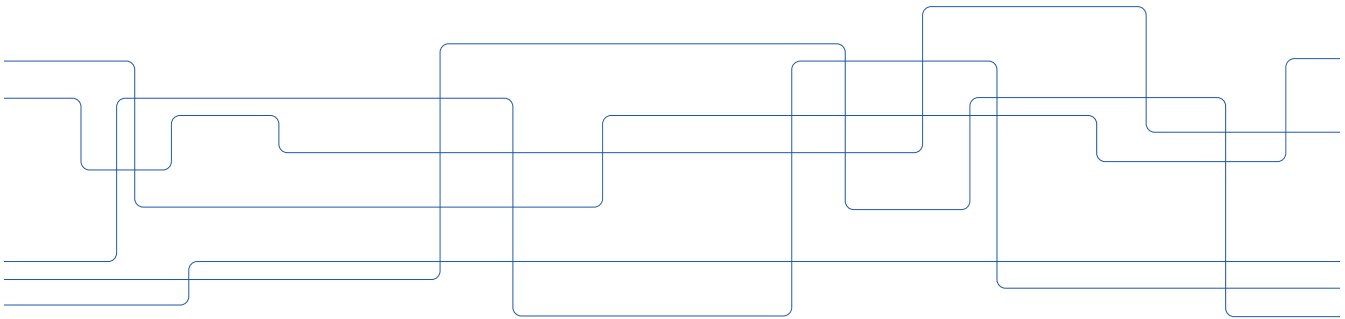
HFN webinarieserie del 2
Managing complex risk and change

Safety performance indicators

Safety assurance - Assuring change

SPIer – säkra förbättringar – drivande indikatorer för förändring

Pernilla Ufvengren, docent sociotekniska system



Monitoring and measurement for safety assurance

ORION - Operational Risk: Implementing Open Norms

By Pernilla Ulfvengren - KTH partner in ORION EU ERASMUS

Introduction

- Pernilla Ulfvengren – Industrial engineering and management, INDEK, KTH
- Nick McDonald & co – Centre for Innovative Human Systems, TCD

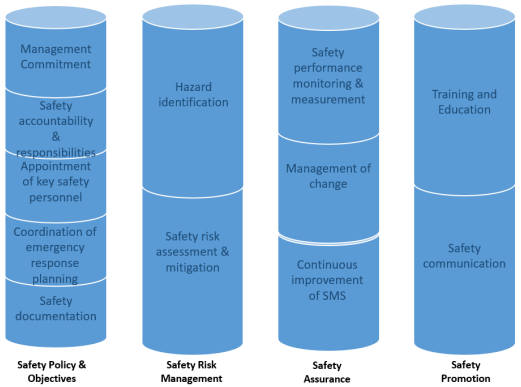
- Main achievements:
  - Evidence based research project sequence (2005-2020)
  - A socio-technical functional and analysis model
  - Governance concept for evidence-based decision-making

Safety management system framework

- SMS includes: organisational structures, accountabilities, policies and procedures that should provide:
  - a systematic approach to managing safety within an organisation
  - a systemic approach, meaning that all actors in the organisation actively contribute to safety

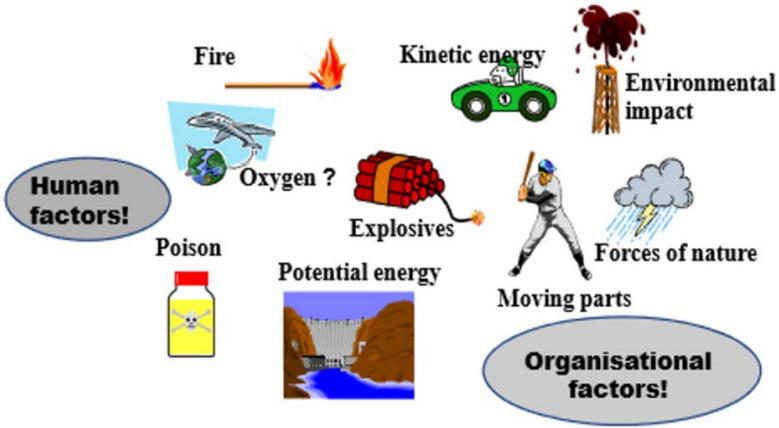
SMS framework pillars:

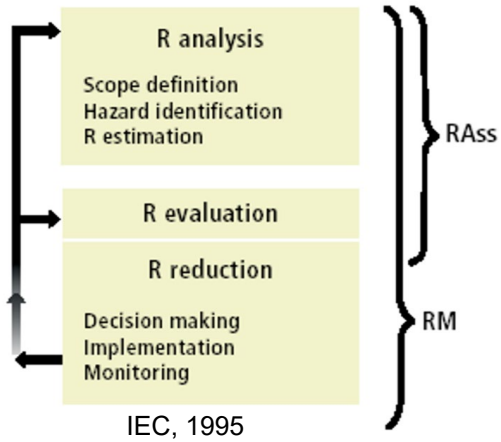
- Safety policy and objectives
- Safety risk management
- Safety assurance
- Safety promotion




Management Commitment
Safety accountability & responsibilities
Appointment of key safety personnel
Coordination of emergency response planning
Safety documentation
Hazard identification
Safety risk assessment & mitigation
Safety performance monitoring & measurement
Management of change
Continuous improvement of SMS
Training and Education
Safety communication
Safety Policy & Objectives
Safety Risk Management
Safety Assurance
Safety Promotion

