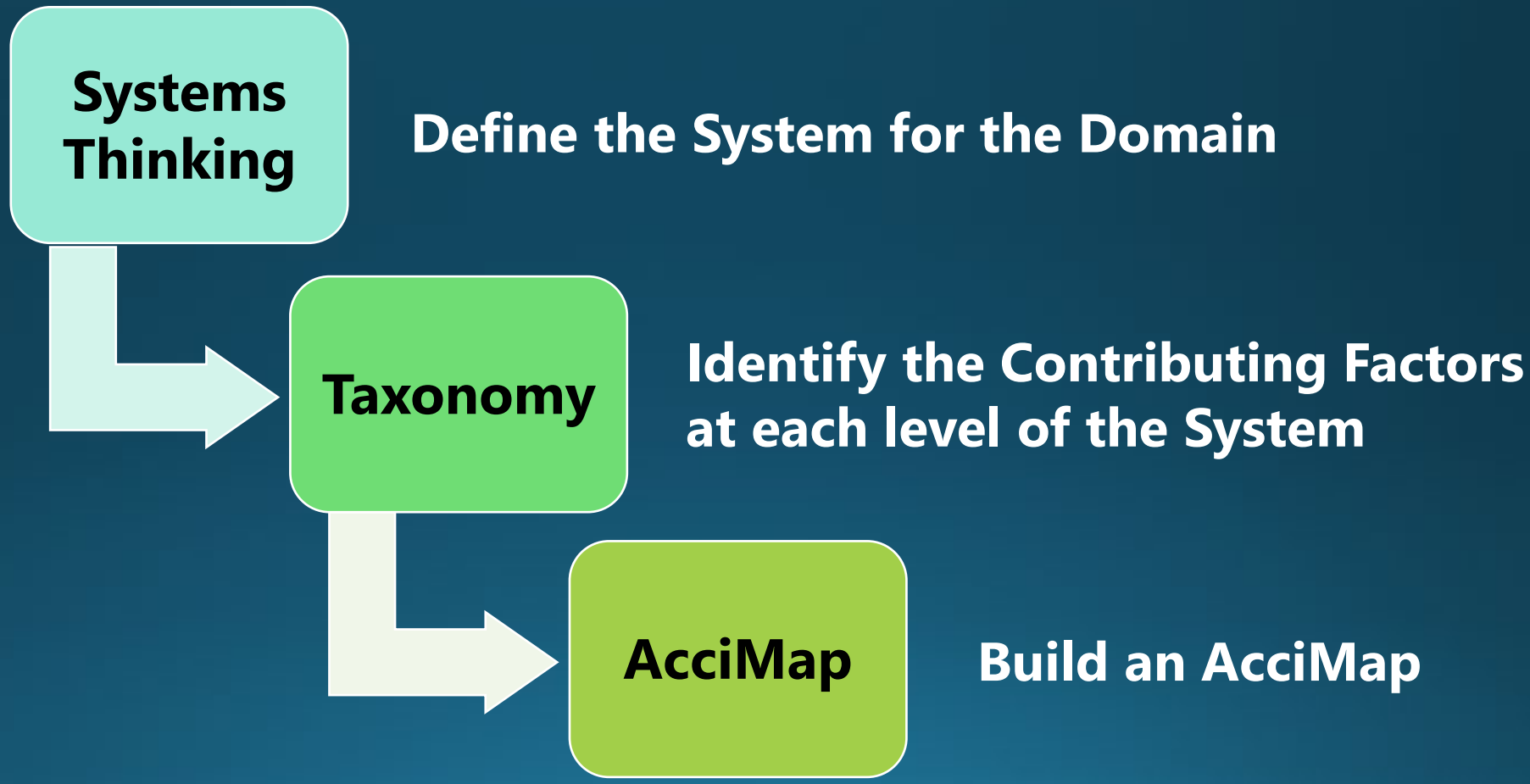


Risk Assessment & Safety Management (RASM)
Contributing Factors





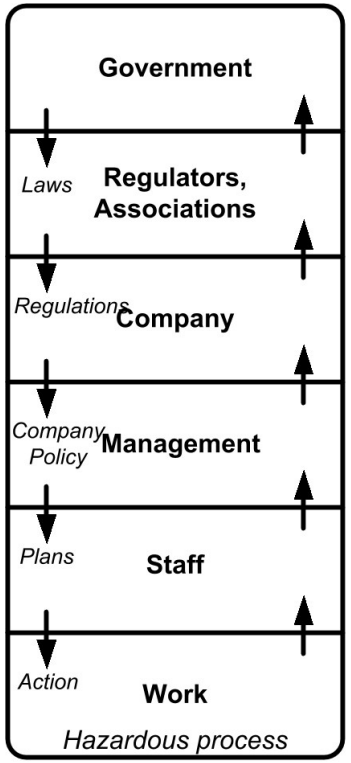
Rasmussen's AcciMap Approach



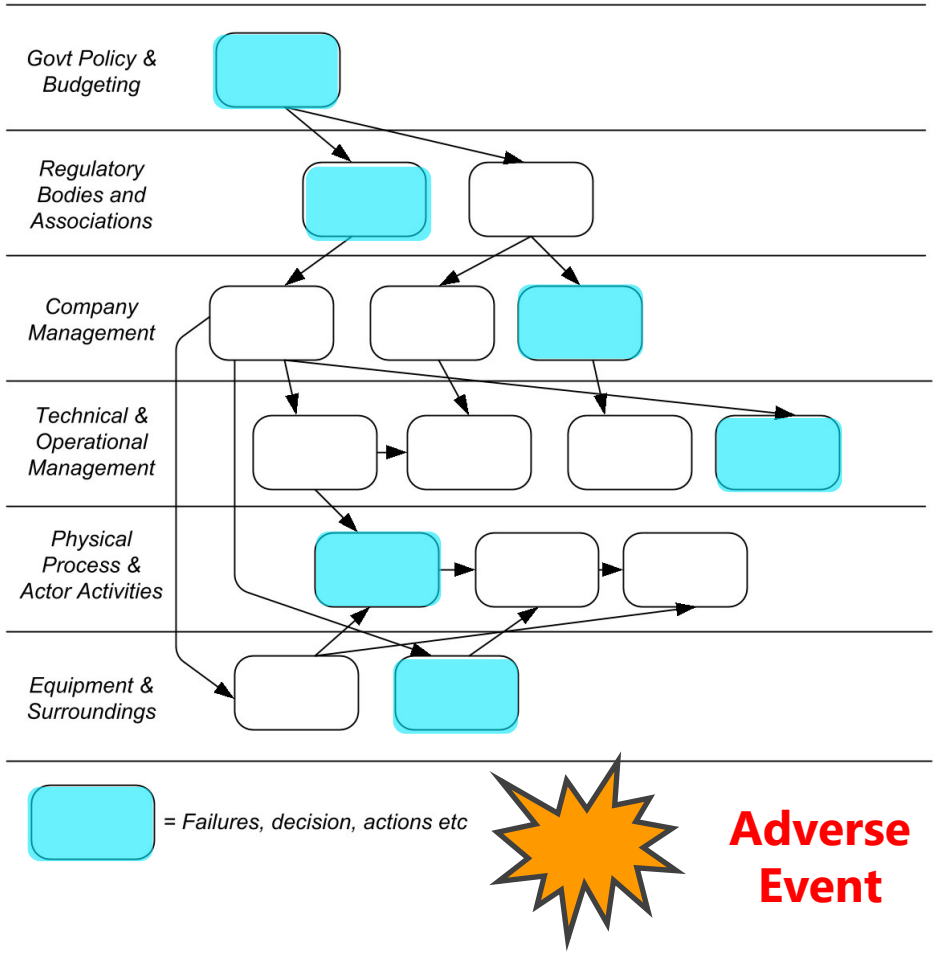
AcciMaps

- Map of a Sociotechnical system
- Root Cause Analysis approach is 'deprecated'

