

# Industrial Safety & Resilience Engineering

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## Positivist vs Constructivist approach of Industrial Safety



# Past(s), Present(s) and Future(s)



Imputation to an agent of the responsibility of an action or its effects

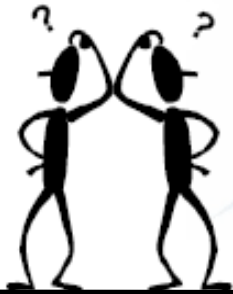
Risk Culture

Accident Investigation

Risk Management

Research of Causality

Barriers Conception



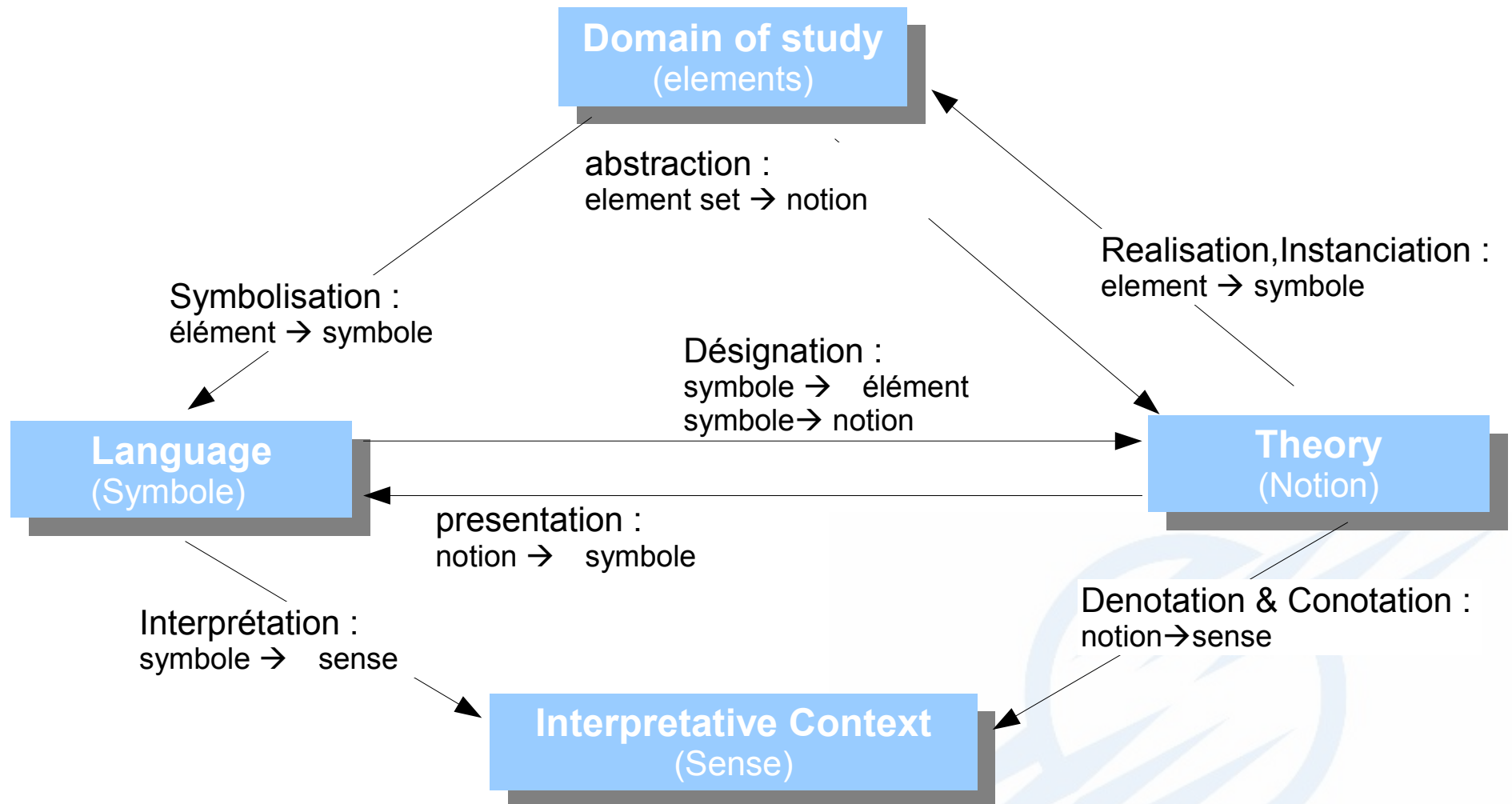
Past

Present

Futur

Potential World of hazard

# The modeling context



# Positivist way of thinking

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## Foundations

### Ontological hypothesis

The knowledge which constitutes progressively science is the knowledge of Reality, a reality independent of the people who define it

### Determinist hypothesis

Any phenomenon is the element of a chain of causality, and at which research process aims at identifying the order of relation between elements

## Knowledge creation

### Analytical method

Don't consider something true until his mind will have assimilated it apparently and distinctly beforehand.

Sort out his difficulties to better examine and solve them

Establish an order of thoughts, by beginning with the simplest up to the most complex and various, and so to keep them and in order.

Review all things to skip nothing

### Principle of sufficient reason

If A is a sufficient cause of B, then the presence of A necessarily implies the presence of B.

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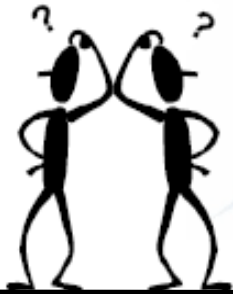
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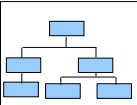
# Risk languages



Technical faults



Human error



Organisational faults

## Accidents factors



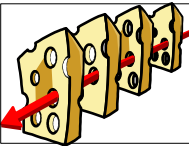
$$\text{Risk} = \text{Alea} * \text{Vulnérabilité}$$



