What does Work-As-Imagined (WAI) And Work-As-Done (WAD) Mean?

Erik Hollnagel
Professor, University of Southern Denmark
Chief Consultant Center for Quality, RSD (DK)
hollnagel.erik@gmail.com

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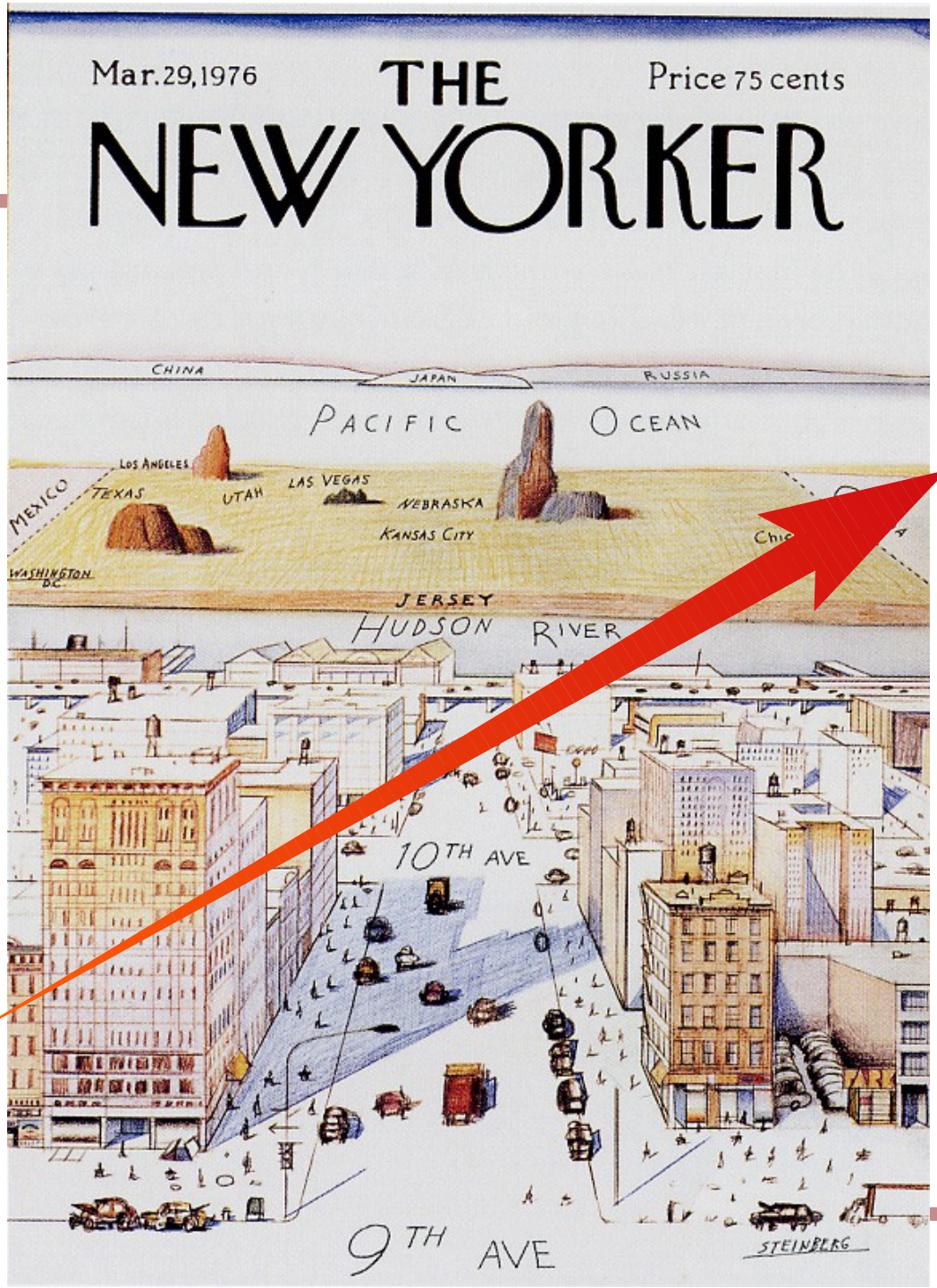
How well do these people ...

Work-as-imagined



Work-as-done

... understand what happens here?

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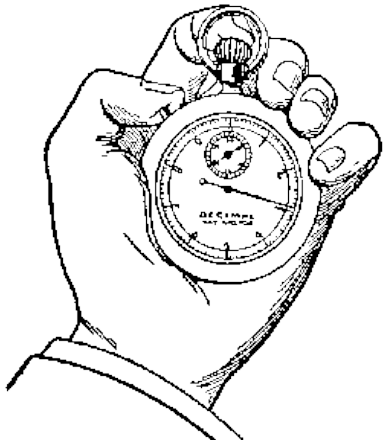
Looking at work-as-done

Scientific management was formulated in the late 19th and early 20th in order to increase efficiency of work and decrease waste. It introduced empirical methods to study work as it actually took place (WAD) – with the intention of prescribing a "better" way of doing it (WAI).

Principles of scientific management (1911)

- Analyse tasks to determine most efficient performance
- Select people to achieve best match between task requirements and capabilities
- Train people to ensure specified performance
- Insure compliance by economic incentives



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WAI-WAD in behavioural science

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Calculus Ratiocinator

Homo Economicus

- Completely informed
- Infinite sensitivity
- Rational

Decision theory assumes all options, outcomes and preferences are known and amenable to evaluation.