Taxonomy

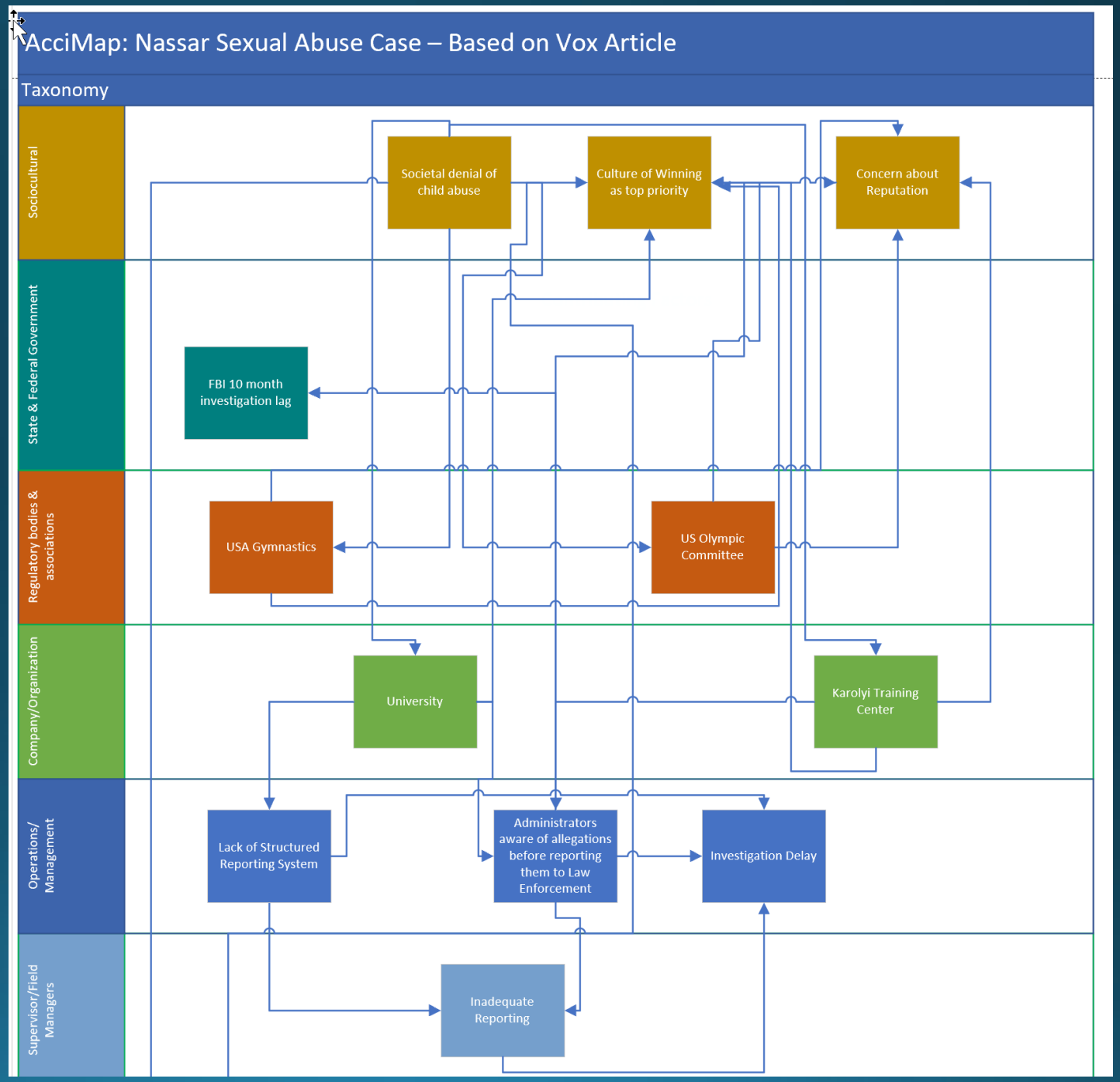


Contributing Factors



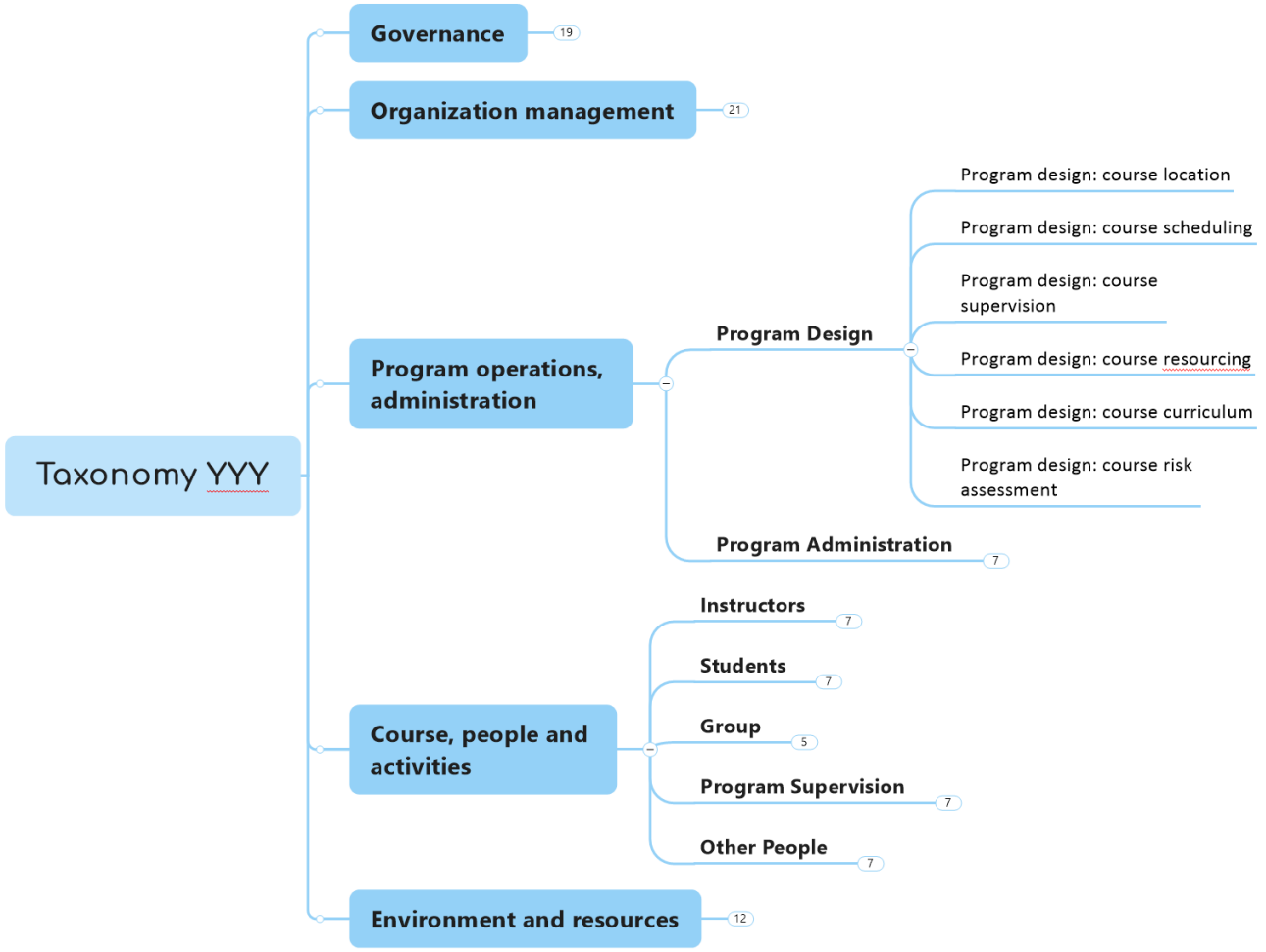
Larry Nassar Case

- AcciMap based on Rasmussen's Systems Thinking Model



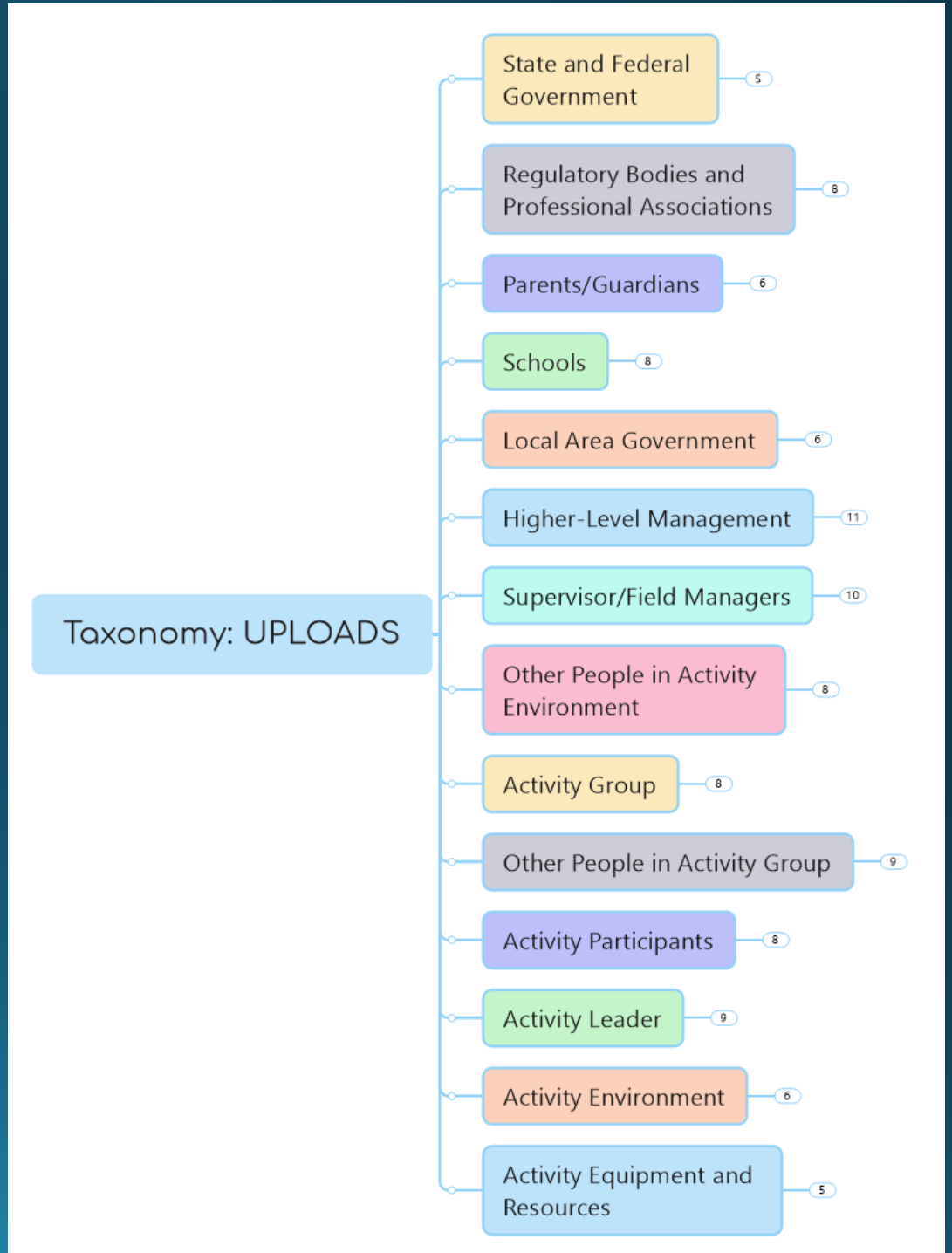
Taxonomy Examples

Sample Taxonomy with XXX, YYY, Generic



Sample Taxonomy

- Taxonomy for Causation in Led Outdoor Activities



From Translating Systems Thinking Into Practice: A Guide to Developing Incident Reporting Systems - By Natassia Goode, Paul M. Salmon, Michael Lenne, Caroline Finch

Case Study

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

Mangatepopo Tragedy - NZ

Building an AcciMap

Domain	Taxonomy	Factors	Relationships	Analysis
Identify the levels of your System based on your Domain	Identify a Taxonomy of Factors	Identify Contributing Factors in the Incident	Identify Relationships between Factors	Formulate Recommendations based on Scope