## Causality Principles



Sequential model

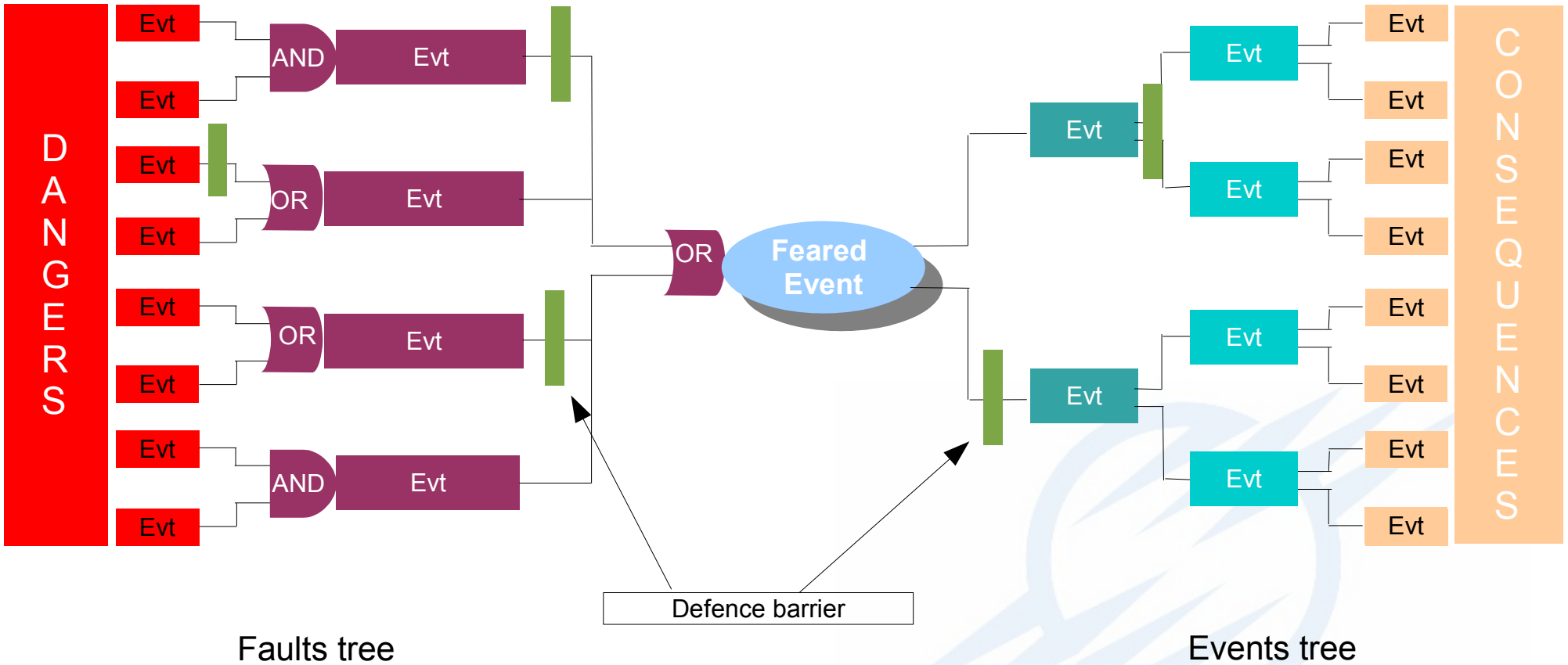


Epidemiological model

$$\text{Risk} = \text{Frequency} * \text{Gravity}$$

Occasionnel					
Peu Fréquent				<b>Prioritaire</b>	
Rare				<b>Tolérable si ALARA</b>	
Extrêmement rare	<b>Acceptable</b>				
Rarissime					
	Modéré	Sérieux	Majeur	Catastrophique	Désastreux

# Risk languages



# Past(s), Present(s) and Future(s)



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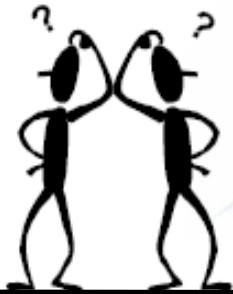
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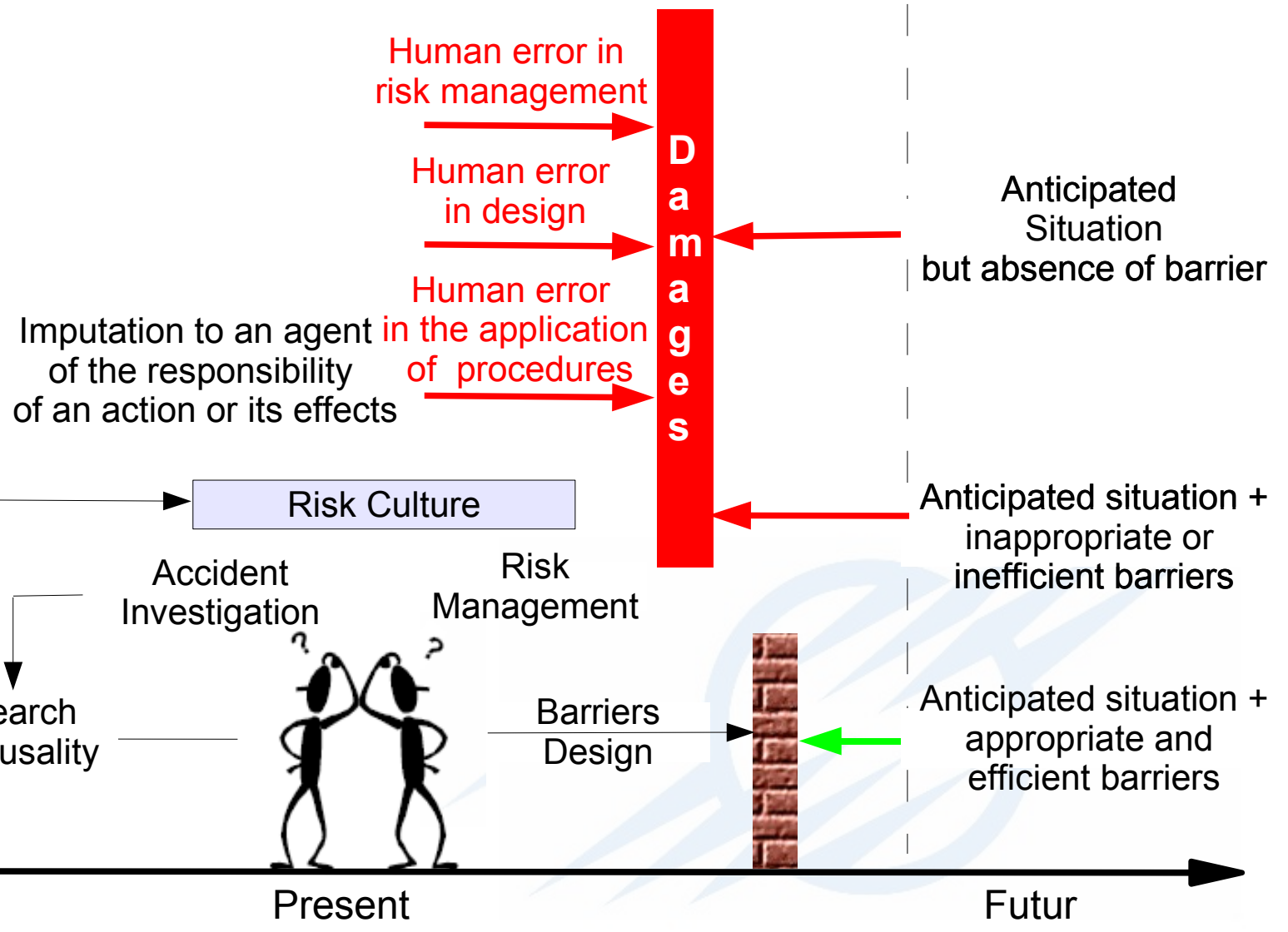
Past