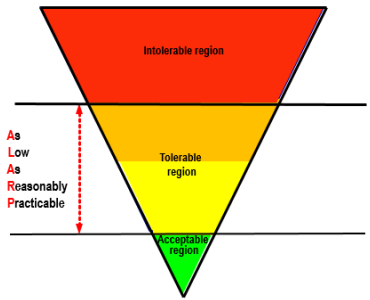
Safety and risk management



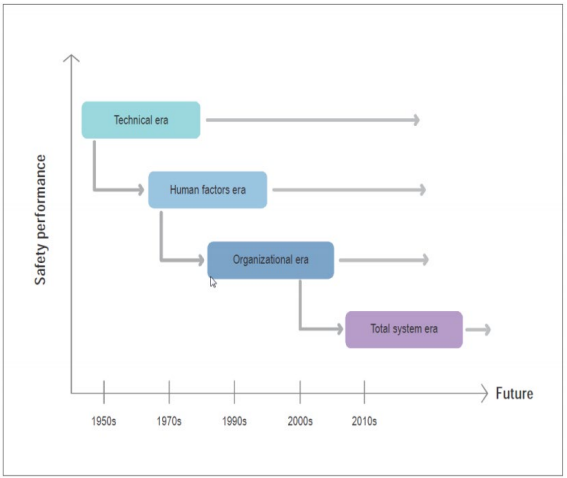


IEC, 1995

Probability	Severity				
	Negligible E	Minor D	Major C	Hazardous B	Catastrophic A
5 - Frequent					
4 - Occasional					
3 - Remote					
2 - Improbable					
1 – Extremely improbable					



Organisational hazard



Era of safety mangement (ICAO, 2019)

Key organisational capabilities with direct and critical influence on the functionality to:

reduce operational risk or fully implement a safety management system

are defined as organizational hazards

Advanced risk knowledge - SMS excellence

SMS components linked to function as a whole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Integrate and analyse risk information
Knowledge creation based on data anaylsis
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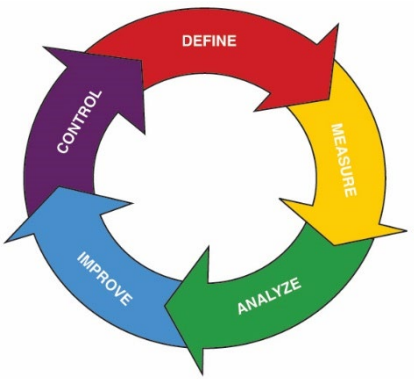
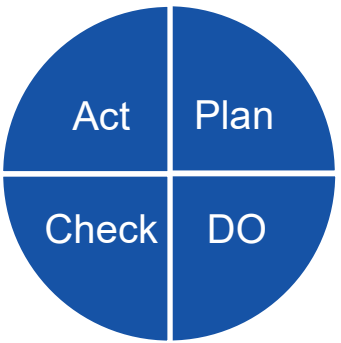
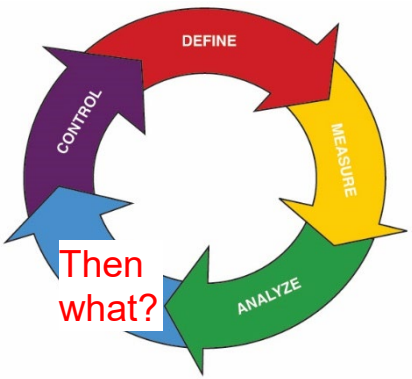
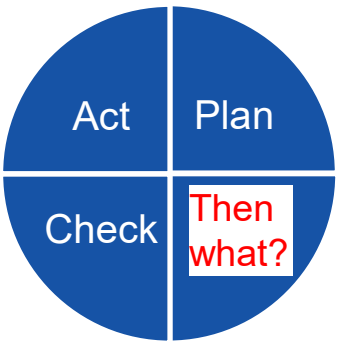
Cycles of improvement and development Complete?

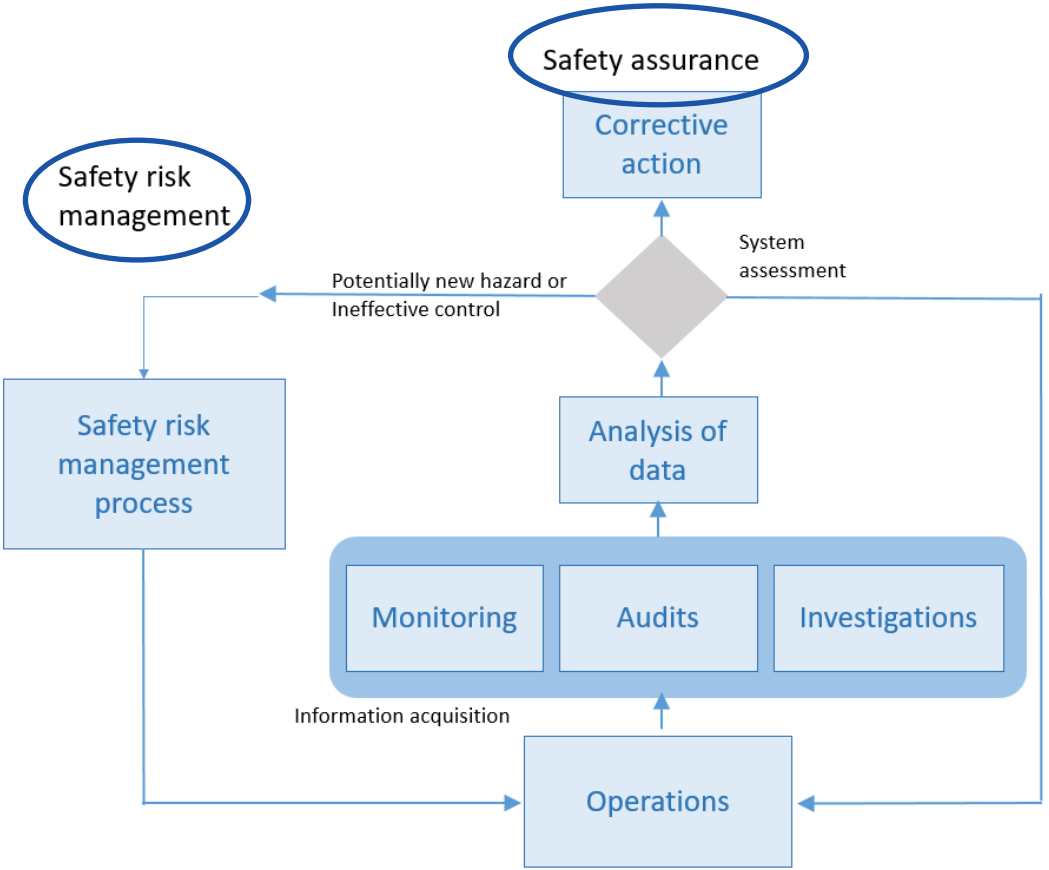




Cycles of improvement and development - Incomplete!