Build an AcciMap

- Use the AcciMap Template
- Enter Contributing Factors at the appropriate Taxonomy Level
- Identify Relationships
- Identify what is In Scope

Scope Assessment

Determining Scope

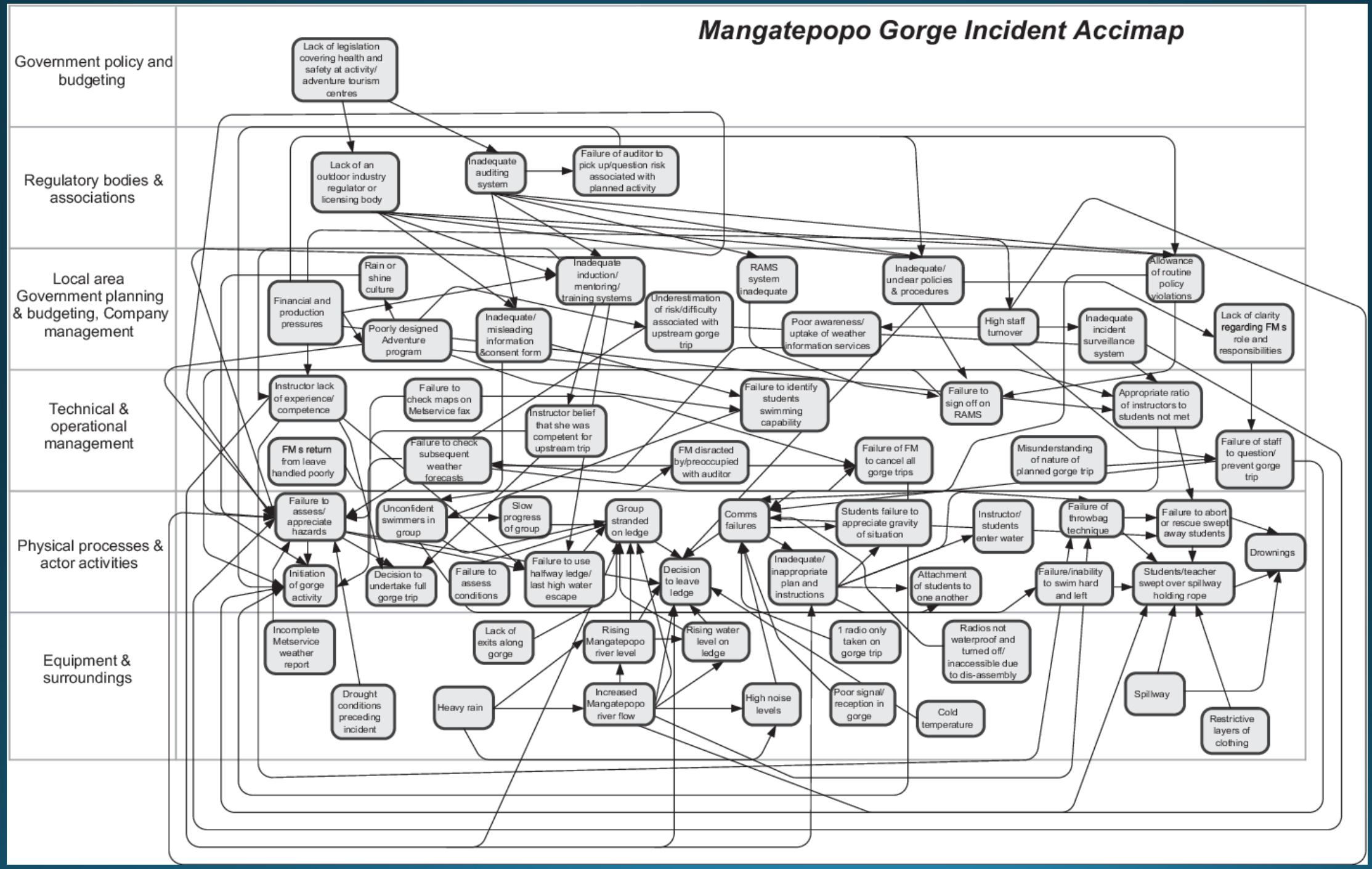
- Based on the Taxonomy determine what things are:
  - In Scope
  - Out of Scope

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?

Analyze in small groups

Report findings

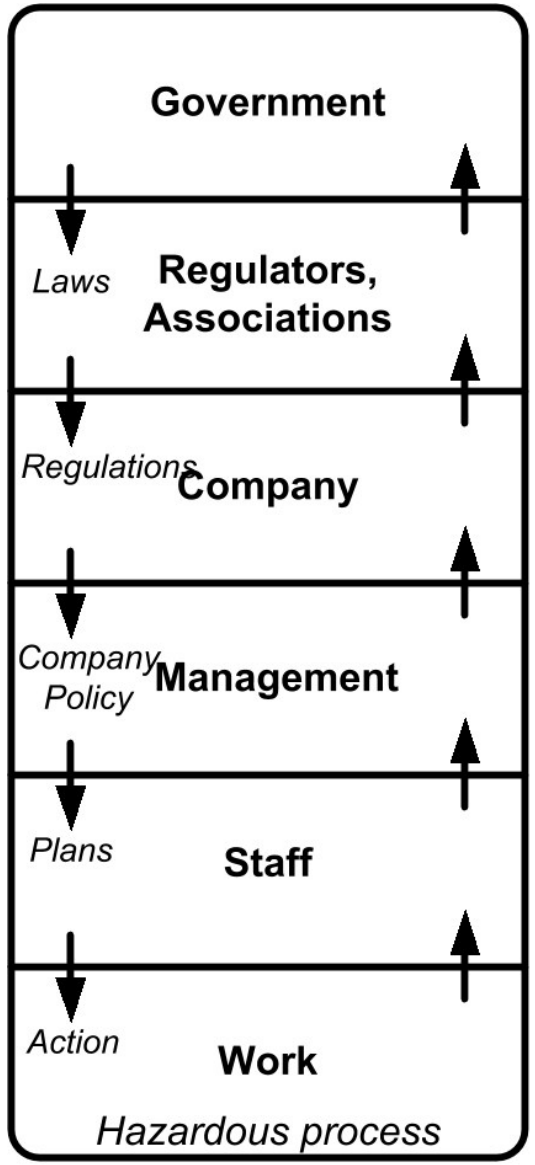

Mangatepopo Gorge Incident Accimap
Government policy and budgeting
Regulatory bodies & associations
Local area Government planning & budgeting, Company management
Technical & operational management
Physical processes & actor activities
Equipment & surroundings
Lack of legislation covering health and safety at activity/ adventure tourism centres
Lack of an outdoor industry regulator or licensing body
Inadequate auditing system
Failure of auditor to pick up/question risk associated with planned activity
Rain or shine culture
Financial and production pressures
Poorly designed Adventure program
Inadequate induction/ mentoring/ training systems
Inadequate/ misleading information &consent form
Underestimation of risk/difficulty associated with upstream gorge trip
RAMS system inadequate
Poor awareness/ uptake of weather information services
Inadequate/ unclear policies & procedures
High staff turnover
Allowance of routine policy violations
Inadequate incident surveillance system
Lack of clarity regarding FM s role and responsibilities
Instructor lack of experience/ competence
Failure to check maps on Metservice fax
Instructor belief that she was competent for upstream trip
Failure to identify students swimming capability
Failure to sign off on RAMS
Appropriate ratio of instructors to students not met
FM s return from leave handled poorly
Failure to check subsequent weather forecasts
FM disracted by/preoccupied with auditor
Failure of FM to cancel all gorge trips
Misunderstanding of nature of planned gorge trip
Failure of staff to question/ prevent gorge trip
Failure to assess/ appreciate hazards
Unconfident swimmers in group
Slow progress of group
Group stranded on ledge
Comms failures
Students failure to appreciate gravity of situation
Instructor/ students enter water
Failure of throwbag technique
Failure to abort or rescue swept away students
Drownings
Initiation of gorge activity
Decision to undertake full gorge trip
Failure to assess conditions
Failure to use halfway ledge/ last high water escape
Decision to leave ledge
Inadequate/ inappropriate plan and instructions
Attachment of students to one another
Failure/inability to swim hard and left
Students/teacher swept over spillway holding rope
Incomplete Metservice weather report
Lack of exits along gorge
Rising Mangatepopo river level
Rising water level on ledge
1 radio only taken on gorge trip
Radios not waterproof and turned off/ inaccessible due to dis-assembly
Drought conditions preceding incident
Heavy rain
Increased Mangatepopo river flow
High noise levels
Poor signal/ reception in gorge
Cold temperature
Spillway
Restrictive layers of clothing

Systems Thinking is all about Data

"Data is Safety"