Present

Futur

Potential World of hazard

# Past(s), Present(s) and Future(s)



Potential World of hazard

## Toward a systemic approach of Industrial Safety



# Constructivist way of thinking

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## Foundations

### Phenomenological hypothesis

People don't know the essence of things (Ontological hypothesis) but the act by which he sees correlation between things

### Teleological hypothesis

Knowledge is construct according to the purposes of the knowing subject.

## Systemic modeling

### Tetralogic loop

System, Organisation, Interaction, Order, Disorder

### Emergence and Constraints

The whole is at the same time more and less than the sum of the parts

### Recursive principle

Elements appear both as product and effect, producer and cause one of the other one

### Dialogic principle

Phenomenon is not comprehensible from a single logic but be understood as conjugate logic which are at the same time rival, opposite and supplementary

### Holographic principle

The whole is in the part which is in the whole

# Ecology of Action

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**As soon as an individual produces an action, the environment catches it. The interactions game may produce results which may be opposite to initial intentions.**

## **The Risk ↔ Precaution loop**

For any action produces in uncertain middle, there is contradiction between the principle of risk and the principle of precaution, one and the other are necessary; it's a question to link them in spite of their opposition.

## **The Action ↔ Context loop**

Action risks the failure, the misappropriation for its initial sense and can even turn round against his originators.

Pervert effects (unforeseen harmful effect is more important than hoped advantageous effect)

Inanity of the innovation (the more this changes, the more it is the same thing)

The bet in dangers of acquired results (they wanted to ameliorate the society, but they succeeded only in abolishing freedom or securities).

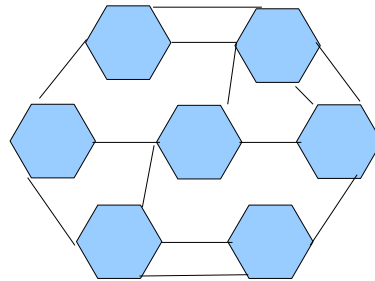
## **Long term unpredictability**

They can envisage or calculate the short term effects of an action, but it's long-term effects are unpredictable

No action is assured to work in the sense of its intention

# Tetralogic loop

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## Organisation

« Layout of relations between components or individuals which produces a complex unit or system, endowed with unknown qualities at the level of components or individuals. »

## Interactions

« Reciprocal actions changing behaviour or nature of elements, bodies, phenomena in presence or in influence »

## System

« Total unit organized by interactions between elements, actions or individuals »

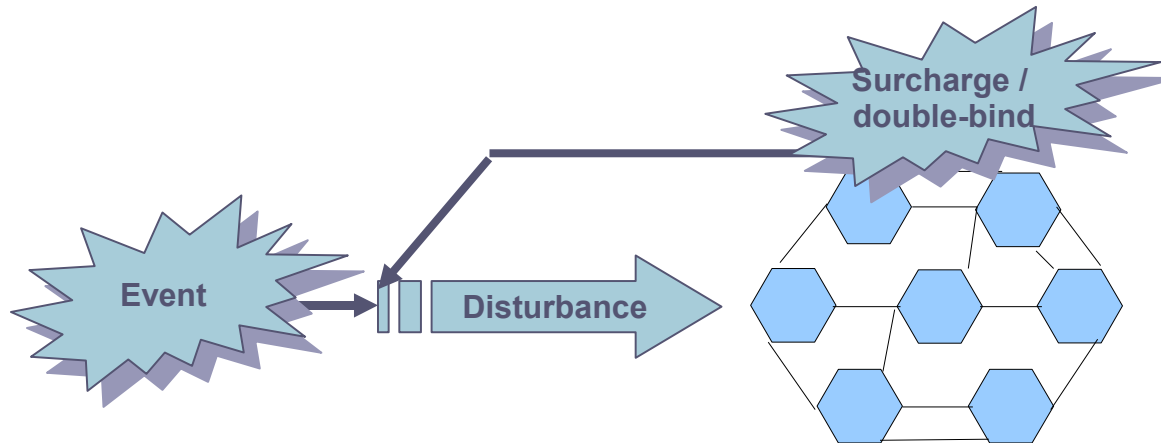
## Order

« Set of laws, constraints, repetitions or constants which constitute the spinal column of the system »

## Disorder

« Disturbances (impacts, events, accidents, noise, errors, etc) which appear in a system, unsettle it, transform it »