Safety assurance
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Safety risk management
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Potentially new hazard or
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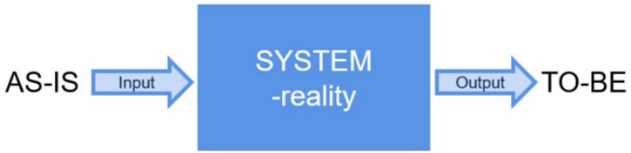
Operations

Safety performance

- Aviation safety has moved away from outcome-based, to performance-based regulatory assessment.
  - It must demonstrate safety performance.

Safety performance= ΔSPI

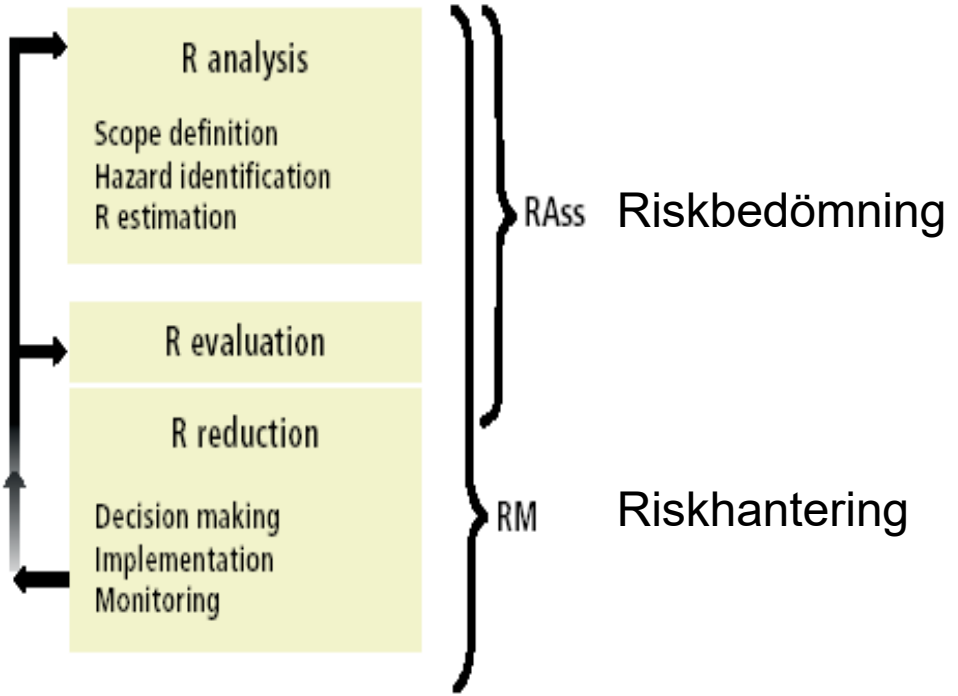


Riskhanteringsprocess

Riskanalys

Riskvärdering

Riskreducering



(IEC Int.Electrotech.Comm, 1995)

Schweizerost modellen beskriver hur system fallerar

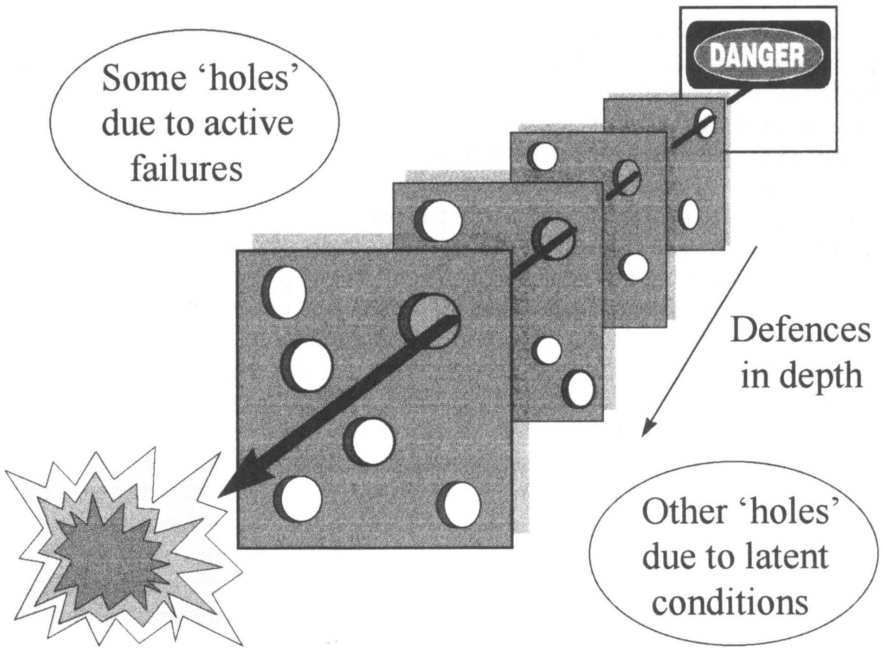


Bild tagen från Reason (1997)

Det hela startar med organisatoriska faktorer:

Strategiska beslut,
Organisatoriska processer
Budgetar
Prognoser
Resurs allokering
Schemaläggning
Planering
Kommunikation
Management
Tillsyn och revision