Naturalistic decisions

"Muddling through"

Satisficing

Naturalistic decision making

Decision theory recognises that most situations show incomplete, dynamically changing conditions and competing goal structures.

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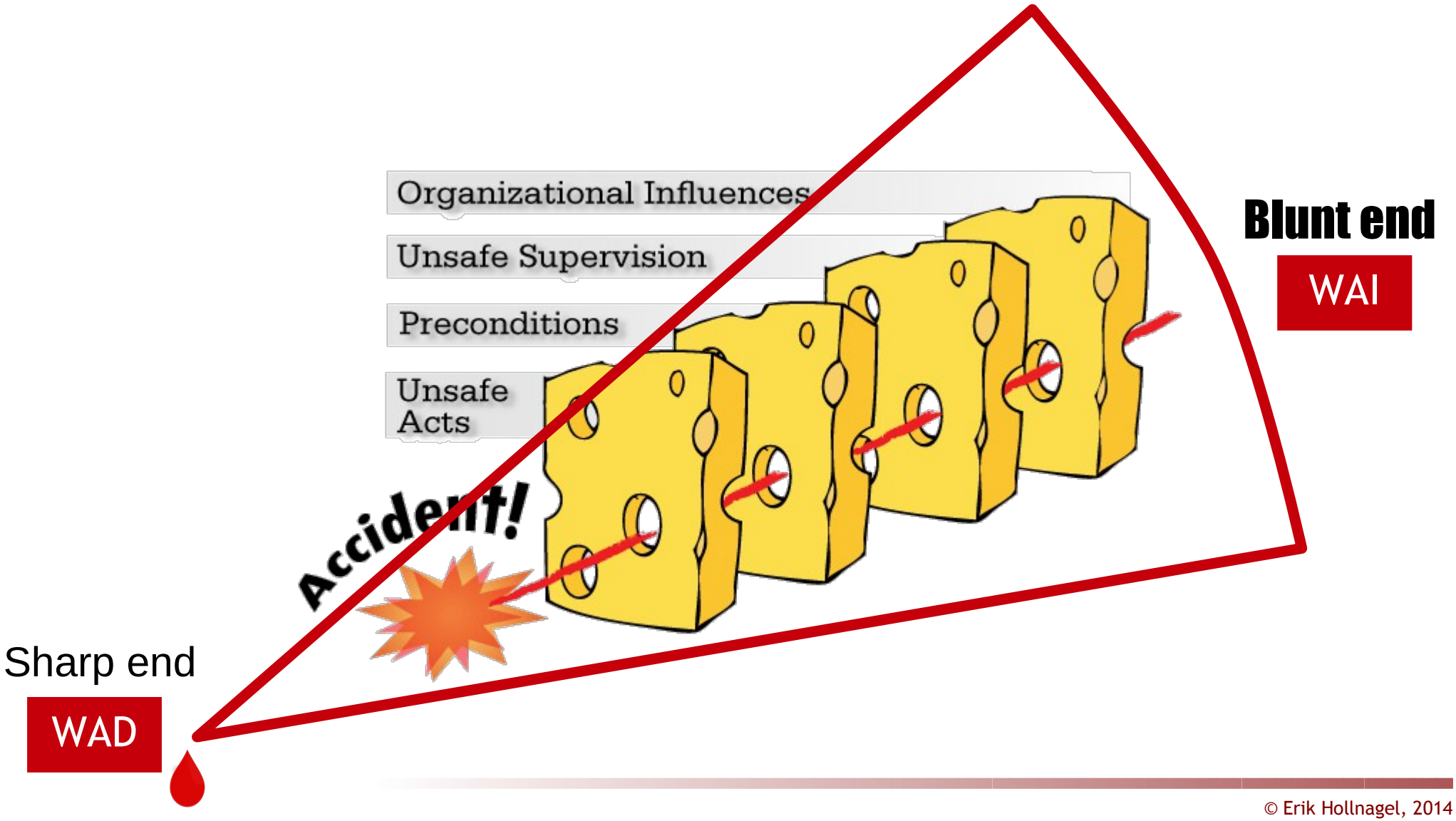
Blunt end and sharp end



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The need to "imagine" how others work

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Design (tools, roles, environment)

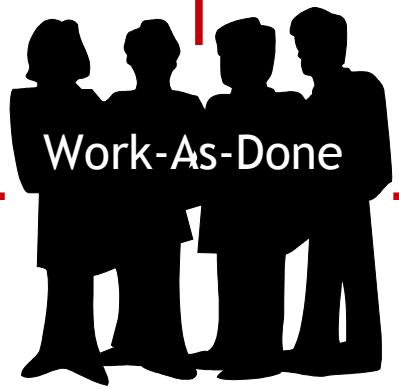
Work-As-Imagined

Work & production planning ("lean" - optimisation)

Work-As-Imagined

Safety management, investigations & auditing

Work-As-Imagined



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Work as imagined – work as done

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Work-as-imagined (WAI) is what designers, managers, and authorities believe happens or should happen.

Work-as-done (WAD) is what actually happens.

Work-as-imagined (WAI) is the basis for design, training, and planning (safety and production).

Work-as-done (WAD) is what people have to do to cope with the complexity of the actual work environment.

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Designing for work-as-imagined

Designer(s)

What tools do the operators need?

What have they been thinking of?

How should it be provided?

What is this supposed to do?