# Tetralogic loop



## Disturbance

### External origin

Event, accident which corrupts the functioning of the system

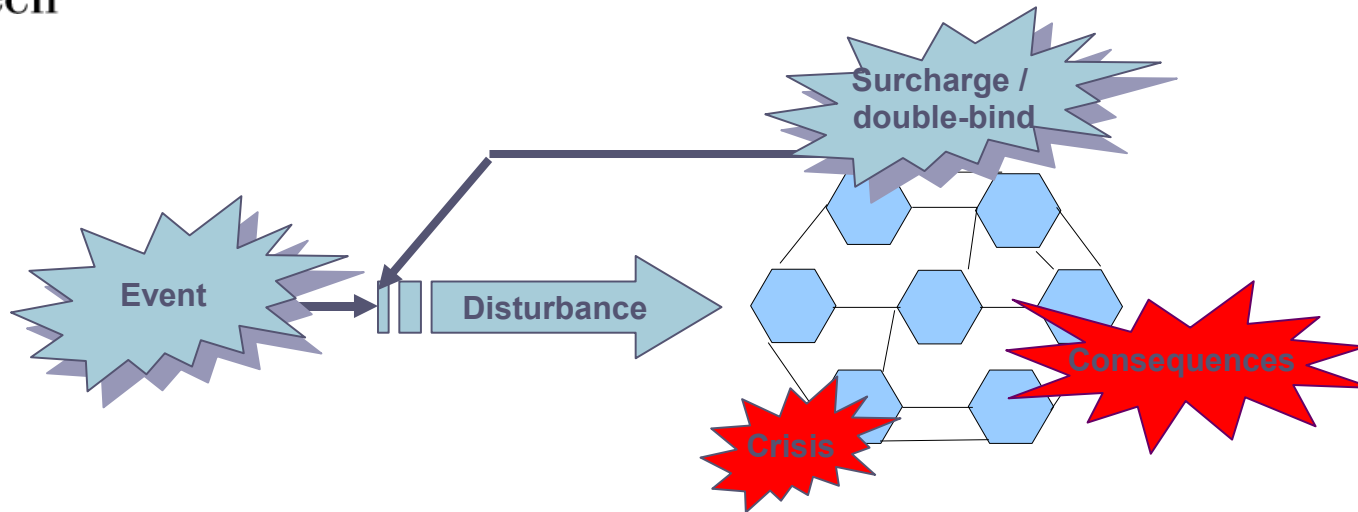
### Internal origin

Issue of obviously not disruptive processes :

**Surcharge:** the system becomes unable to resolve problems that it solved under a certain threshold

**Double-Bind:** the system stick between two opposite requirements is paralysed, unsettled and affected

# Tetralogic loop



## Disturbance consequences

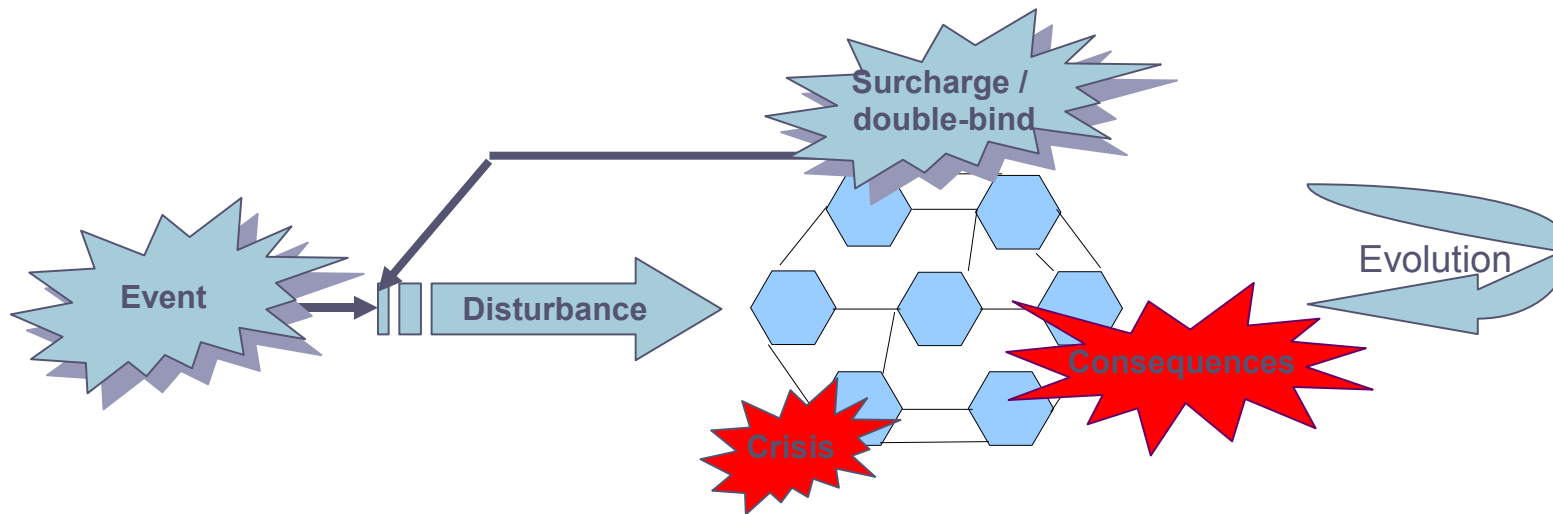
Disturbance consequences are dysfunctions where it was functionality, break where it was continuity, positive feedback, where it was negative feedback, conflict where it was complementarity

## Crisis

From Krisis (decision), it's the decisive instant, in the evolution of an uncertain process which allows diagnosis. It's the instant when, at the same time disturbance and uncertainties come into sight.

Crisis raises suddenly the presence, the force and the form of facts that usually or in normal situation are invisible.

# Tetralogic loop



## Regressive change

The system loses in complexity, in suppleness: decline manifests itself most by the loss of the richest quality, of freedom, which are the most recent and most fragile characters, and by the strengthening of the rigid or most primitive structures all at once

## Progressive change

The system increase it's complexity by acquiring new qualities and new ownership

# Emergence and constraint

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« The whole is at the same time more and less than the sum of the parts »