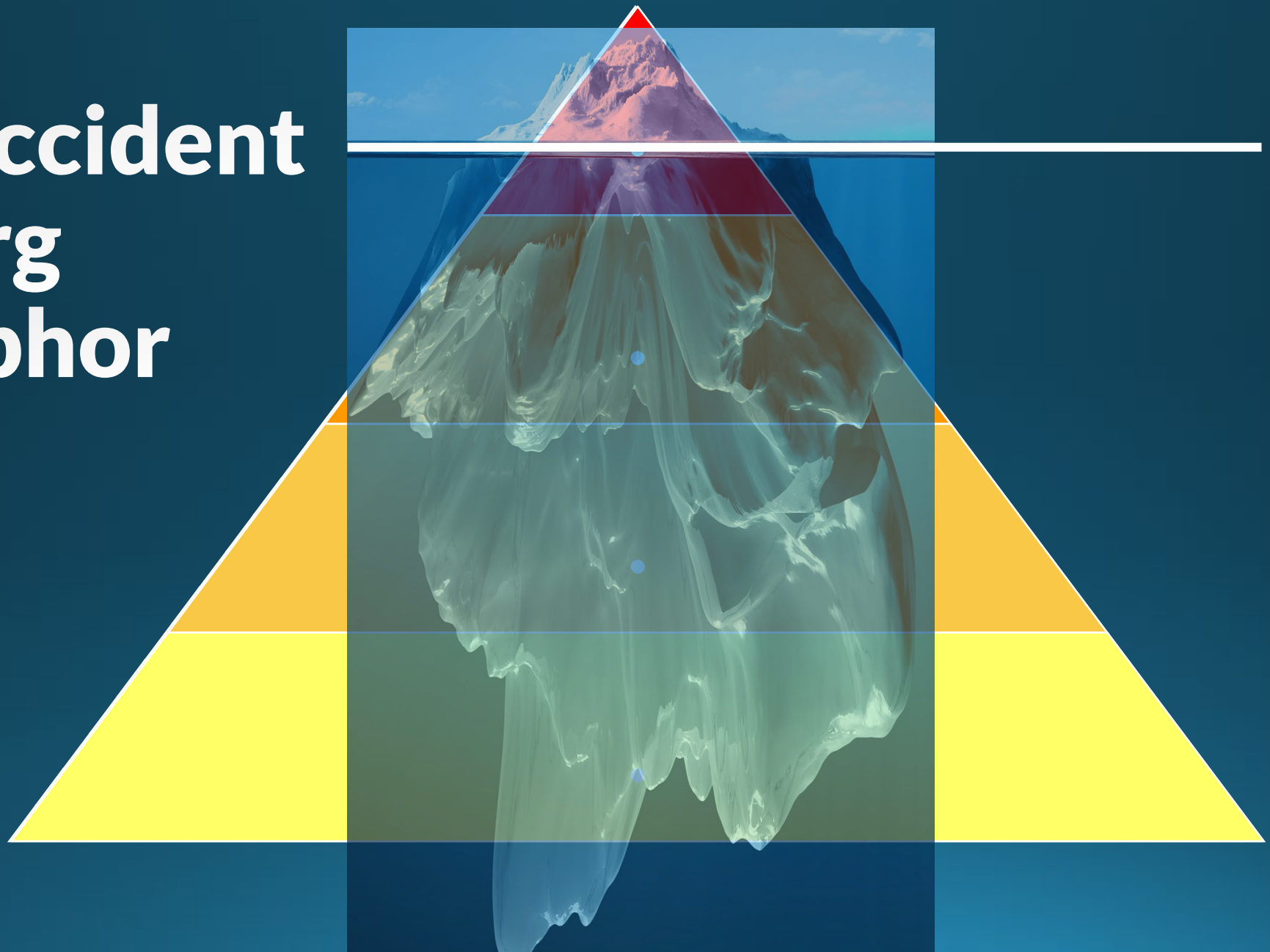
Incident Data Collection

- Systems Thinking requires that you collect incident and near miss data in order to assess and manage risk

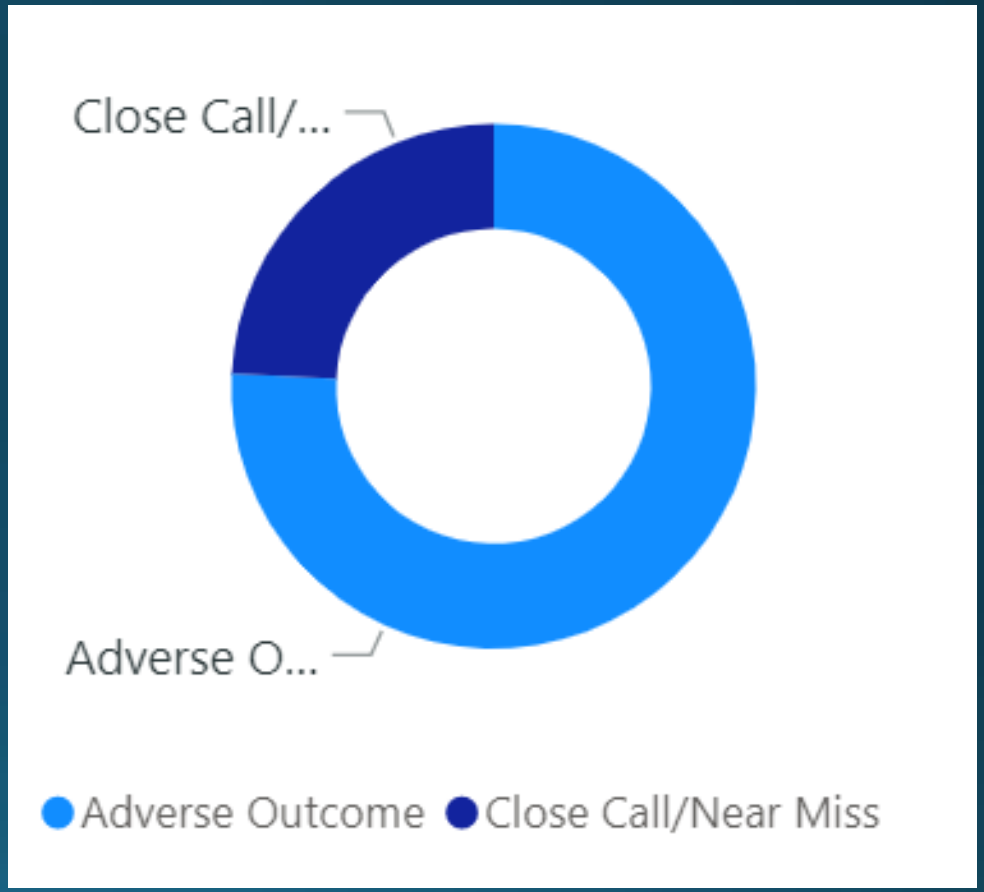


Accident Pyramid

The Accident Iceberg Metaphor

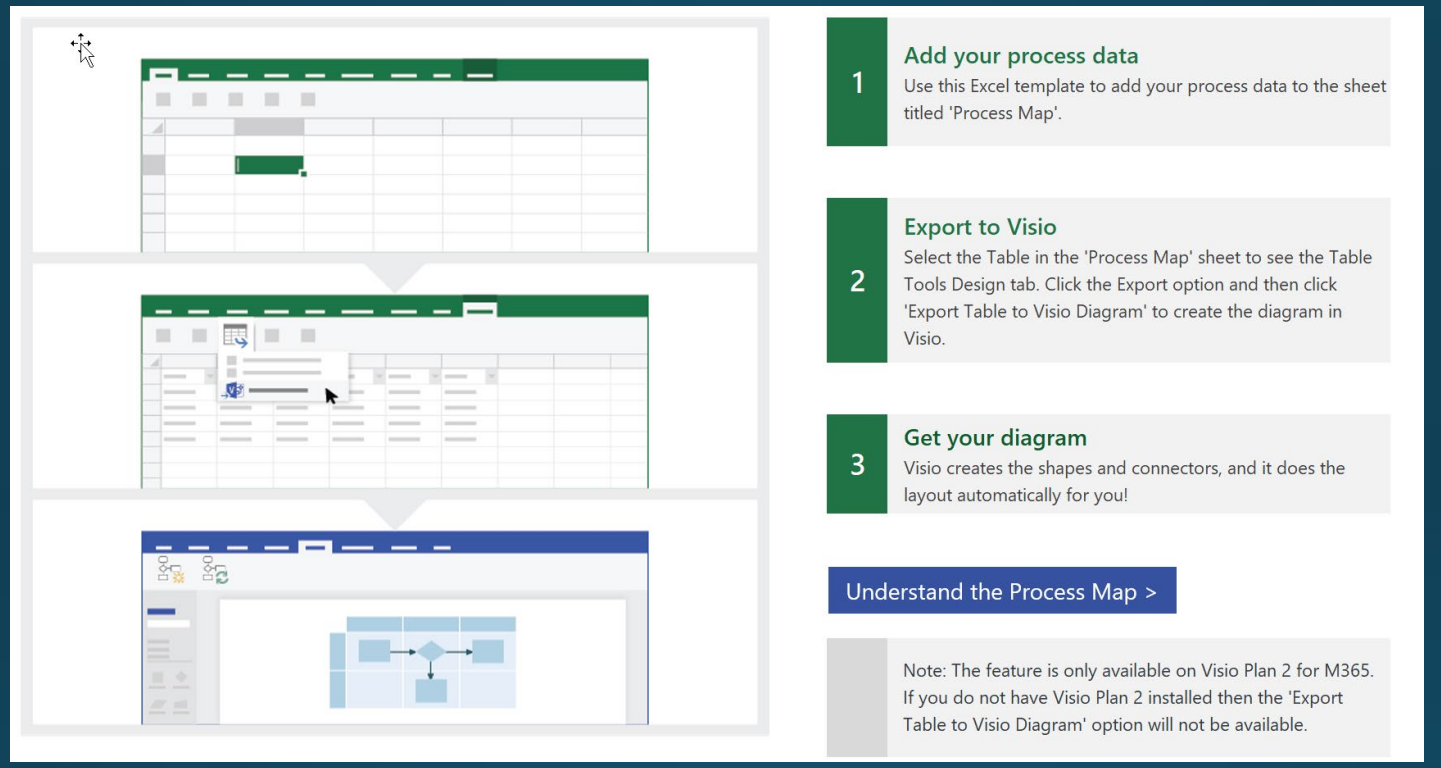


How many Near Miss Reports are you getting?



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?