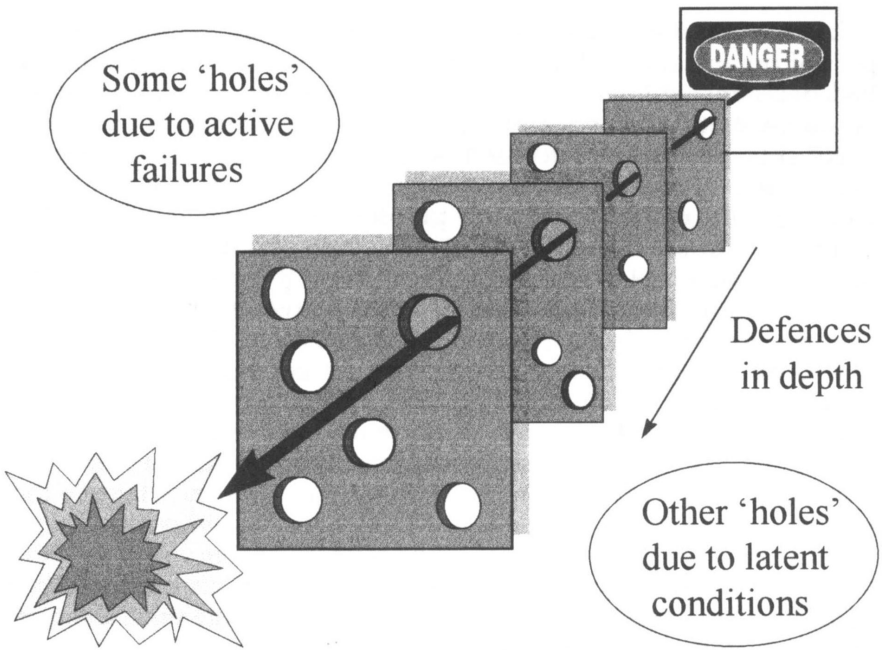


Bild tagen från Reason (1997)

Dessa faktorer transformeras sen, i värsta fall, genom olika systemnivåer till:

Tidspress
Undermålig utrustning,
Bristande gränssnitt,
Bristande träning,
Otillräcklig bemanning
Dåliga arbetsförutsättningar
Usel arbetsmiljö
Låg lön, låg status
Icke relevanta och inte tillämpbara procedurer och rutiner,
Dålig kommunikation
etc…

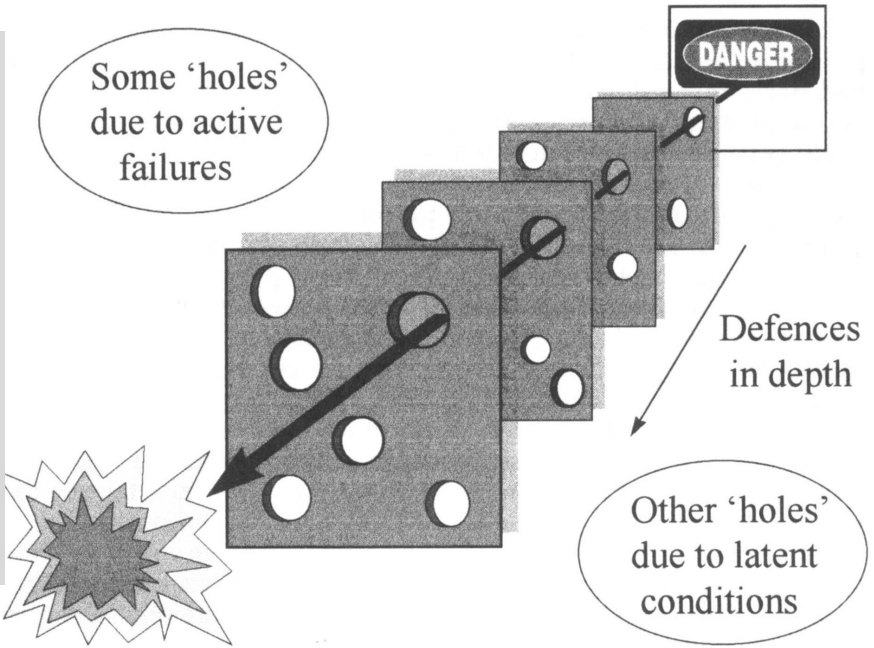


Bild tagen från Reason (1997)

Ways to measure

measures of routine safety related activities

measures of failures (deviations) detected during these activities

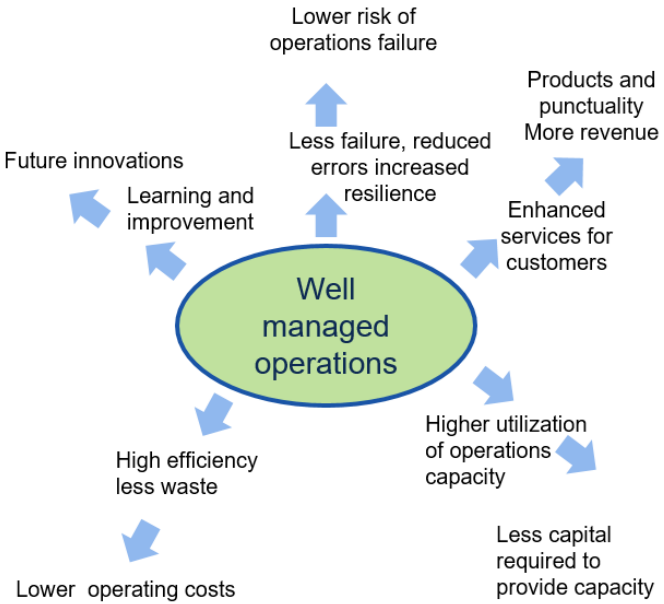
measures of events (incidents) that occur during operations

Leading and lagging logic in safety

	OUTCOME 1	OUTCOME 2
LEADING	☹ Undesired	☺ Desired
LAGGING	☺ Desired	☹ Undesired
Potential review issue	Leading indicator too far removed from critical control	Control system ineffective
Potential cause	Measuring in the wrong place or the wrong thing	Doing the wrong thing (or not well enough…)

Well managed operations create value

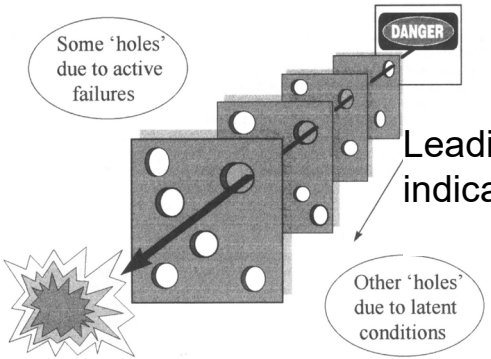
- Well manged operations lead to values desired for any organisation, even complex sociotechnical operations:
  - Learning and improvement
  - Higher utilization of operations capacity
  - High efficiency and less waste
  - Higher utilization of operations capacity
  - And most importantly less failure, reduced errors and increased resilience which will lower risk or operations failure