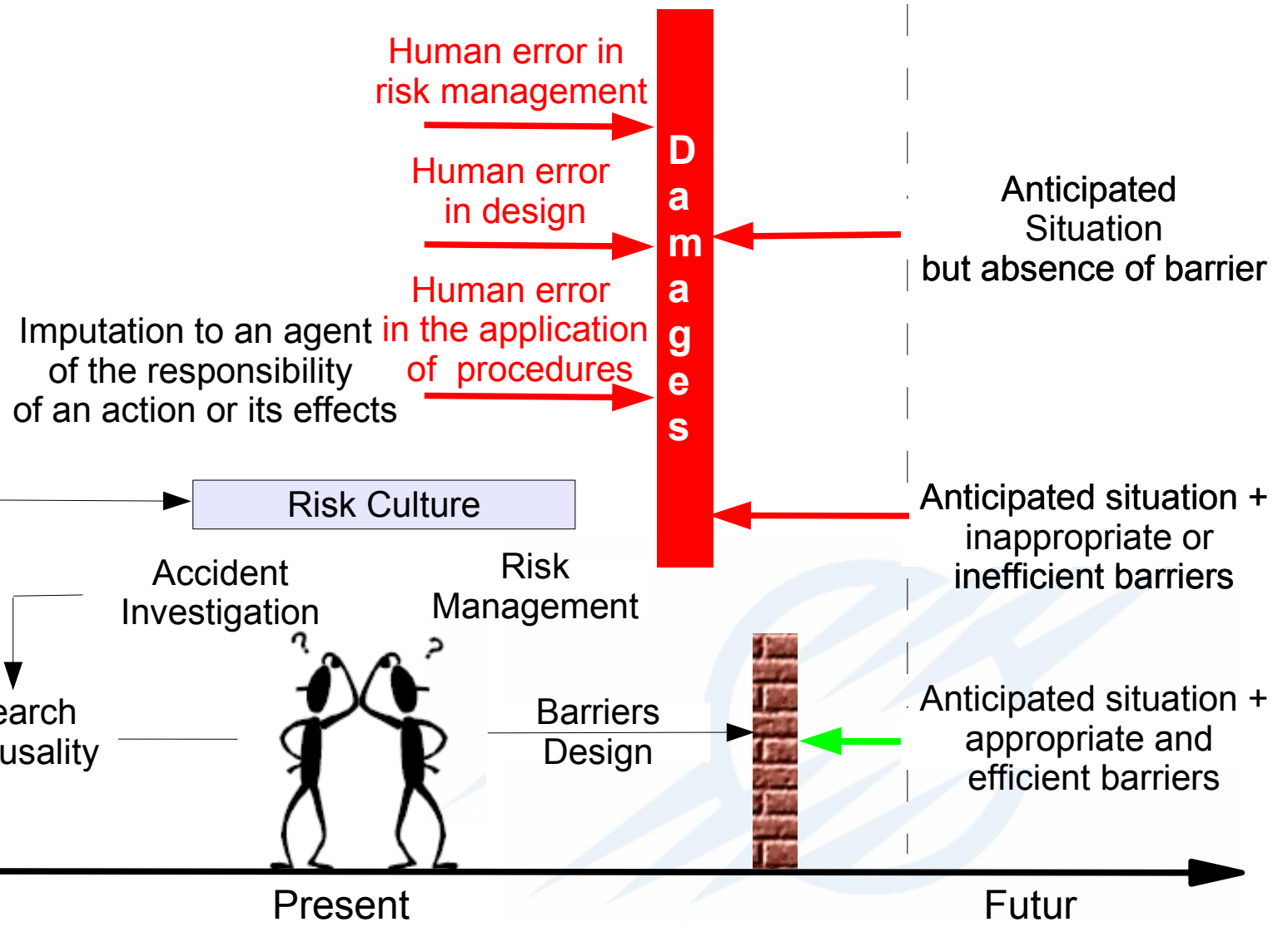
Accident can emerge of the relations between the elements of the system and not only with the failure of a component of the system.

Accident can be the consequence of the composition of the behaviour of elements in interaction. If we study elements independently of each other, no abnormalities can be detected.

Interactions may be at the origin of the surcharge of the system (conflict related to resources, time, precondition of activities, etc.)

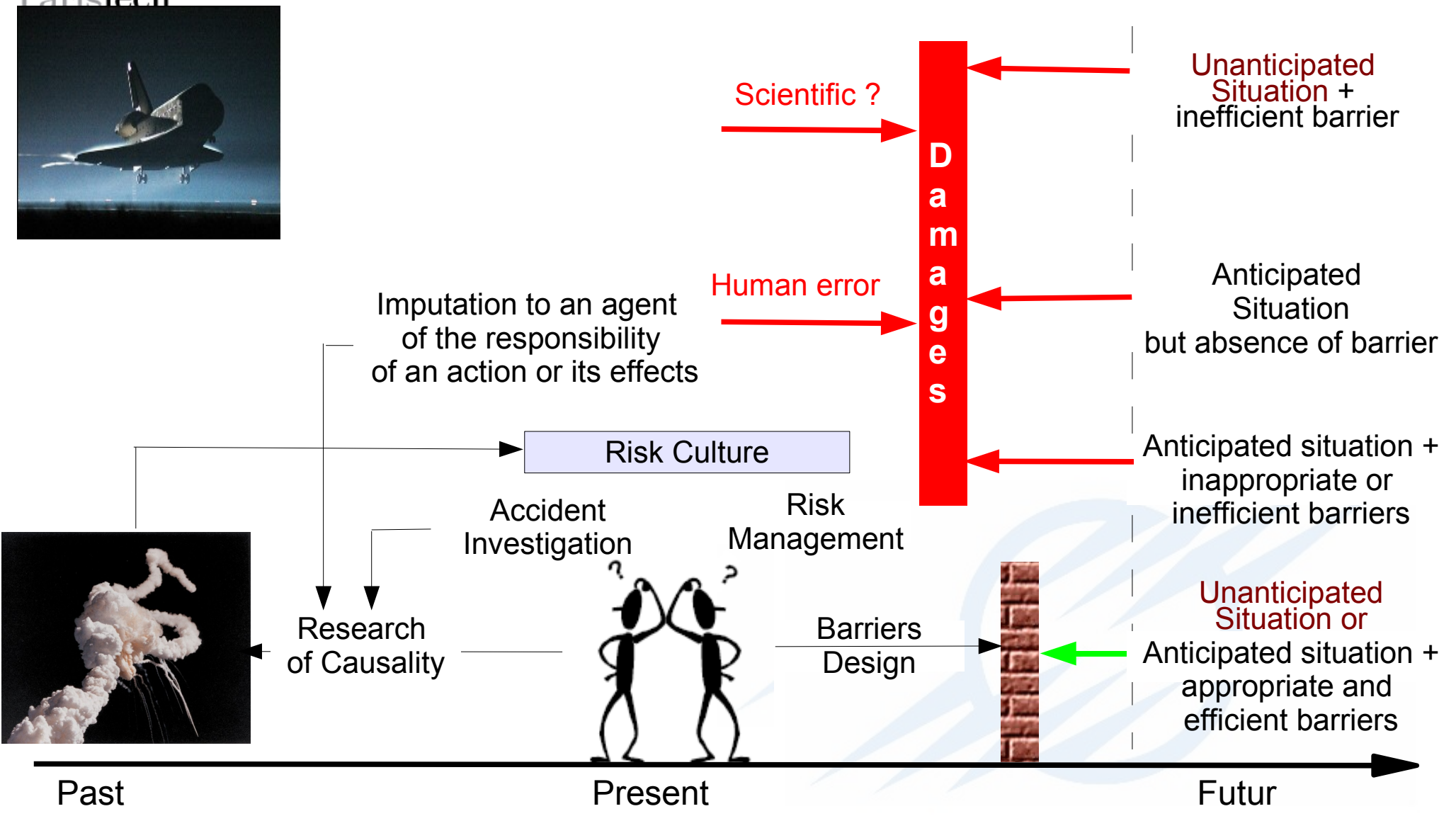
Interactions may be at the origin of double-bind due to the necessity to achieve opposite goals or follow contradictory rules.