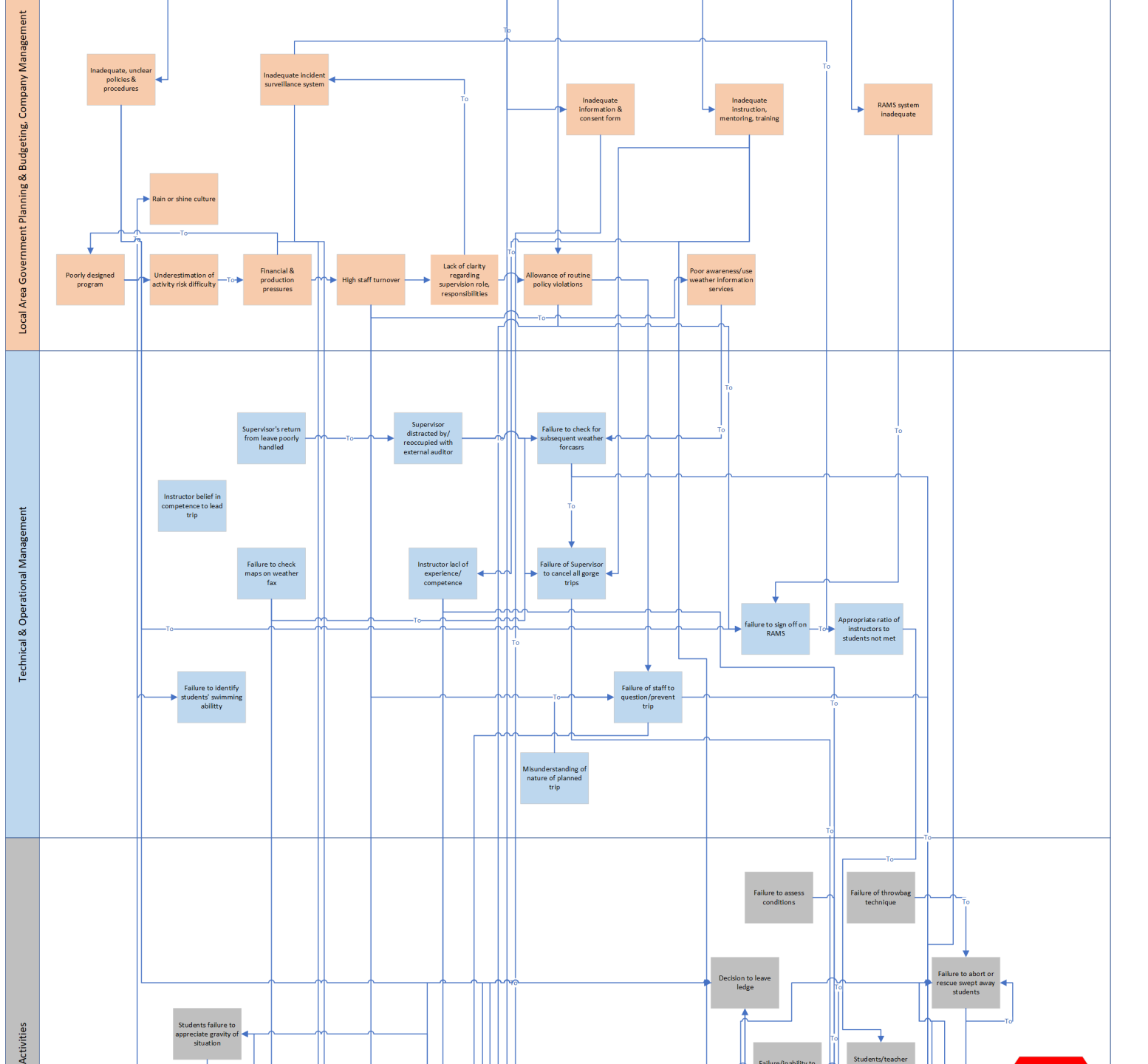
Creating AcciMaps - Excel

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 lacl 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 forcasrs	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 user halfway ledge/last high water escape	E8
Physical Processes & Actor Activities	Group stranded on ledge	
Physical Processes & Actor Activities	Decision to leave ledge	

Generated AcciMap

- Autogenerated AcciMap from an Excel spreadsheet



Concepts

Systems Thinking

Safety-II

Mitigating Factors

Taxonomy

Safety-II

What's Going Right?

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

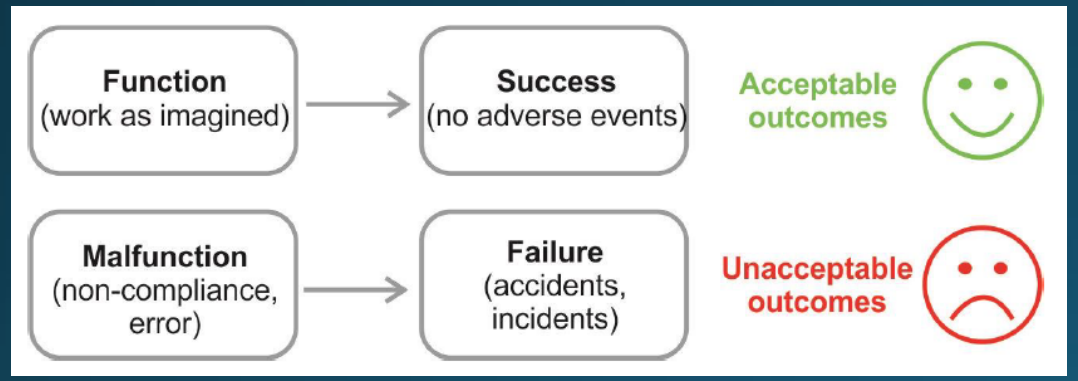
"Trying to understand safety by only looking at incidents is like trying to understand successful marriages by only looking at divorces."
- Marit de Vos 2018

	Safety-II
Definition of Safety	As many things as possible go right
Safety Management Principle	Proactive, continuously try to anticipate developments and events
View of Human Factors	Humans are seen as a resource necessary for system flexibility and resilience. They provide flexible solutions to many problems.
Accident Investigation	Things basically happened in the same way 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.

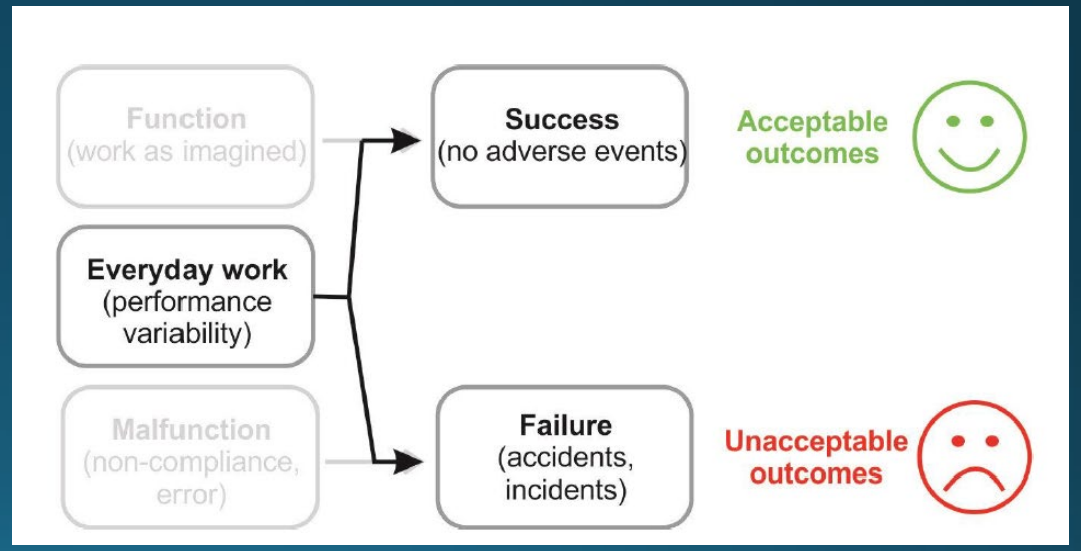
Safety-II

Hollnagel, E. Wears, R., Braithwaite, J. - EUROCONTROL (2013). *From Safety-I to Safety-II (A White Paper)*. Brussels.

Safety-I



Safety-II



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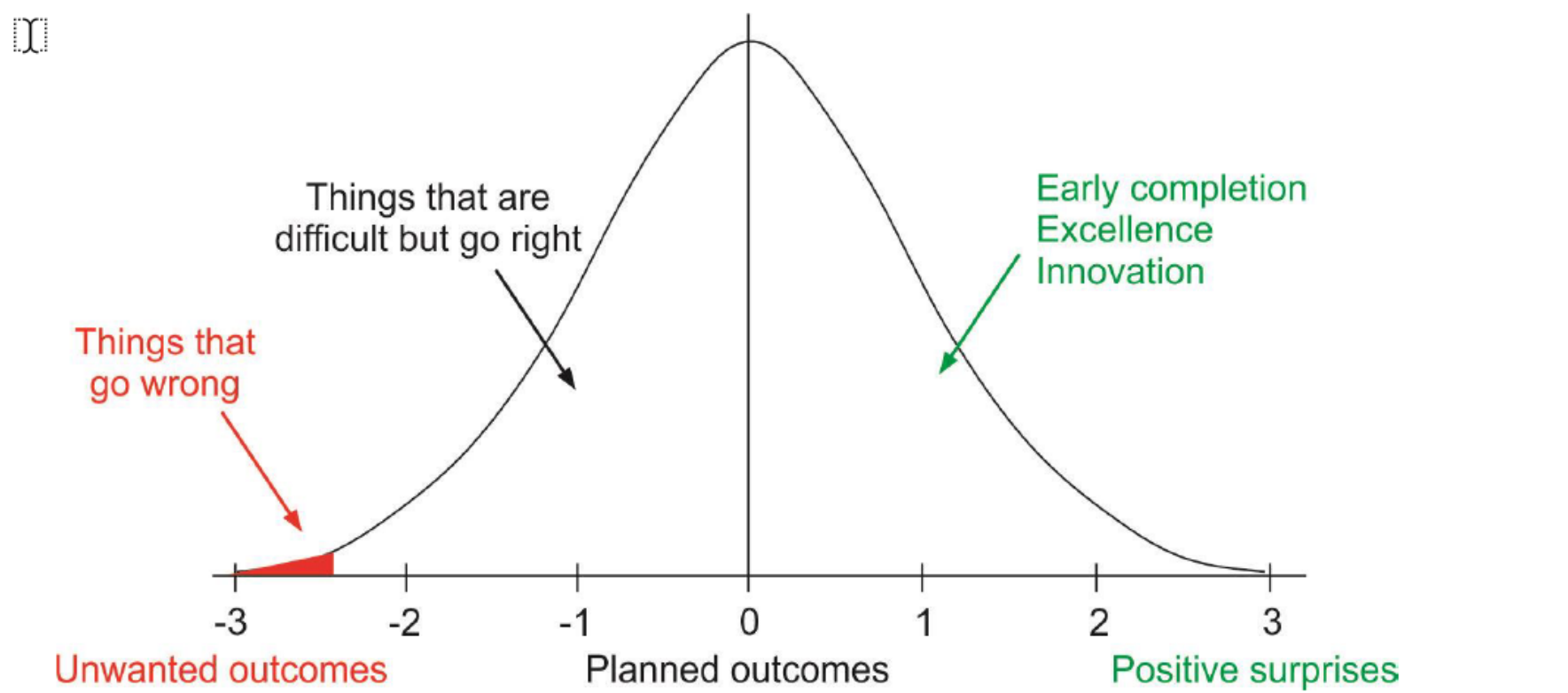


Figure 9: Event probability and safety focus

Hollnagel, E. Wears, R., Braithwaite, J. - EUROCONTROL (2013). *From Safety-I to Safety-II (A White Paper)*. Brussels.