How will it fit existing ways of working?

Why does it not fit the way we work?

How should it be used correctly?

How can we get it to work?

End users (ATCOs)

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Managing work-as-imagined

Safety synthesis

Procedures

"Runway incursions will be substantially reduced and aviation safety improved through the use of clear, unambiguous phraseologies related to surface operations."

During a normal work, on different sectors and different positions. a controller has to consider around about 70 – 100 restrictions – although NOT all at the same time .

Audits

To ensure that safety in the provision of ATS is maintained, the ATS authority has to implement formal and systematic safety management programmes for ATS under its jurisdiction. Furthermore, one of ICAO's requirements is the regular conduct of safety audits of ATS by trained, experienced and qualified personnel.

Performance targets (SESAR goals for 2020)

enable threefold increase in capacity
improve safety by a factor of 10
cut ATM costs by half
reduce environmental impact by 10%

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The sharp end and the blunt end

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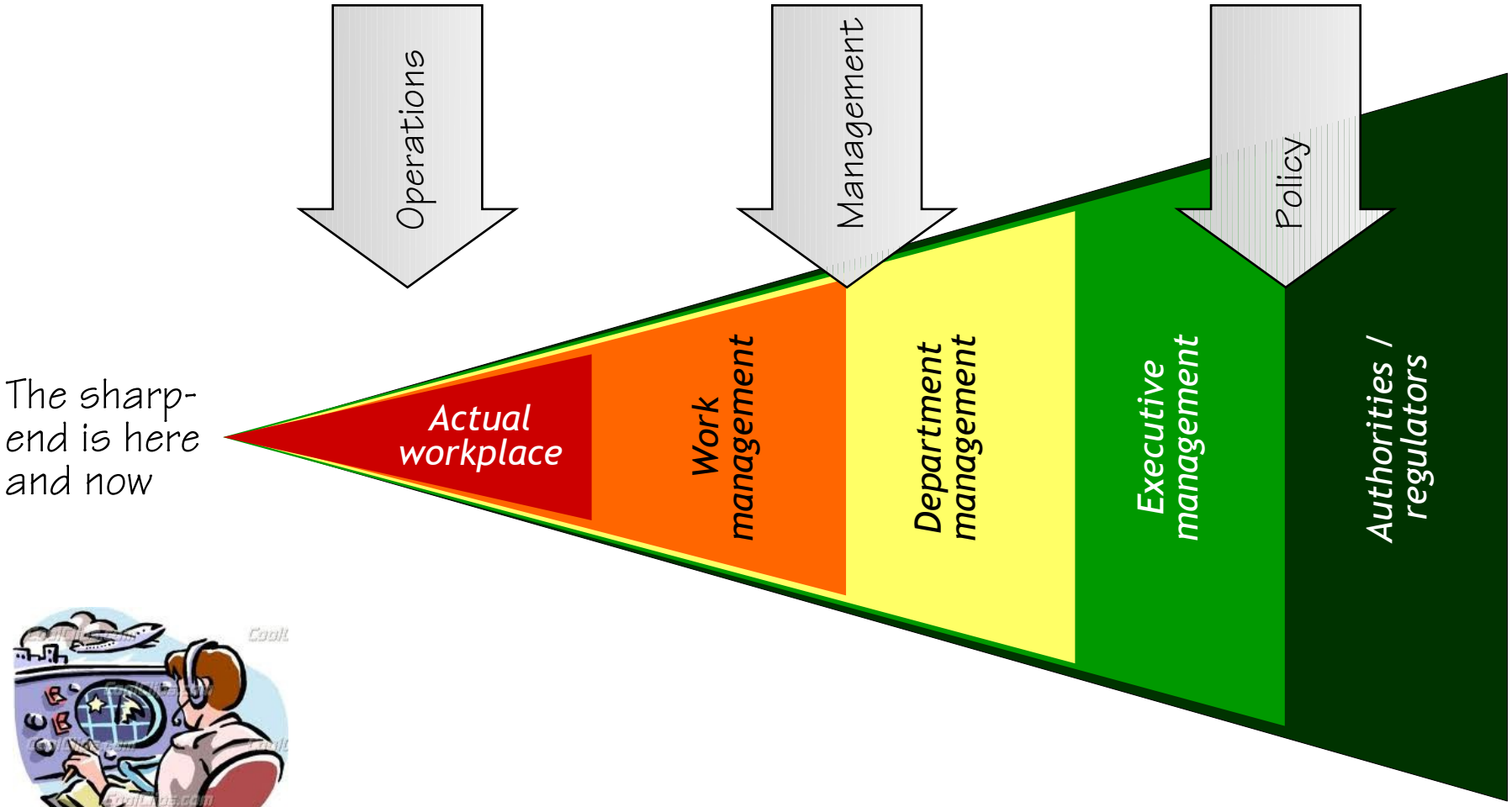