# Past(s), Present(s) and Future(s)



Potential World of hazard

# Past(s), Present(s) and Future(s)



Potential World of hazard

# Dialogic principle

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Phenomenon is not comprehensible from a single logic but be understood as conjugate logic which are at the same time rival, opposite and supplementary

## Dialogic entropy – negentropy

Entropy principle indicates phenomenon which are at the origin of disorder, disorganization and degeneration (failures, double-bind, surcharge, etc.) present in each organisation.

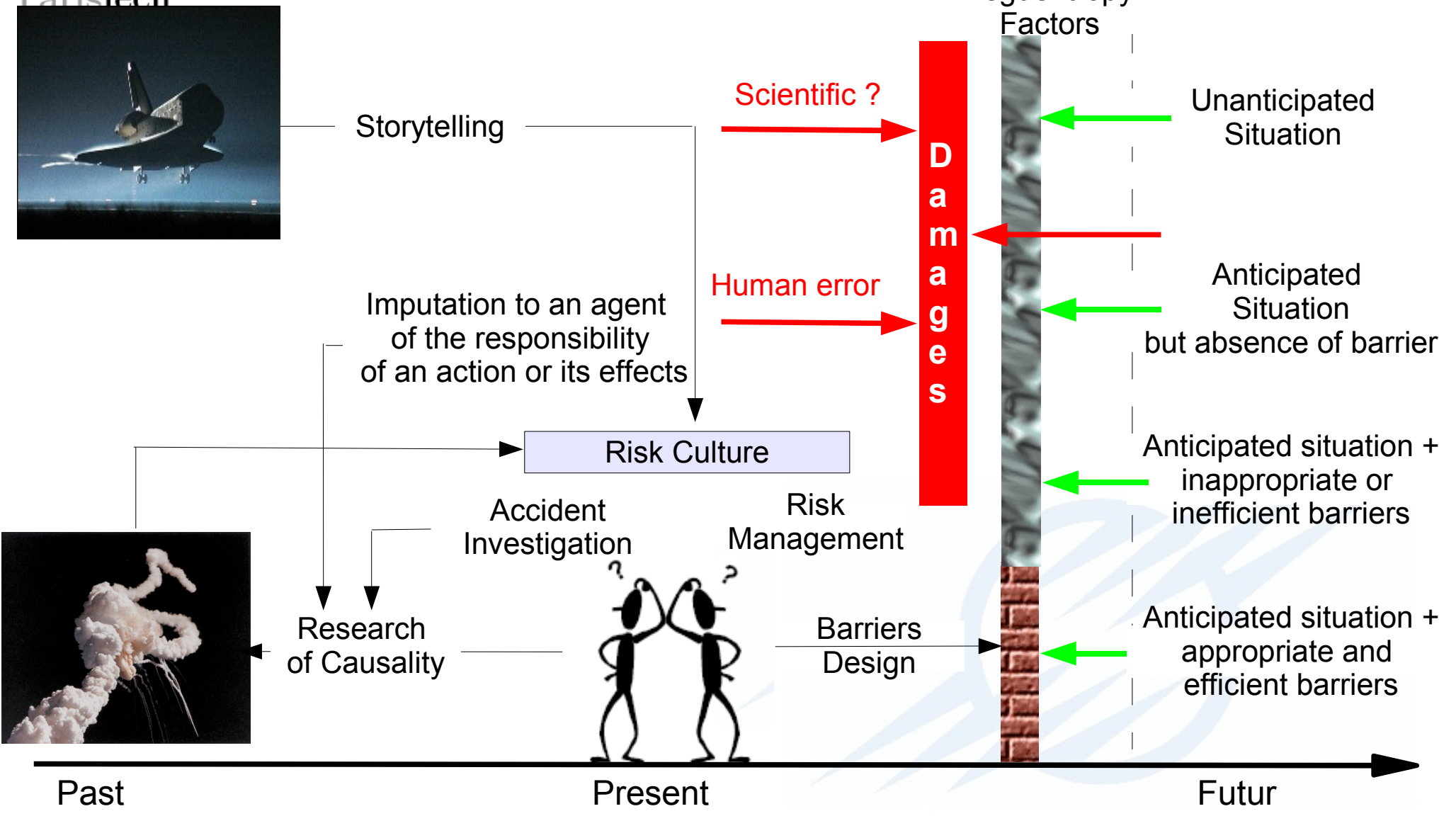
Negentropy principle indicates phenomenon which are at the origin of reorganization, regeneration, development and complexification necessary for organisational process to cope the happening of disturbances related to the entropy phenomena.

Decreasing entropy reacquires to limit the source of freedom of the organisation

Increase negentropy requires to increase the source of freedom of the organisation.

Decrease of entropy depends on sources of negentropie which opposes to it while being in their turn at the origin of the emergence of disturbances and therefore entropy.