Safety-I Data Approach

- Reduce number of adverse events
- Look for failures & malfunctions, try to eliminate causes and improve barriers
- Learning only uses a fraction of the data available

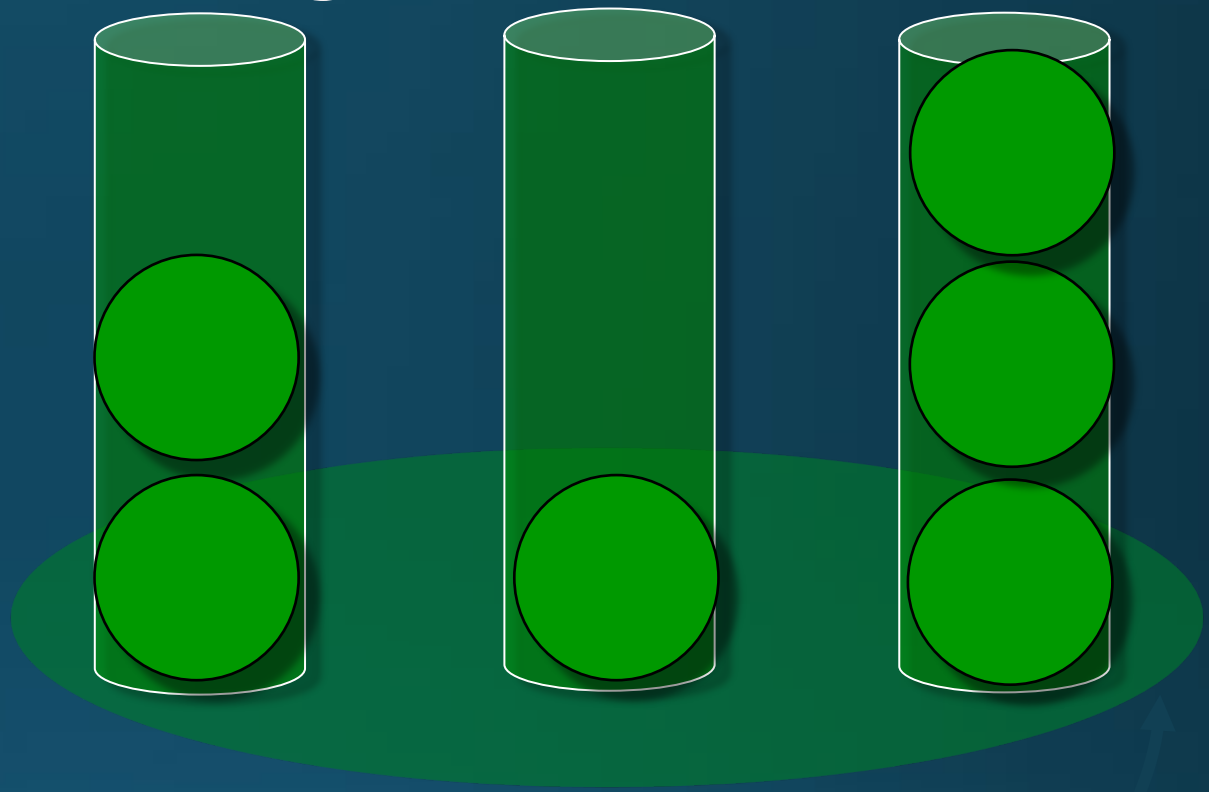
Safety-II Data Approach

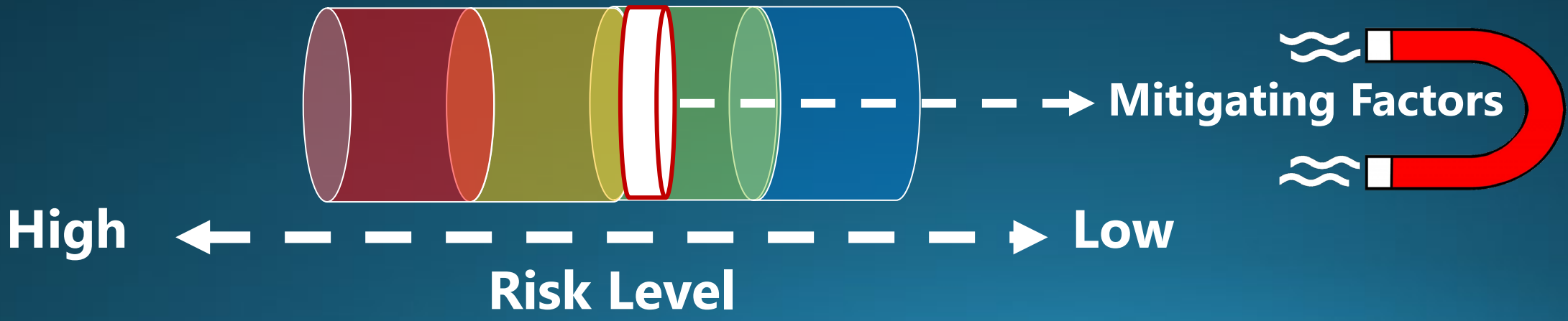
- Ability to succeed under varying conditions
- Use what goes right to understand everyday performance to do better and be safer
- Learning uses most of the data available

1 failure in 10,000 events

9,999 non-failures in 10,000 events

Risk Assessment & Safety Management (RASM)
Mitigating Factors





Safety-I & Safety-II

- It is not Safety-I **or** Safety-II
- It is Safety-I **and** Safety-II

"Look at what goes right as well as what goes wrong, and learn from what works as well as from what fails."

RASM – Safety-I & Safety-II

When Assess Using 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

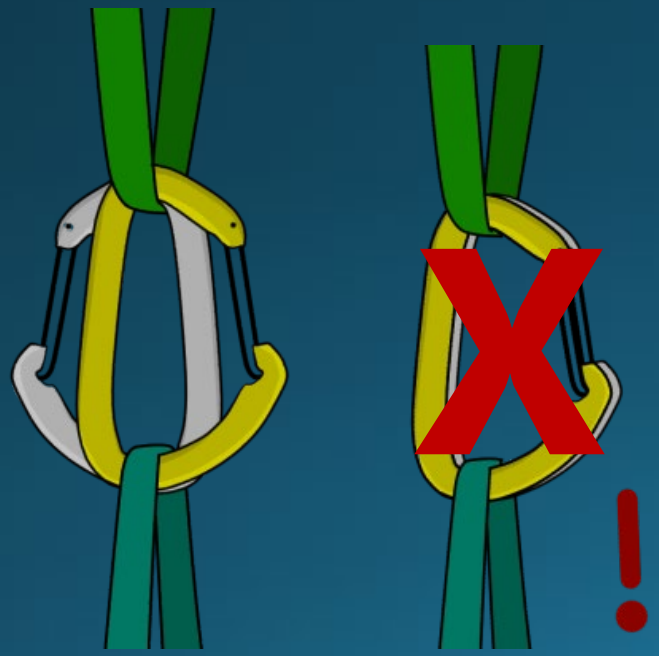
Safety-II – Complex Systems

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

When do to use Safety-I vs Safety-II?

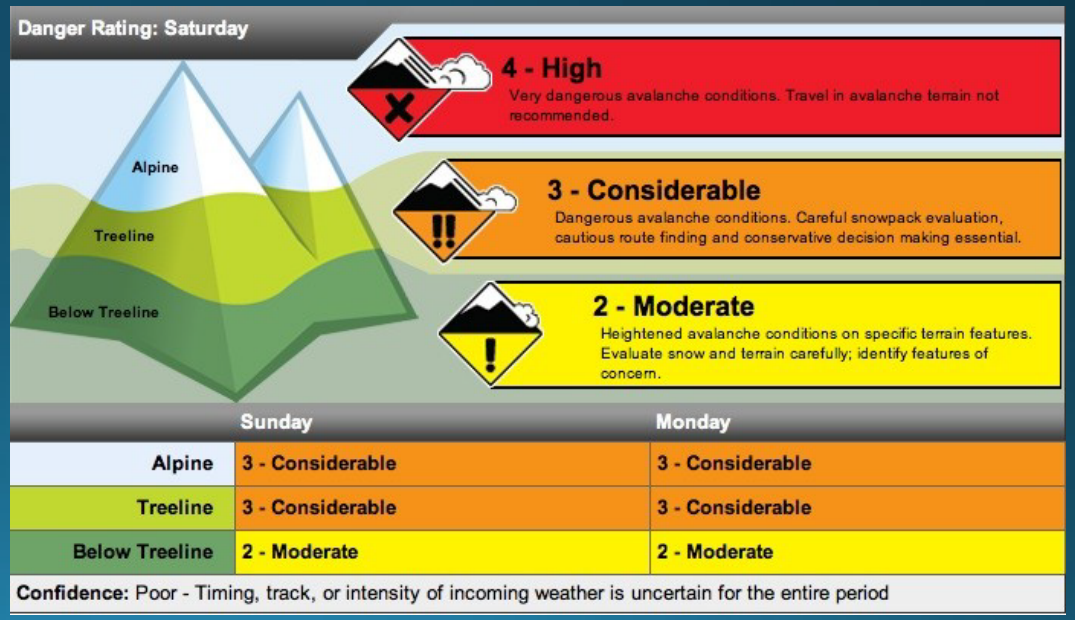
Simple Bimodal System

- Carabiners set as Opposite and Opposed



Complex System

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



	Sunday	Monday
Alpine	3 - Considerable	3 - Considerable
Treeline	3 - Considerable	3 - Considerable
Below Treeline	2 - Moderate	2 - Moderate