The sharp-end is here and now

The blunt-end is earlier and somewhere else

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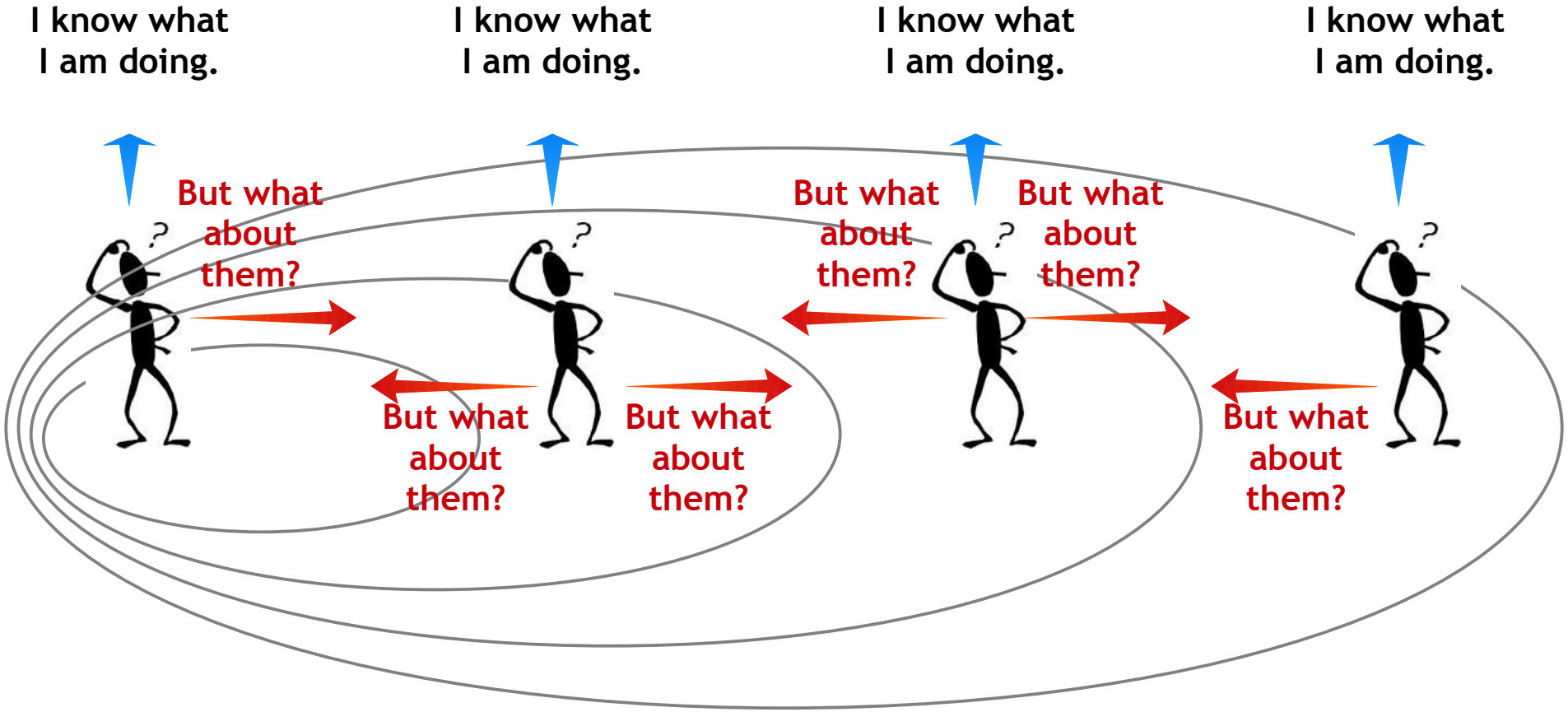
"Us" and "Them"



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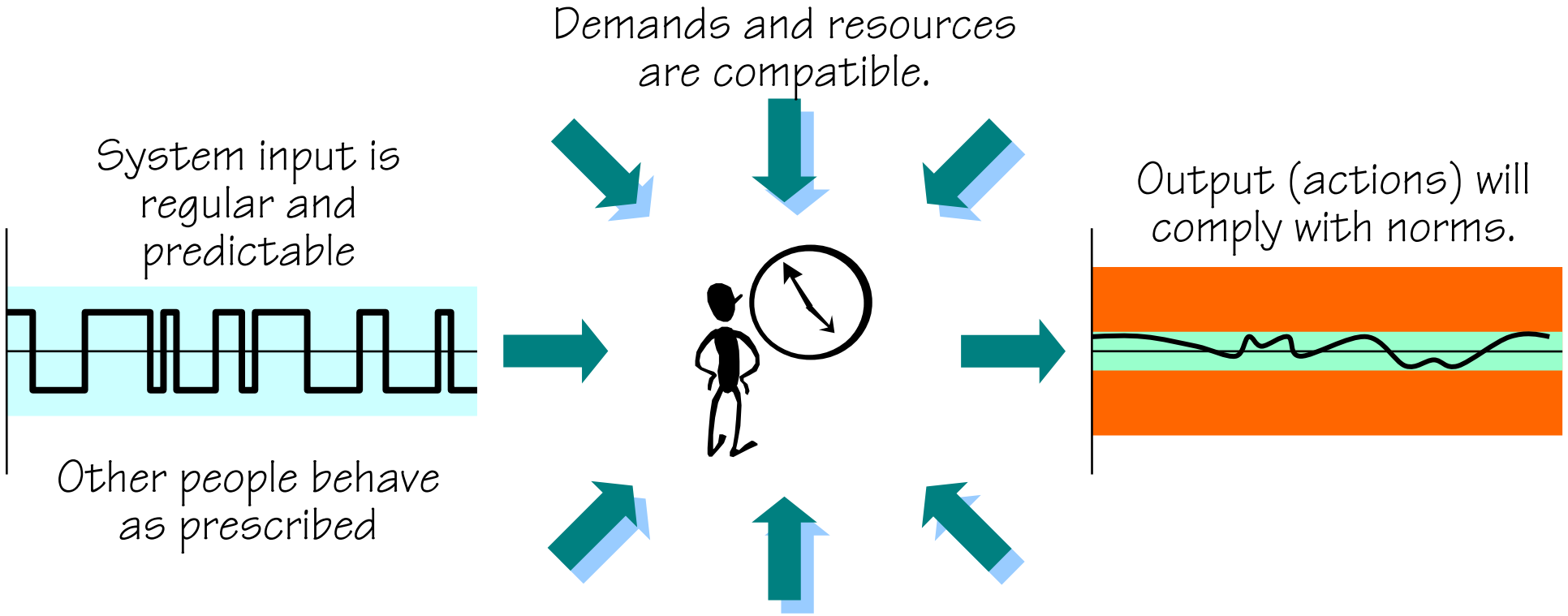
Work as imagined - design assumptions