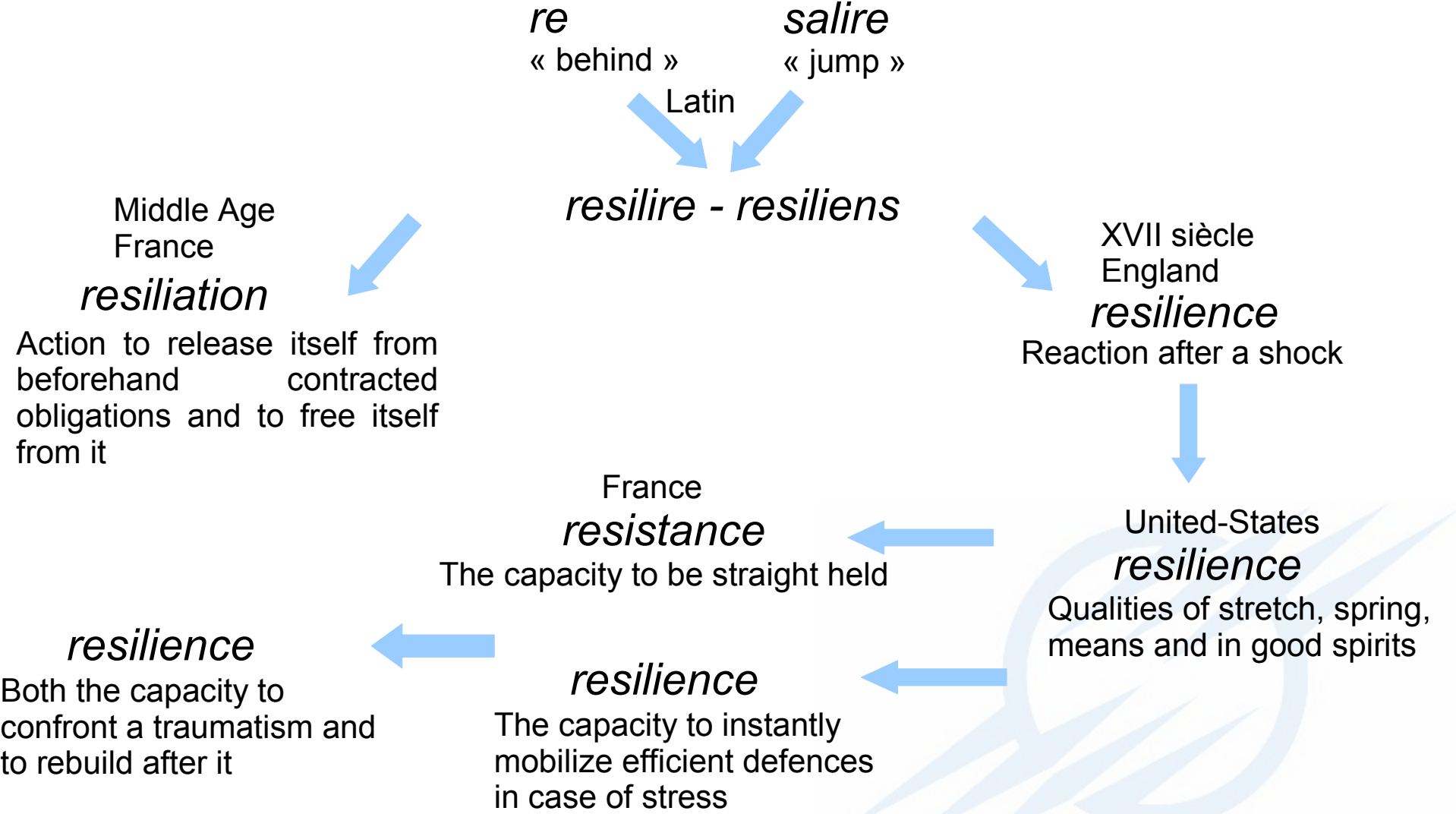
# Past(s), Present(s) and Future(s)



## From negentropy to resilience



# Resilience etymology



# Resilience theories

Resilience

Capacity to confront  
a traumatism

Rebound after  
a shock

Materials

Computer Science

Physiology

Psychology of  
Stress

Children  
Psychology

Leadership  
Psychology

Organisation  
sociology

Economy

Ecology

Geography

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# About Resilience

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« The capacity to success, lived and to develop positively, in a socially allowable way, in spite of stress or misfortune which include normally the serious risk of a negative end » B. Cyrulnik

« Resilience is the intrinsic ability of a system to adjust its functioning prior to or following changes and disturbances, so that it can sustain operations even after a major mishap or in the presence of continuous stress » E. Hollnagel

« Organization 's ability to retain or recover rapidly a stable condition, enabling it to pursue its activities during after a major accident, or in the presence of great and ongoing pressure » (Wreathall 's, 2006)

« Ability to manage great pressure as well as conflicts between safety and production objectives » (Lin, 2006, Hale and Heijer, 2006)

# About Resilience

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## Foundations

Some features reduce the risk that a traumatism produces a break

Some stresses can be received as positive challenges by certain persons, while they are received as disasters by others

## About Resilience

Resilience is related to a set of phenomena characterized by good results in spite of serious threats for adaptation or development of a system

Resilience depends of the interaction between different internal and external conditions of a system and the dynamic of the environmental context in which it evolves.

Resilience is never absolute, complete, acquired, but variables according to circumstances, nature of traumas, contexts and stages of life.

A resilient system is not an invincible system. He cannot be resilient in all situation, at all times and in all circumstances.

# Resilience Factors

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## Physiology

Defence factors

Coping factors

## Social Psychology

Individual Factors (behaviours, cognitive aptitude, intelligence)

Family Factors (cohesion and interest on behalf of the children)

Social Environmental factors (professor, social worker, etc)

Aptitude to be happy

Aptitude to get involved in a productive job

Good emotional security

Aptitude to develop satisfactory relationship with other

# Resilience Factors

## Leadership

Turn Liabilities into Pluses

Speak frankly and simply

Determination

Historical Imagination

Aptitude to have a global vision of the situation and to be vigilant with details