Confidence: Poor - Timing, track, or intensity of incoming weather is uncertain for the entire period

Transitioning to Safety-II

- **Look for What Goes Right:** look at what goes right as well as what goes wrong, and learn from what works as well as from what fails.
- **Focus on Frequent Events:** look for what happens regularly and focus on events based on their frequency rather than their severity.
- **Remain Sensitive to the Possibility of Failure:** although Safety-II focuses on things that go right, it is still necessary to keep in mind that things can also go wrong and to 'remain sensitive to the possibility of failure'.
- **Be Thorough as well as Efficient:** do not privilege efficiency over thoroughness—or at least, not unduly.
- **Investing in Safety, the Gains from Safety:** making things go right is an investment in safety and productivity

Concepts

Systems Thinking

Safety-I

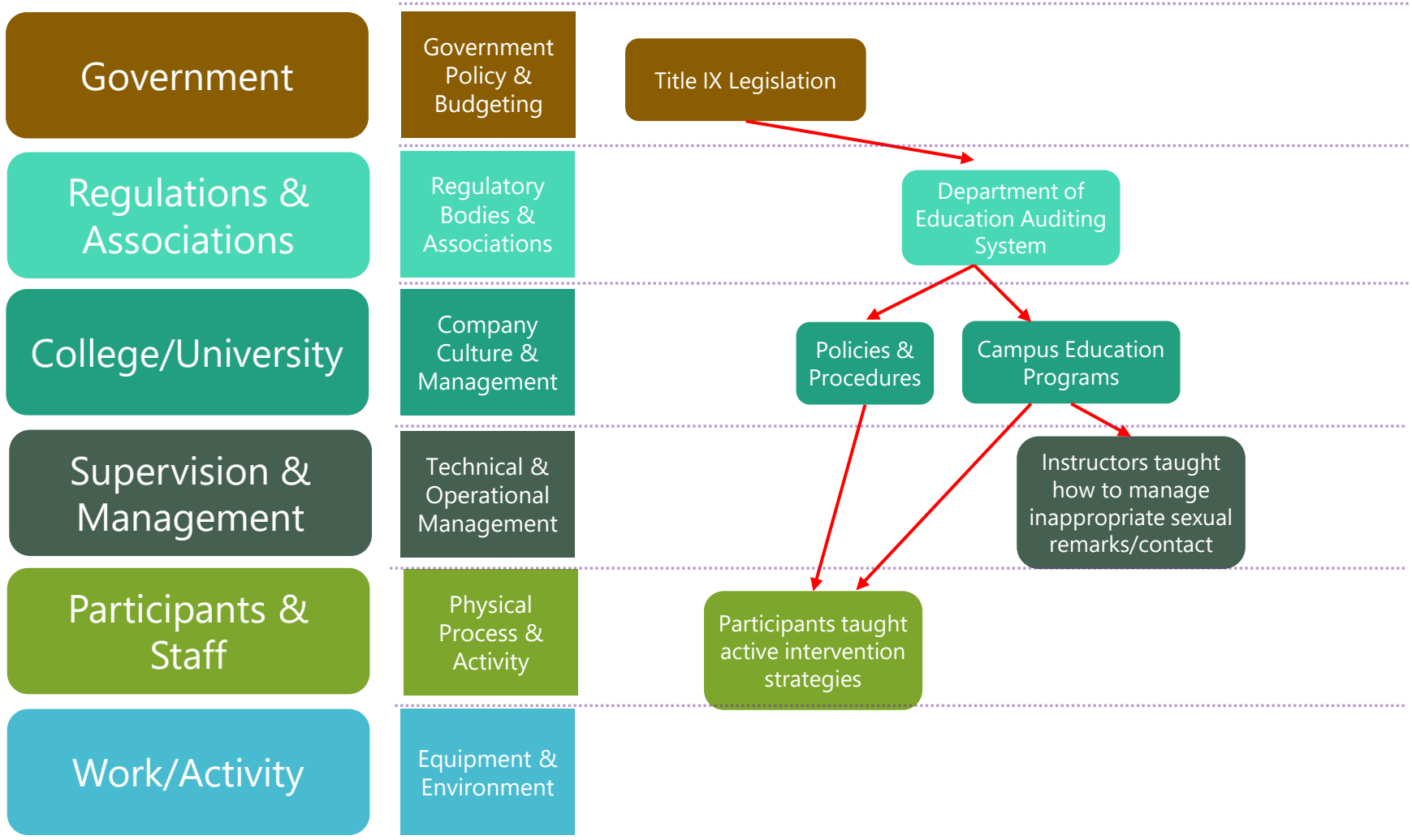
Safety-II

Safety-II PreventiMaps

- **Safety-I** = **AcciMaps**
  Contributing Factor Analysis of “What went wrong?”

- **Safety-II** = **PreventiMaps**
  Mitigating Factor Analysis of “What went right?”

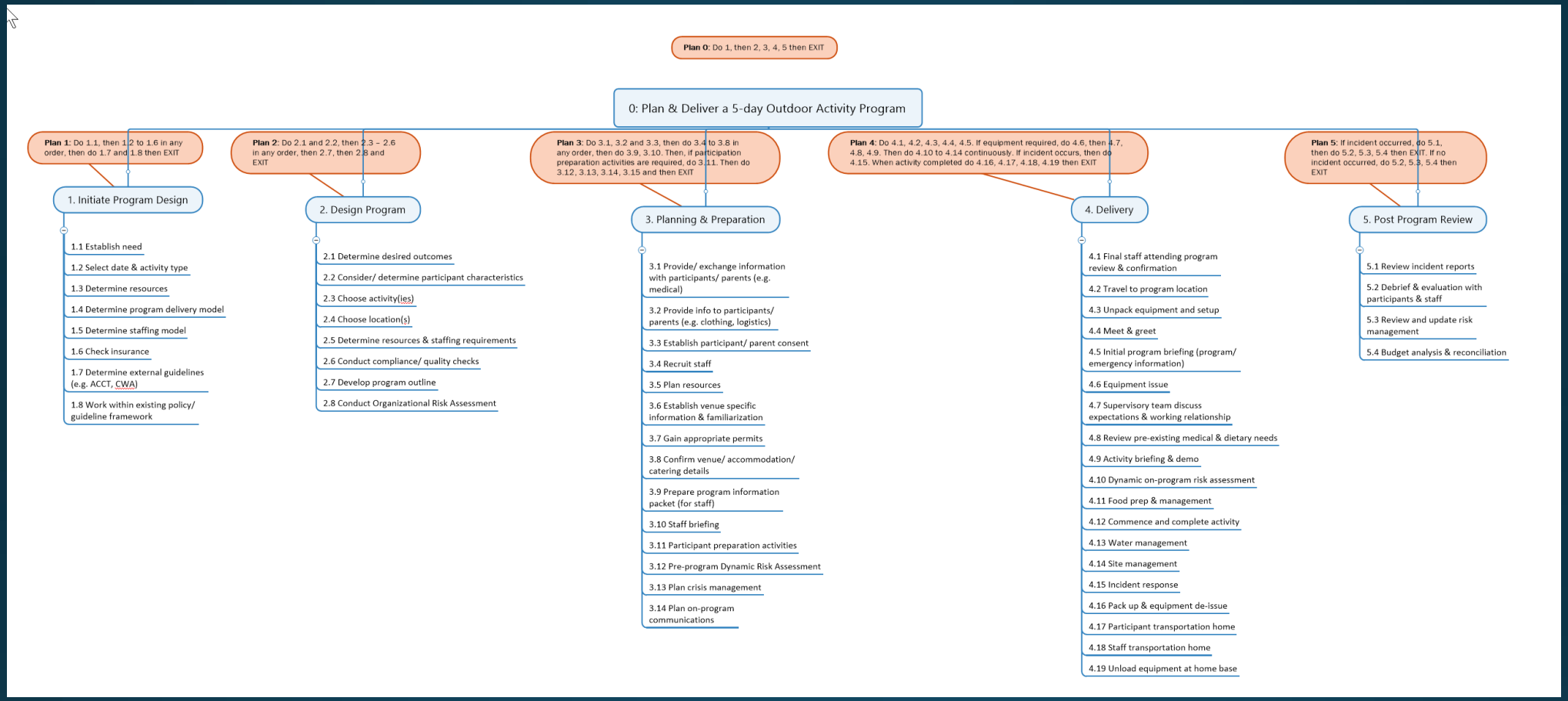
PreventiMap: Title IX Implementation on Campus



How to Integrate Safety-I & Safety-II?