... no need to make adjustments

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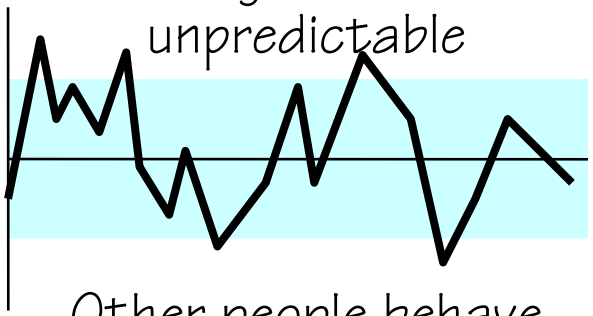
Work as done

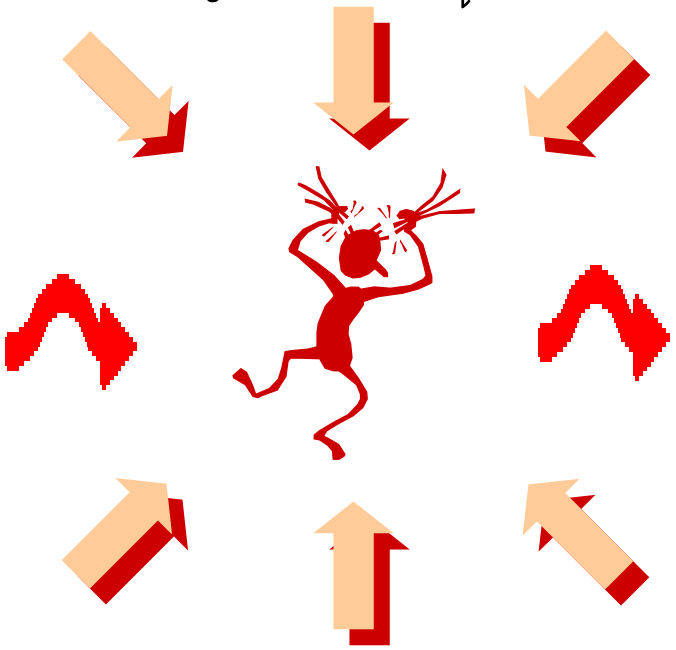
Safety Synthesis

Demands vary and resources may be inadequate.

System input may be irregular and unpredictable

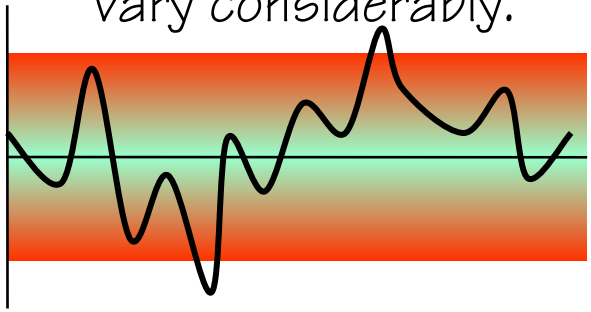


Other people behave egocentrically



Working conditions may at times be sub-optimal.

Output (actions) will vary considerably.



... necessary to make local adjustments
Efficiency-Thoroughness Trade-Off (ETTO)

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Performance adjustments are necessary

Availability of resources (time, manpower, materials, information, etc.) may be limited and uncertain.

People adjust what they do to match the situation.

Performance variability is inevitable, ubiquitous, and necessary.

Because of resource limitations, performance adjustments will always be approximate.

Performance variability is the reason why everyday work is safe and effective.

Performance variability is the reason why things sometimes go wrong.

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Efficiency-Thoroughness Trade-Off

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Thoroughness: Time to think

Recognising situation.
Choosing and planning.

If thoroughness dominates, there may be too little time to carry out the actions.

Neglect pending actions
Miss new events

Efficiency: Time to do

Implementing plans.
Executing actions.

If efficiency dominates, actions may be badly prepared or wrong

Miss pre-conditions
Look for expected results

Time & resources needed

Time & resources available

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Focused and scattered work

Work at the sharp end is usually focused:
Activities are joined (are a whole).
Activities have a clear beginning and end.
Dependence on others – outside team – is limited.
Work environment is designed with specialised support (tools, training, etc.)
Information is concentrated.

Work at the blunt end is often scattered:
Activities are isolated, only loosely connected to what went before or what comes after.
Dependence on others often considerable.
Work environment is generic.
Information is dispersed.