Operations Management (Slack et al., 2010)

Ständiga förbättringar

Measurement and monitoring - implications of different models



Leading indicators

Lagging indicators

Driving indicators

~~Leading indicators~~

Lagging indicators

Leading, lagging and *driving*

- With risk of confusion with current safety performance indicator paradigm, the leading indicator as in performance measure and management will be called ”driving indicator” in this context of safety performance.
- Leading and lagging for monitoring operations and identifying hazards and non-conformity. Driving and lagging for monitoring development work and demonstrating safety performance.

Leading and lagging measures in operations management

- Performance measurement is defined as
- ”the process of quantifying the efficiency and effectiveness of action where a performance measure can be defined as a metric used to **quantify the efficiency and/or effectiveness of an action”** (Neely et al.,1995).
- In performance measurement and management literature:
  - “lagging performance measures represent the results from (intended) actions previously taken,
  - while leading performance measures are the measures that lead to, or drive, the results achieved in the lagging performance measures” (Niven, 2006).
- Leading performance measures should predict performance of lagging indicators (ibid).
- As such, we can conclude that leading performance measures, measure performance drivers and at the same time validate the assumed model.

Sociotechnical system models

Product development example

Leading measures.

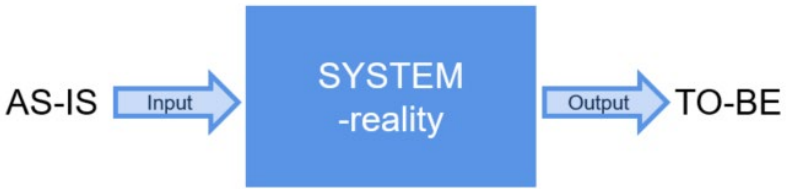
- Drive and influence activities with a link to goals for lagging measures according to how the system works **(assumed model)**
- The **model** suggest: participation in seminars or forums, will increase collaboration that in turn is predicted to increase number of new solutions and products.
- Leading measures may be set to monitor and enforce activities.

Lagging measures.

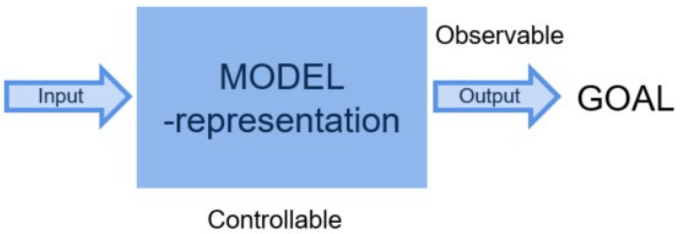
- Intended improvement in terms of number of new solutions, products, services, revenue, value business cases, resulting from the driving activities
- Lagging measures set to assure intended effect.
- **Two possible outcomes**, nothing changes, or it is successful
- In case it fails… two options
  - driving activities **did not happen** (see leading indicators monitoring)
  - or they did not have effect, the **model was insufficient**.

System models and control

System is the **reality**
Model is the **representation**
Cause and effect from a given **input** and expected **output.**
System control - the capability to apply specific input to reach an intended outcome, requires **a model** – understanding of the system, a system **goal** - desired system performance, and **observable** and **controllable** mechanisms or behaviour.



System control
- Model
- Goal
- Observable
- Controllable



Runway Incursions (1/2)

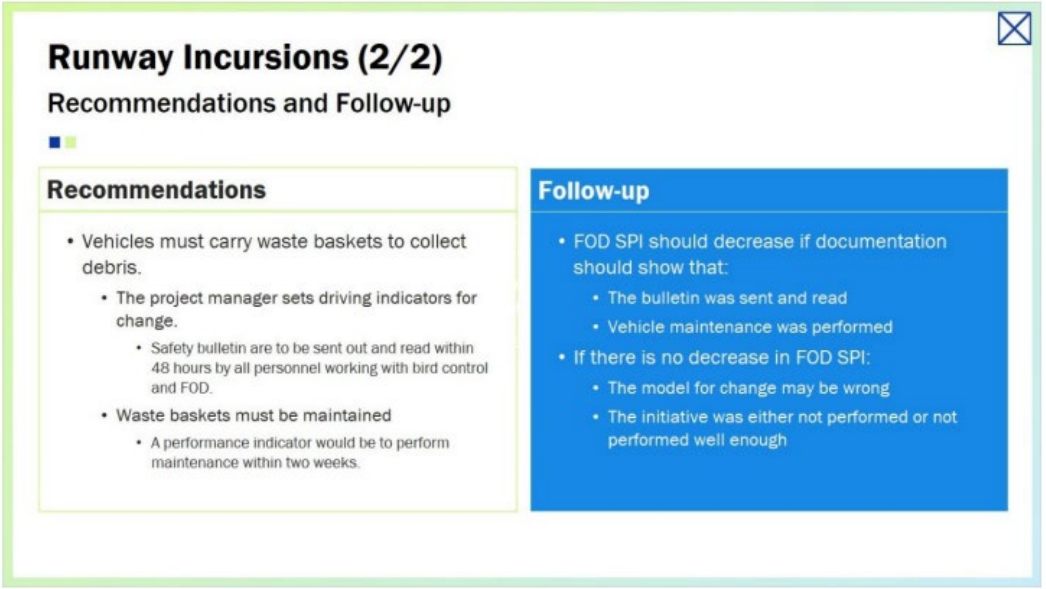
What is Causing the Increase in FODs?

- Foreign object debris (FODs) are causing runway incursions.
- A threshold for the SPI (FOD numbers) over a period of time is set as a risk control.
  - FODs start to increase.
- Analysis concludes that FODs have increased due to a new vehicle that:
  - Monitors birds
  - Collects FODs
    - They are leaving FODs behind.