- There is often a correlative relationship between Contributing Factors in Safety-I and the Mitigating Factors in Safety-II
  - “What is wrong points the way to what should be right”
- Any Incident/Near Miss analysis you do with Safety-I presents a set of targets for Safety-II

Deconstruct Contributing Factor to Safety-II Goals (Design Thinking)



Hierarchical Task Analysis (HTA)

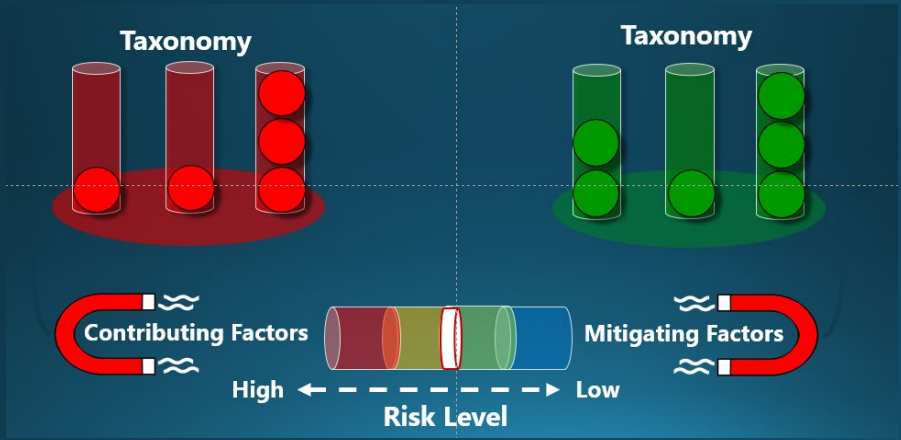
Identifying risks and emergent risks across sociotechnical systems: The NETworked Hazard Analysis and Risk Management System (NETHARMS). Clare Dallat, Paul Salmon, Natassia Goode

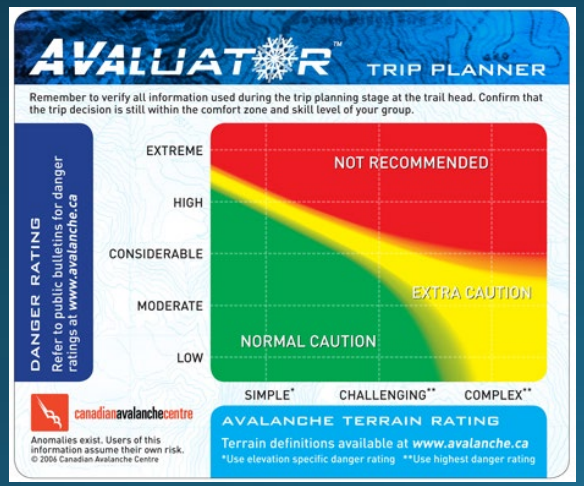
Case Study – Part 2

Designing a Successful System with HTA or Self Study an Incident

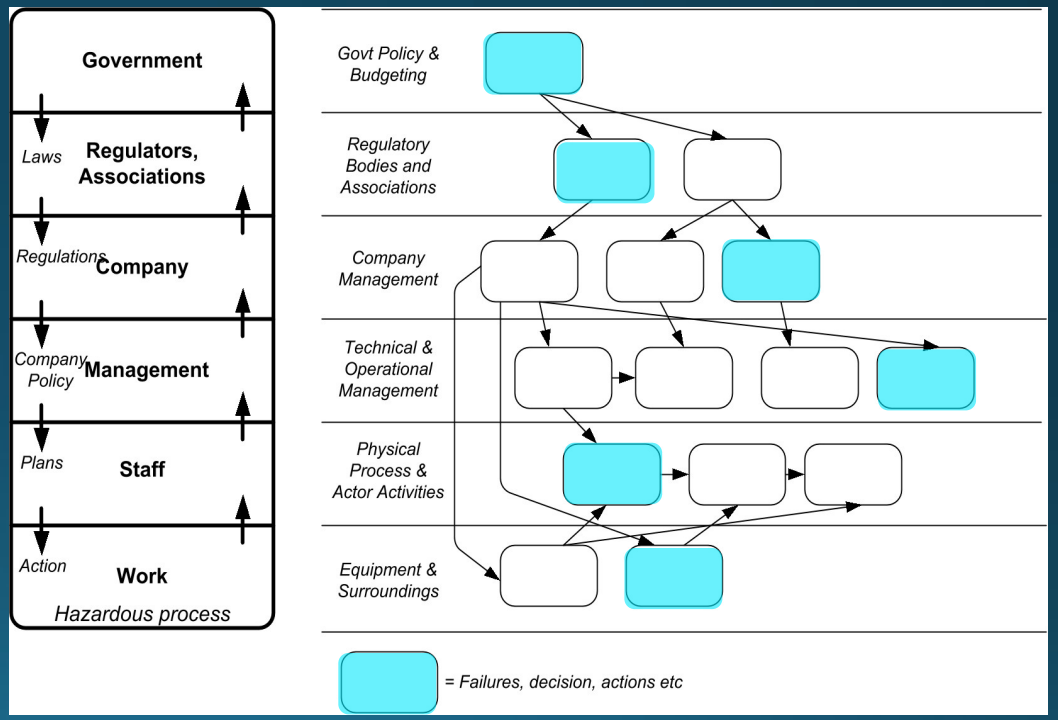
Using Different Tools at Different Levels

Instructor Level





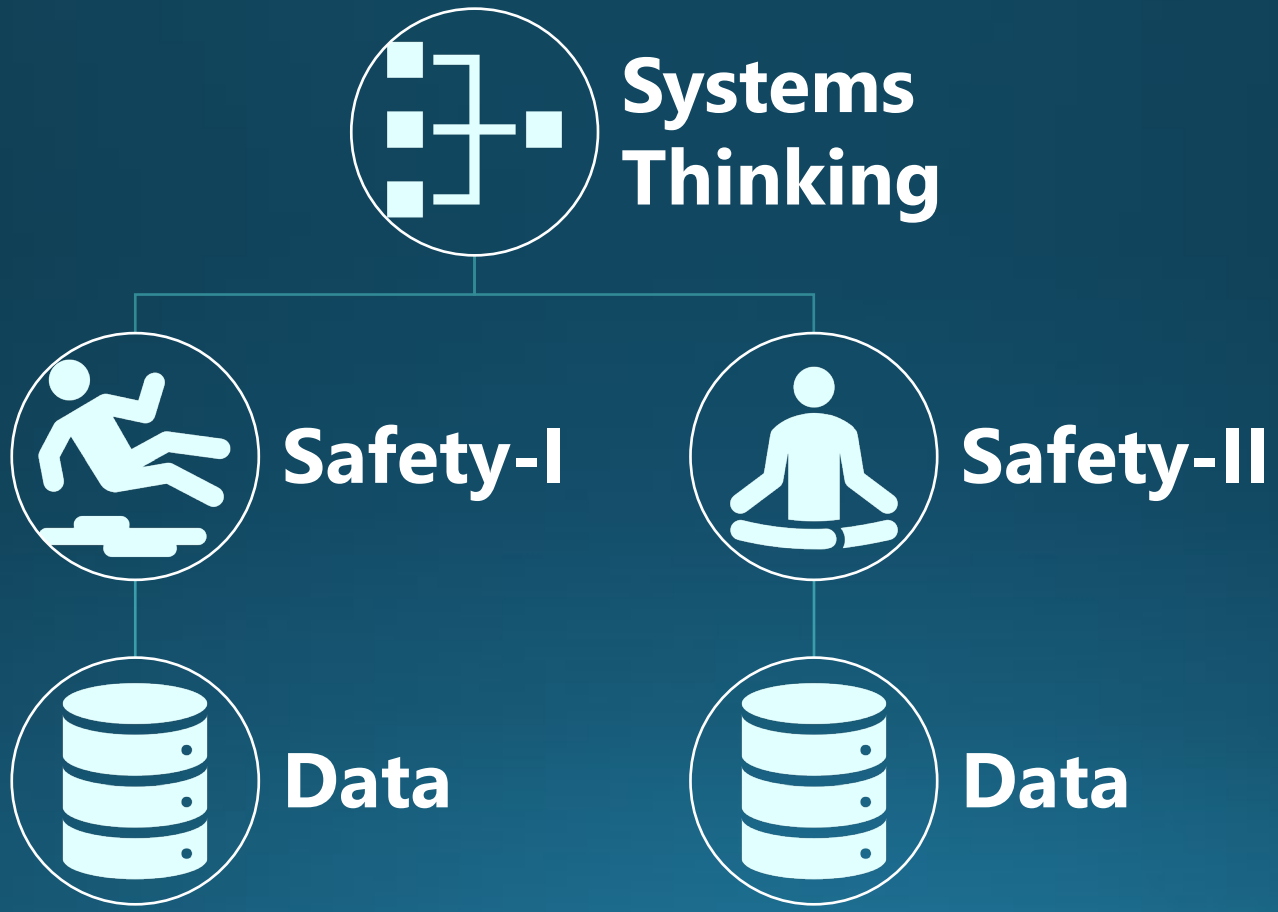
Organizational Level



Implementing Safety Culture Change

- Responsibility runs up and down the entire organization
- Moves away from ‘Blame Culture’
- Individuals need to be held accountable, but only for those things that they have control over
- Encourages incident and close call reporting
- More Data means deeper understanding

Concepts



Key Concepts

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

Three Action Steps

- Implement Rasmussen's Systems Thinking approach in your organization for both Safety-I and Safety-II frameworks. Analyze adverse outcomes and near misses for the contributing factors that 'led' to the event. Analyze the mitigating factors in place that prevented an incident and determine how to 'expand' these factors.

- Understand the role that Risk Management Information Systems play in the collection and analysis of accident and near miss data through building AcciMaps and PreventiMaps.

- Analyze your data and determine when factors are 'in scope' allowing actionable steps to be implemented for managing risk or 'out of scope' limiting organizational response.

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-whte-papr.pdf
- Translating Systems Thinking Into Practice: A Guide to Developing Incident Reporting Systems – Goode, Salmon, Lenne, Finch – Available at Amazon Books

Videos & Articles

- SystemsThinking - A New Direction in Healthcare Incident Investigation - https://www.youtube.com/watch?v=5oYV3Dqe0A8
- 1.5.5 Safety-I vs Safety-II - https://www.youtube.com/watch?v=WM0LVv9NrhM
- 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=oMtLS0FNDZs
- 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=IoYUQlWiRgc
- Dr. Todd Conklin speech "Risk Analysis is Fixed in Time - But Hazards Ebb and Flow: https://www.youtube.com/watch?v=X211fU39808

Videos & Articles

- Guidelines for AcciMap Analysis: 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=zqZVGaFIhyw
- FAA Safety Management Systems (SMS) Fundamentals: Policy: https://www.youtube.com/watch?v=j8N0PZx5YwM
- 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
- 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.

Data is safety.

Resources

www.IncidentAnalytix.com/blog
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www.OutdoorEd.com

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