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ETTOing at the sharp end

Limitations	Part of work, but not always easy to see.
Resources, means	Many, specific, due to system design.
Decision space	Limited (local).
Detection, correction	Good possibilities (part of system design).
Predictability	Reasonable in most cases.
Time frame	Decisions: short Consequences: short

AVOID

anything that may have negative consequences for yourself, your group, or organisation

CREATE/MAINTAIN

conditions that are necessary to carry out the work.

COMPENSATE FOR

conditions that makes work difficult or impossible.

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ETTOing at the blunt end

Limitations	Vague, uncertain, usually time and money
Resources, means	Limited, general
Decision space	Large, extensive (global)
Detection, correction	Few possibilites (delays).
Predictability	Low, due to complexity and delays
Time frame	Decisions: short Consequences: long

CREATE/MAINTAIN

conditions that are necessary to carry out the work.

AVOID

anything that may have negative consequences for yourself, your group, or organisation

COMPENSATE FOR

conditions that makes work difficult or impossible.

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Delay in getting information

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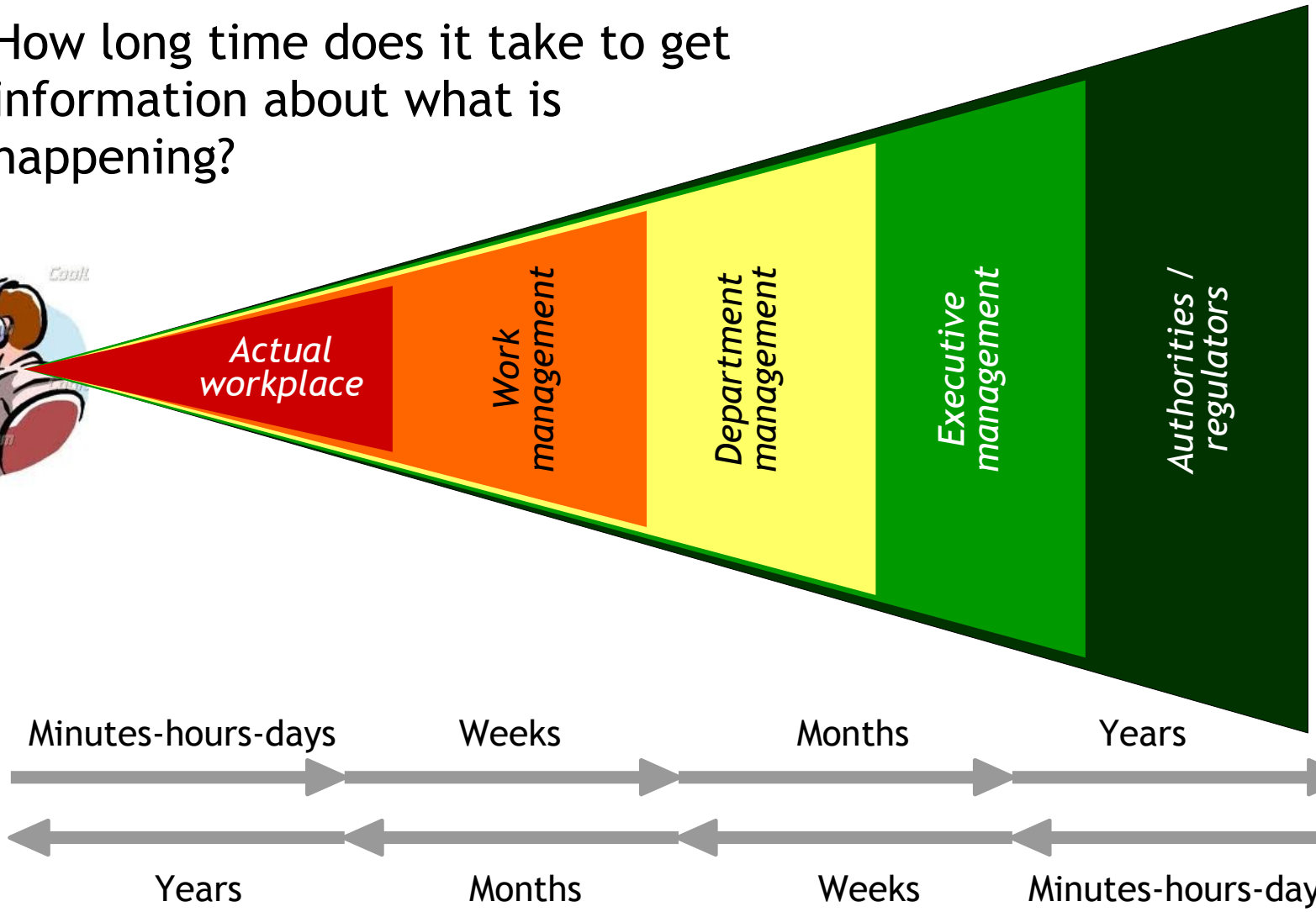
ΔT How long time does it take to get information about what is happening?