? Does the organisation have the capability and system control to initiate and reduce operational risk to reduce SPI to an acceptable level over a period of time?

- All those spreading debris:
  - Must be notified immediately to change behaviours
  - Collaborate with operators to devise an action plan

- In safety management practice a leading indicator warns that an hazard associated with identified risk is monitored.
- When leading indicator warns before an event, incident or accident, such as a runway incursion, the control is effective. If a FOD incident happens before actions are taken the control is ineffective.
- The lagging indicator is an undesired event happening – runway



- In critical review of SPIs in literature a title is ”Leading, lagging, whatever…”
- In another view the no of debris or any debris could be the lagging indicator. A decided procedure could be monitored as a leading indicator and the no of debris could be a lagging indicator.
- Still when the control is ineffective a change is required. Indicators for this change is called driving indicators here, with a common lagging indicator.

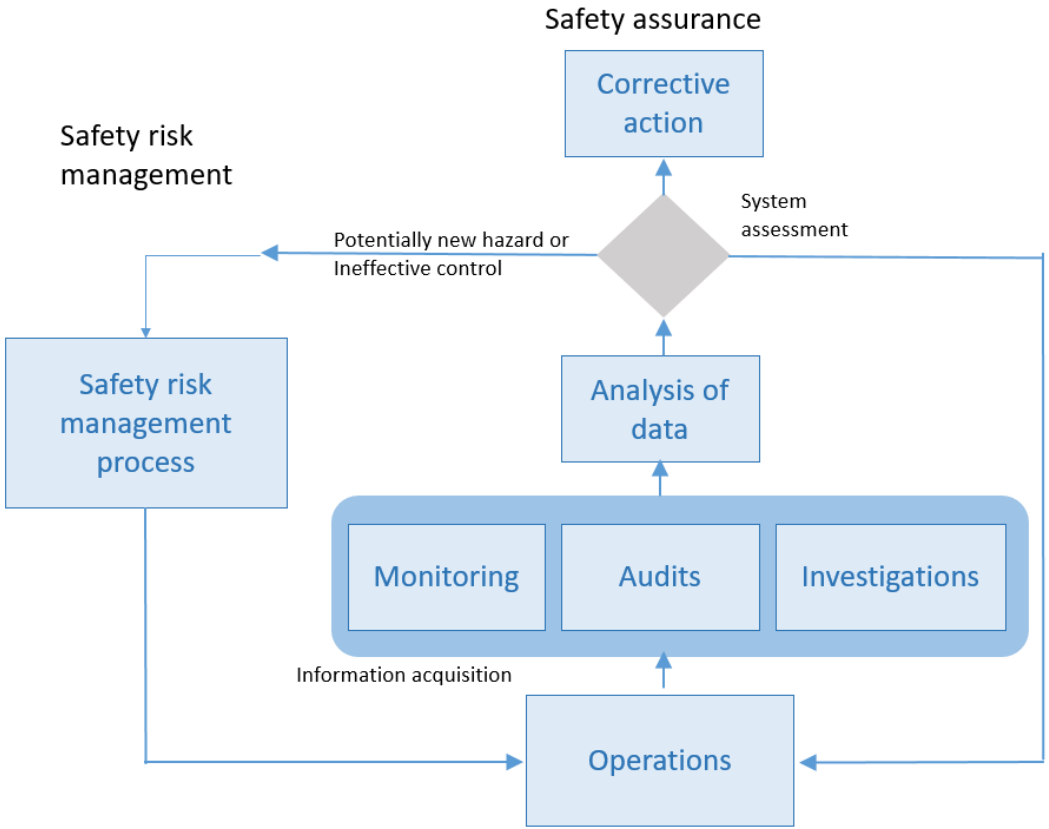
Safety assurance as described in an SMS

- **Safety performance monitoring and measurement;**
- Organisational capability to verify the safety performance.
- Validate the effectiveness of safety risks controls.
- Safety performance shall be verified in reference to the safety performance indicators and targets.
- Effectiveness achieved with a series of safety performance indicators fit for purpose.
- There is a means to measure and monitor trends and take appropriate action when necessary.

Safety Assurance

Safety performance= ΔSPI

ORION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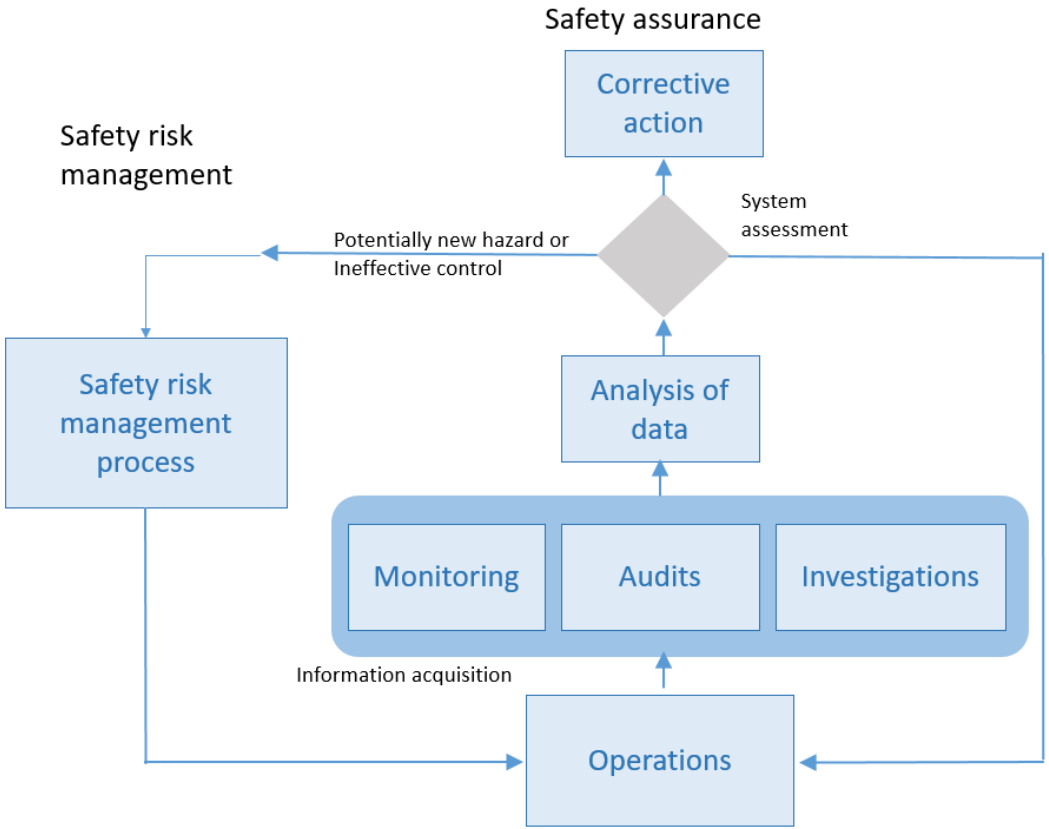
Safety assurance as described in an SMS