Conscience of reality

Aptitude to build an identity

Creativity

## Resilience engineering

Knowing what has happened

Knowing what to do

Knowing what to look for

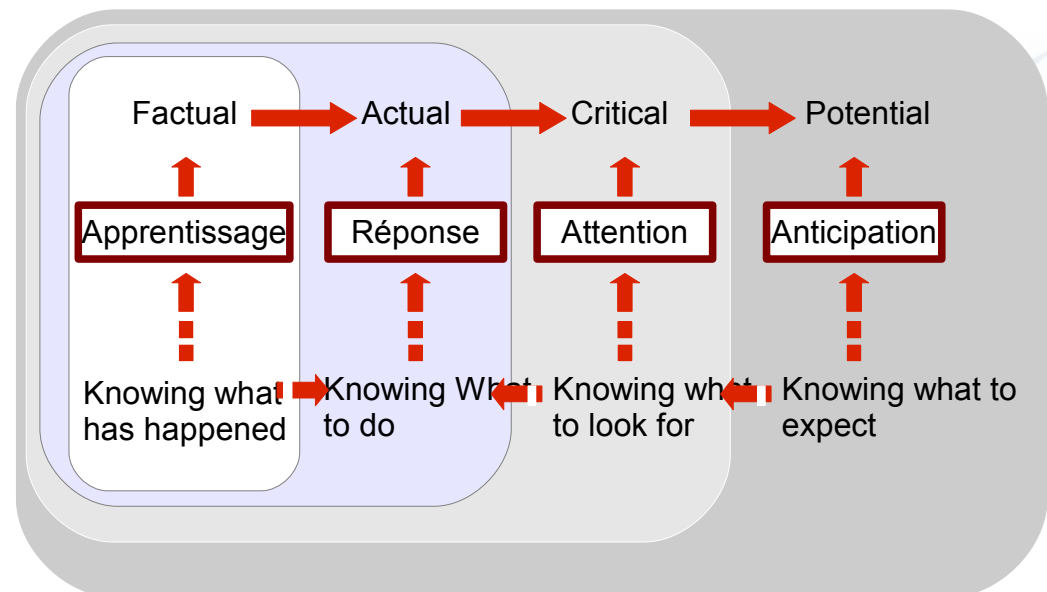
Knowing what to expect

Buffering capacity

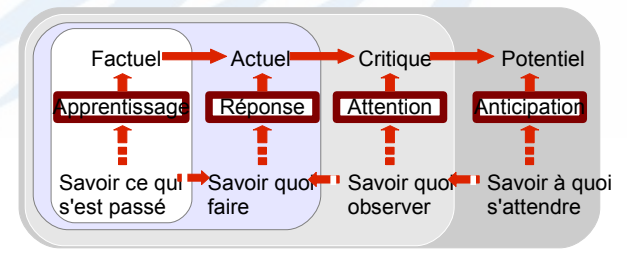
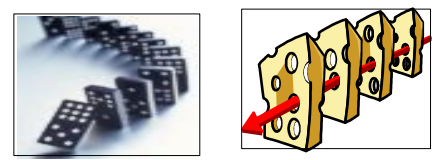
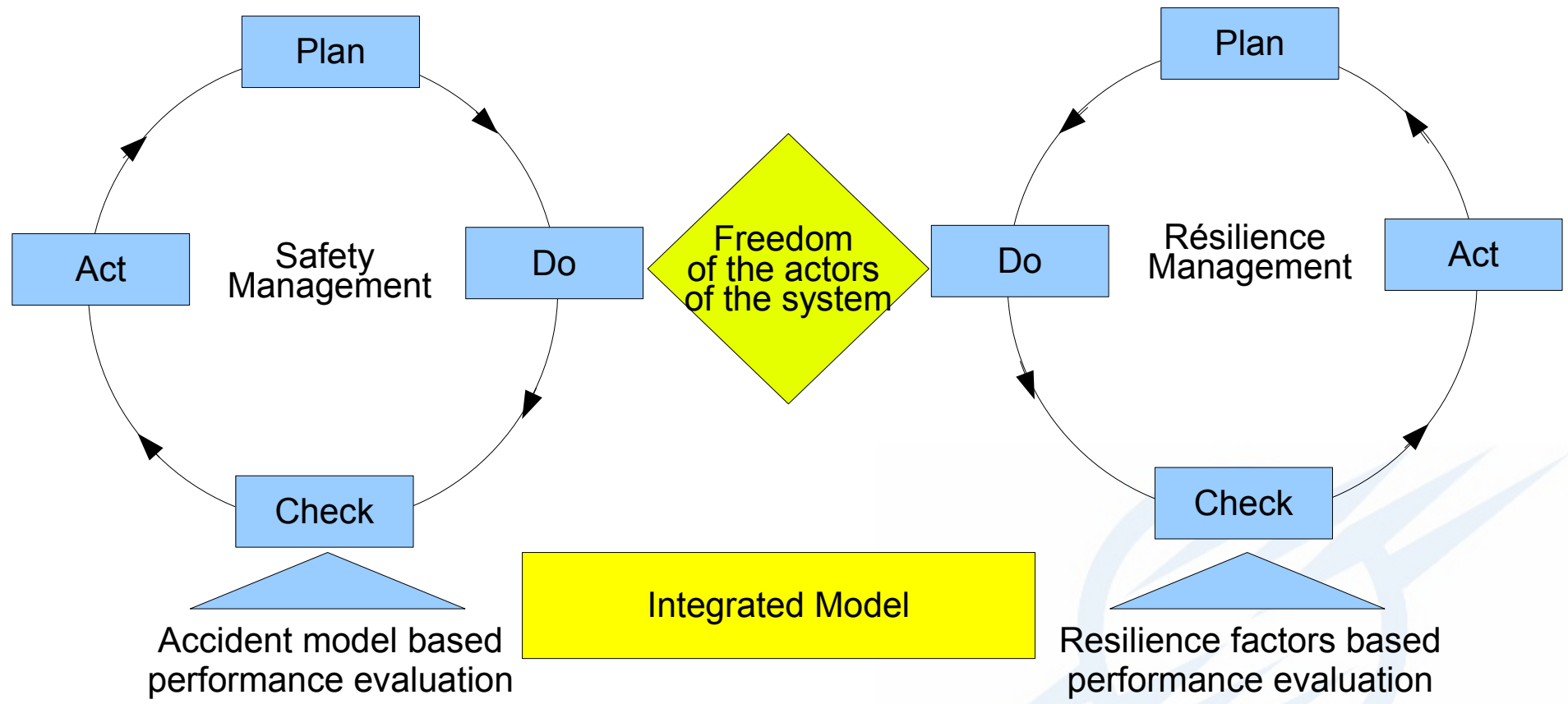
Flexibility

Tolerance

Managing margins



# Dialogic entropy – negentropy management loop



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