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Decay of information

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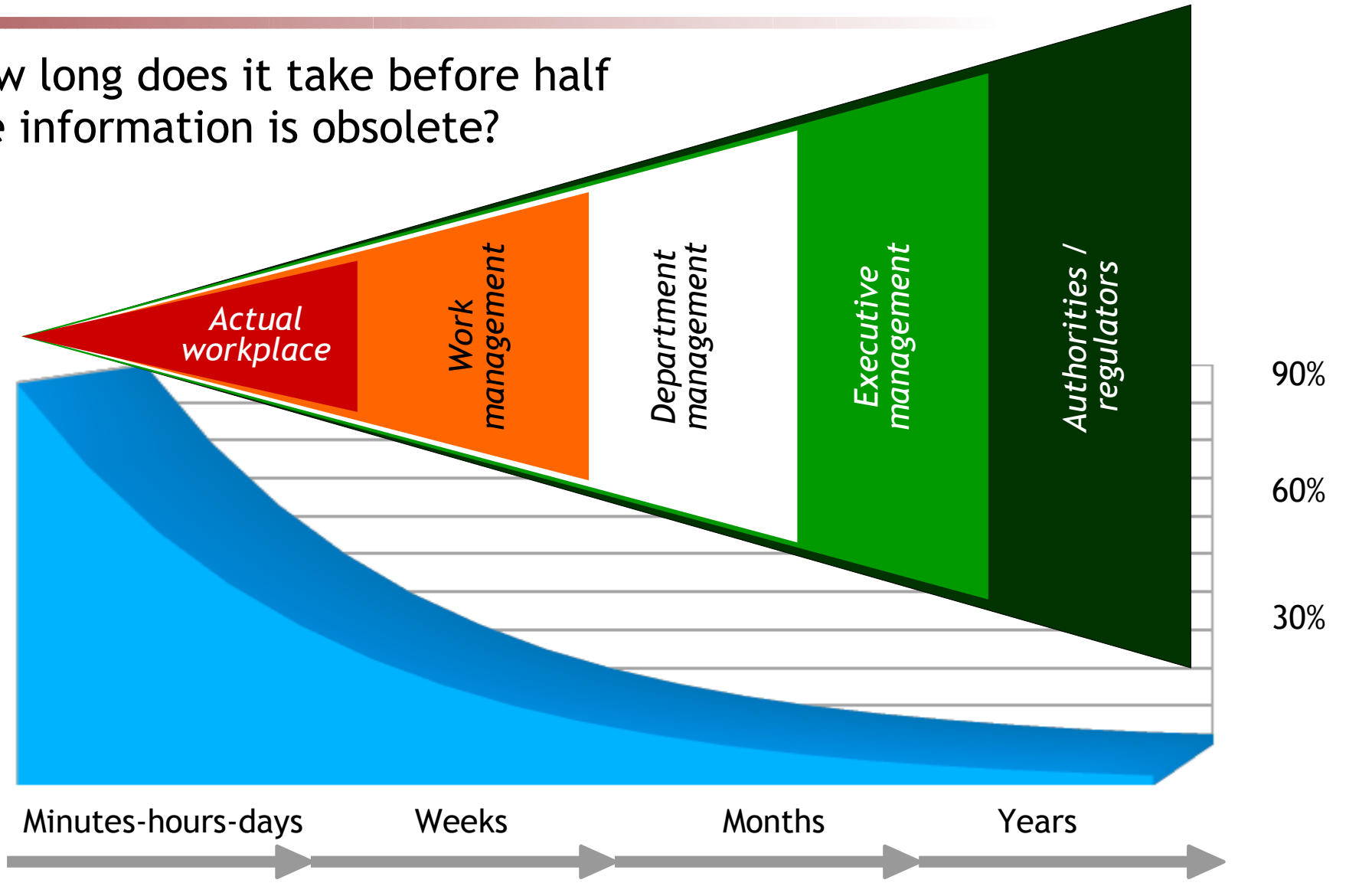
$T_{1/2}$ How long does it take before half the information is obsolete?



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Different roles of the blunt end

Work management
(schedules - norms)

BE prescribes and prepares work for the SE;
BE manages how SE do their work (quality, productivity)

Production planning
("lean" - optimisation)

BE – as the monitor or manager of actions
(sampling rate, level of detail, ETTO organisational)

Investigations & auditing
(errors - compliance)

BE – as regulator and arbiter, right or wrong.
Limited time to do their work

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Contrafactual reasoning

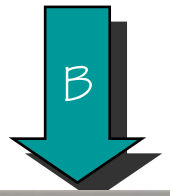
FRAM

Going back through a sequence, investigators often wonder why opportunities to avoid bad outcomes were missed. This, however, does not explain the failure

"Why didn't he do A"?

"Why didn't he do B"?

Actual outcome



Possible outcome 1

Possible outcome 2

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The 90% solution

When something goes wrong, e.g., 1 event out of 10.000 (10E-4), humans are assumed to be responsible in 80-90% of the cases.

Who or what are responsible for the remaining 10-20%?

Investigation of failures is accepted as important.

When something goes right, e.g., 9.999 events out of 10.000, are humans also responsible in 80-90% of the cases?

Who or what are responsible for the remaining 10-20%?

Investigation of successes is rarely undertaken.

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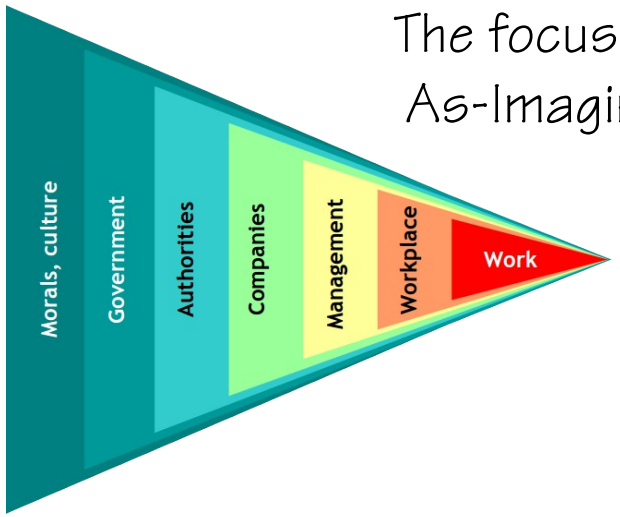
Problems with safety as risk reduction

The causality credo lead to explanations in terms of simple causes and effects.