- **Management of change; (NOT CHANGE MGMT!)**
- Formal process to identify changes within the organisation and its operation
- Established processes and services may be affected by changes elsewhere.
- Eliminate or modify safety risk controls that are no longer needed due to changes in the operational environment.
- Effectiveness achieved with a safety risk management system that assess all major changes to the organisation and its operations.

Safety Assurance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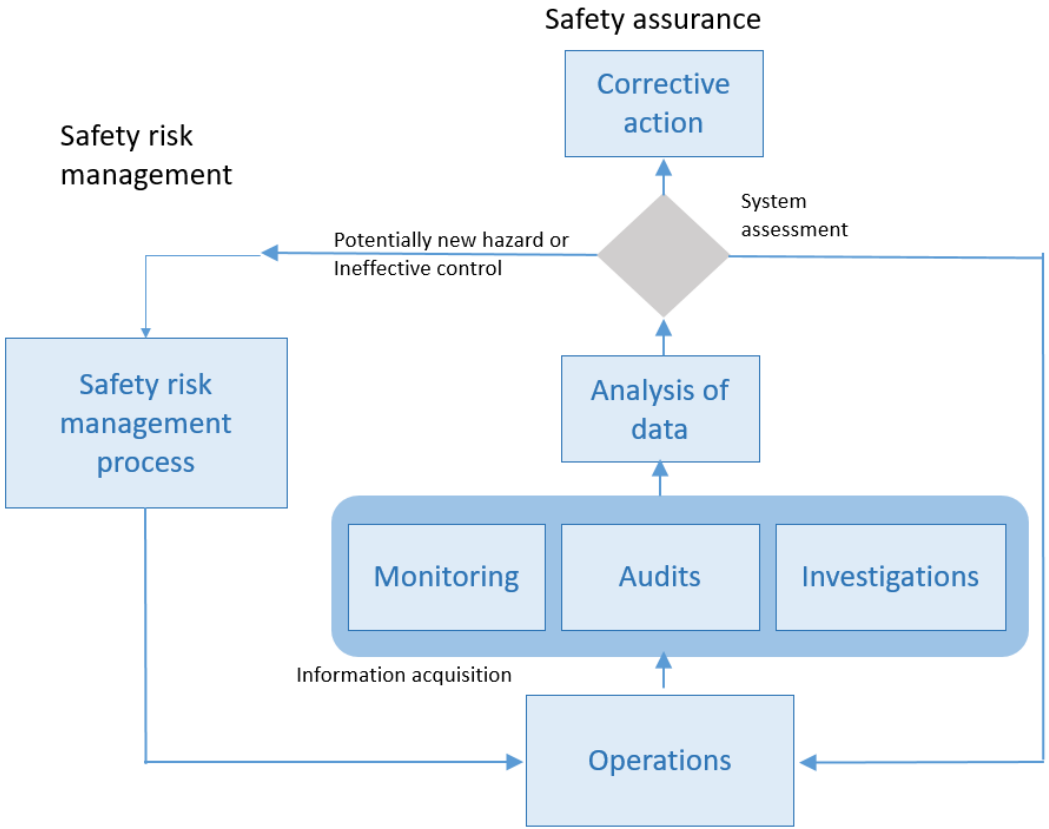
Safety assurance as described in an SMS

- **Continuous improvement of the SMS.**
- Formal process to identify the causes of substandard performance of the SMS,
- determine the implications of substandard performance of the SMS,
- determine substandard performance in operations, and eliminate or mitigate such causes.
- Effectiveness achieved when the SMS performance is monitored.
- The SMS identify potential areas of improvement and the outcomes of this process lead to improvements to the safety management system.

Safety Assurance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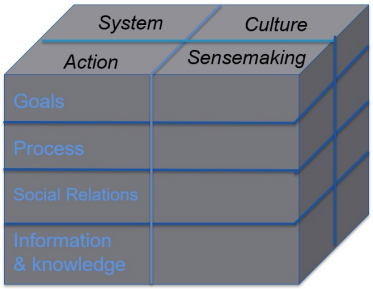
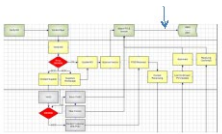
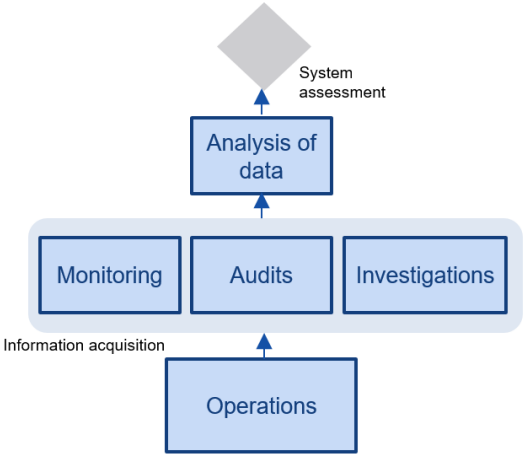
Advanced risk knowledge - SMS excellence