The 90% solution: "human error" - humans in wilful disregard of critical cues or factors.

Explanations are incomplete and misleading, hence an ineffective basis for changes.

Investigations are concluded a "culprit" has been found. This severely limits learning.



The focus on failures juxtaposes Work-As-Imagined and Work-As-Done – and assume the former is correct (blunt-end or management perspective).

Incidents are described by after-the-fact stories. In hindsight they seem to be easily preventable by relatively simple measures, such as new policies and procedures or calls to increase vigilance or compliance of operators.

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WAD ≠ WAI – seen from the blunt end

Limited time

Limited resources

Limited information

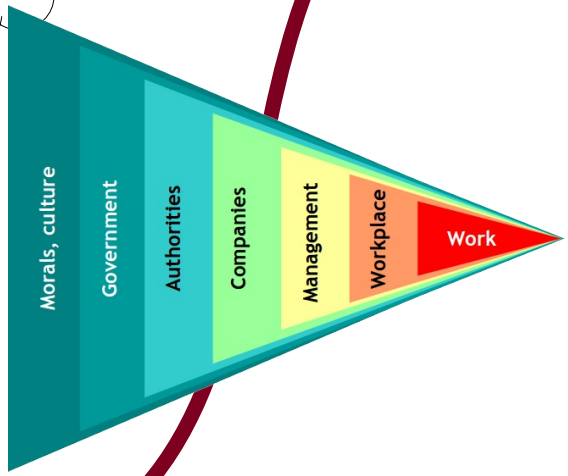
Clear causes

Clear conclusions

Accident model

Accident model

The people who investigate the accident.



The people who, directly or indirectly, are involved in the accident.

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WYLFIWYF

Accident investigation follow a What-You-Look-For-Is-What-You-Find (WYLFIWYF) principle.

Accident investigations that look for causes, find causes. The assumptions about the nature of accidents (causality credo) constrain the analysis.

Human error
Technical malfunction
Organisational failure
Incorrect design

Bad maintenance
Safety culture
Latent conditions
Violation, non-compliance

We can be safe – with a little more effort, a few more resources, a more refined set of recommendations from a knowledgeable inquiry, some new tools, an updated IT system, a better policy, and an improved safety culture.
In other words, WAD should be made more like WAI.

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Work-as-done: The non-compliance view

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Unintentional

Unintentional Understanding failure – when people have a different understanding of what the procedure is and what they have to do.

Unintentional Awareness failure – when people are not aware of the existence of a rule or procedure and therefore operate with any reference to it.

Intentional

Situational non-compliance – when the situation makes it impossible to do the job and be compliant, e.g., because of insufficient time or resources.

Optimizing non-compliance for company benefit – individuals take short-cuts believing that this will achieve what they believe the company, and their superiors, really want;

Optimizing non-compliance for personal benefit – short-cuts taken to achieve purely personal goals;

Exceptional non-compliance – deviations from the official procedures that may be difficult to follow under specific, and usually novel, circumstances.

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WYLFIWYF

Looking at work-as-done also follows a What-You-Look-For-Is-What-You-Find (WYLFIWYF) principle.

"Safe" and "unsafe" behaviours
Happen in the same way
Adjustments / improvisation can be useful
People successfully balance competing goals

Work studies should focus on how things normally work and why that succeeds.
Something that goes wrong, has usually gone right many times before.

We can only be safe if we understand how work is done.
Neither WAI nor WAD are absolute references, but both serve useful purposes.
There are no 'silver bullets' - no simple solutions.
We must learn how continuously to realign WAI with WAD.

Best practice
Culture of resilience
Learning from experience
Coping with complexity

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Work-as-done: The ETTO view

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Aspect	Avoid	Maintain/establish	Compensate for
Time	Waste of time	Time buffer	Inadequate timing
Human effort	Waste of effort	Spare effort / work capacity	Manpower shortage
Workplace (HF)	Inadequate work conditions	Workable conditions	HMS deficiencies
Workload /stress	Work overload	Manageable workload	Overload (underload)
Materials / resources	Waste of material & resources	Buffer of material / resources	Unavailability / inaccessibility
Equipment / tools	Improper use	Workable equipment / tools	Unavailability of tools
Finance (cost)	Waste of money	Financial buffer	Excessive cost
Data	Data overload	Data buffer	Missing data

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When worlds collide …

WAI ≠ WAD

WAI ≠ WAD

Solution: Make sure that WAD is more like WAI.

Tempting because WAI seems to be clear and well-defined, and it is easier to prescribe that WAD should be changed than to change WAI.

WAI ≠ WAD

Solution: Adjust WAI to be more like WAD.

Difficult because WAD appears to be unclear and difficult to grasp, because WAD is forever changing, and because it will threaten those in charge.

WAI ≠ WAD

Solution: Realign WAI and WAD.

To change WAI: Get information about WAD faster. Improve quality of information about WAD (Safety-II).

To change WAD: Encourage mindfulness. Make informal communication easier.

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