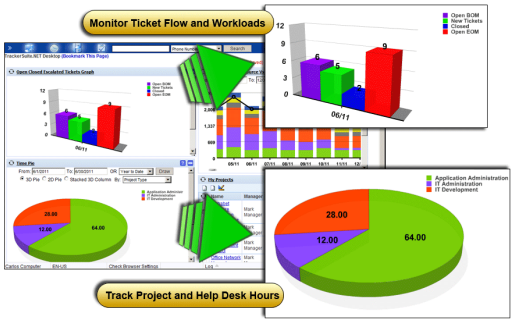
SMS components linked to function as a whole

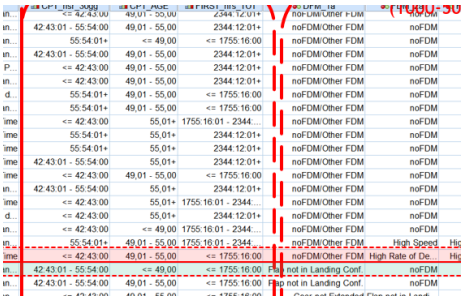
Qualitative AND quantitative data







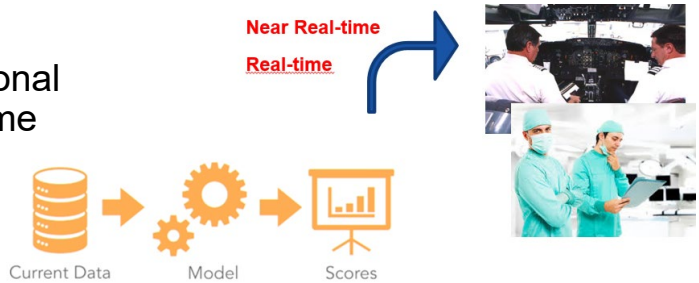




ORION

Risk information produced and delivered

– to manage operational risk in near real- time



– to manage system development and change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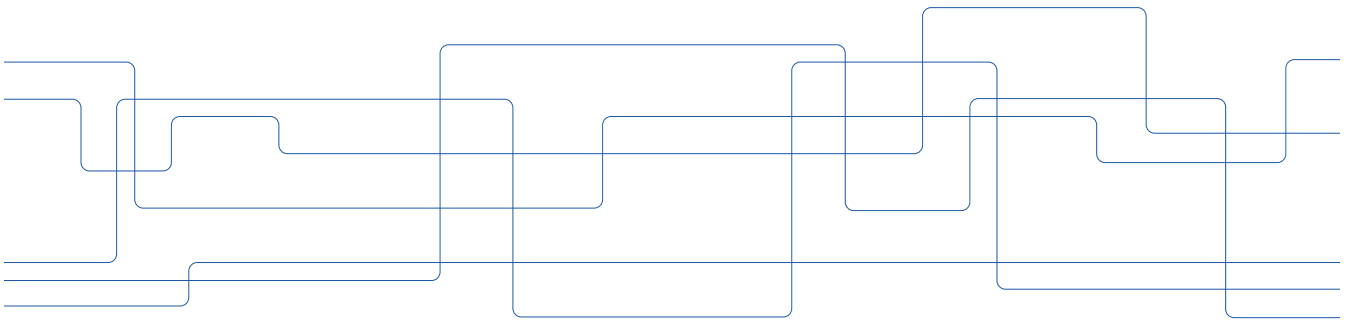
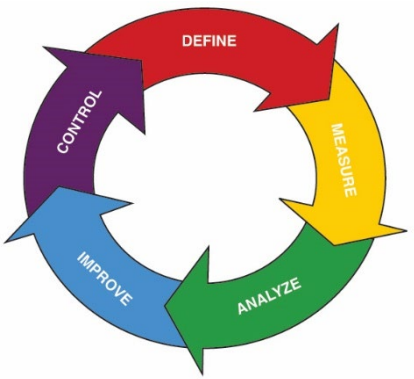
Tack för att du lyssnade!

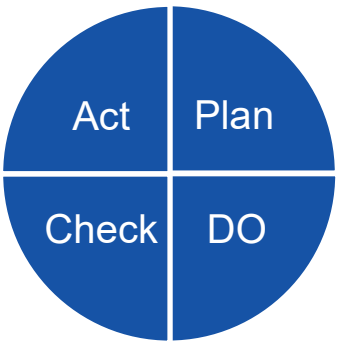
Pernilla Ulfvengren

pernilla.ulfvengren@indek.kth.se



Complete cycles of improvement and development





Sagt av astronaut: ”Ground control is the extended arm of the mission crew"

- Balansera kontroll och att erbjuda rätt stöd!
- Samla in och mäta relevanta data, övervaka och utvärdera prestation och resultat!
- Underlätta arbete och ge stöd och resurser för att kunna göra jobbet!
- Det bör framgå av de aktiviteter som görs hur dessa

Evidence from socio-technical approaches

- Quality management movements throughout industrial history have common factors for success!
- Organizing development work applying sociotechnical principles:
  - > *Local quality improvement work groups*
  - > *Integrating know-how for improvements*
  - > *Flatter organisations*
  - > *Decentralised decision-making*
  - > *Broader assignments and team work*
  - > *Increased dialogue and democracy between managers and operators*
  - > *Internal mobility and flow organisation*
- The common factor for success is the way human activities are integrated with a flow of data and information in each principle mentioned!

Metrics, measures and indicators

- **Measure**: a measure is as a quantitative expression composed of a number.
- **Metric**: a quantitative fraction expression, based on a standard or unit of measurement, like number of hard landings per a 1000 flights.
- **Indicator**: An indicator is a measure of something that cannot be measured directly and depend on the explanatory value of the model or logic behind it.
- A common rule of thumb is that measures or indicators should be:

(1) relevant to the goal;

(2) easily measured and understandable to users; and

(3) provide reliable information, either in quantitative or qualitative form.

Ways to measure

measures of routine safety related activities

measures of failures (deviations) detected during these activities

measures of events (incidents) that occur during operations

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SMS framework pillars:

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