AFSCET

How to think autonomy and safety for the Mars manned exploration mission ?

Stéphane Grès

1.1.ESTIMATE LEVEL OF SAFETY AND REALITY

- **The estimate level of risk (Intrinsecal Safety)**

  One accident in 100 flights is somehow « buit-in » and may possibly be improved only marginaly.
  (Complex space system as Shuttle)

- **Reality and figures (Between April 1961 and December 1999)**

  - 400 human ventured into orbit around our planet.
  - 24 human on the moon (12 on surface)
  - 11 lost their lives while completing their missions
  - Several dozen were injured or killed in various flying or training accidents.

From David J. Shayler DISASTERS AND ACCIDENT IN MANNED SPACEFLIGHT (1999)

1.2. KNOWN LIMITS (50 YEARS)

- Experience return underline structural assembling problems and component limit.(Challenger and Columbia)
- Necessity of retroaction and learning process between astronauts, designers and manufacturers. (Apollo 1)
- Survivability is in link with formation and training of the crew. Excessive programming rationality could be an undertaking for crisis resolutions. (Apollo 13)

4 & 5 Organisation seen as the link between the project and the actor network is not able to perceive risks and act in real time (in critical situations). (Columbia)

From David J. Shayler DISASTERS AND ACCIDENT IN MANNED SPACEFLIGHT, 1999

PART 2

BEYOND LIMITS

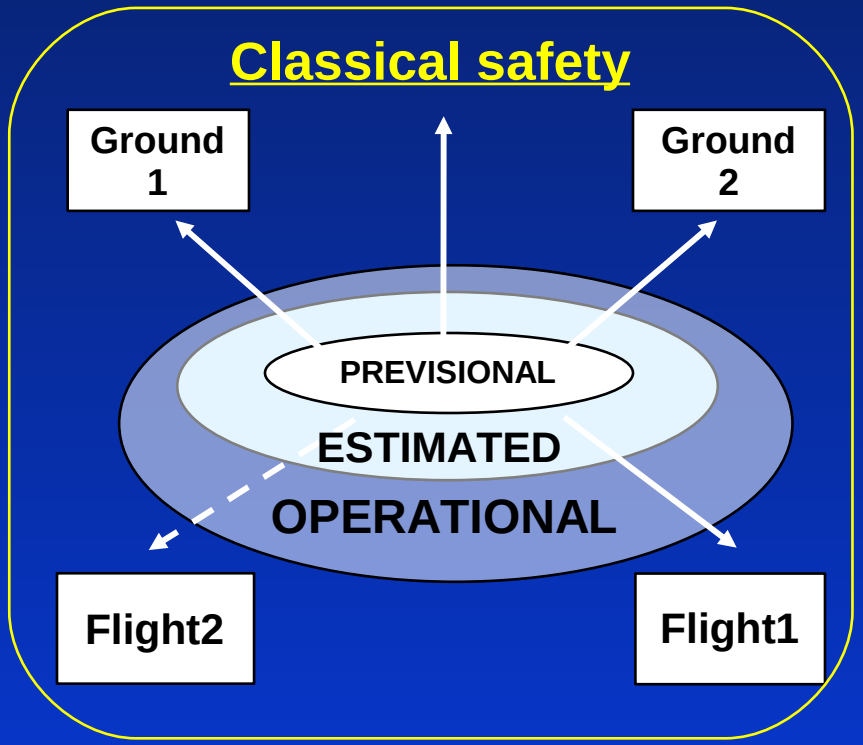
2.1. ALREADY KNOWN LIMITS TO OVERPASS

From system to Men interactions in the early design stage

- **Help to reach the profund psychology of Human being in uncertainity and unforseeable situations (self knowledge and managing relations to differencies)**
- **Interpersonnal communication and cognition to ameliorate (from the early stage of design to operational stage) project / organization**

2.2. ACTUAL LIMITS IN ORGANIZATION

1.BUILDING SAFETY FROM A CENTER



2. RELATIVE FAILS…EXAMPLES (Airbus, Challenger, Tchernobyl…)

3. CENTRALISED SAFETY AND/OR DISTRIBUTED SAFETY ?

Needs of renewed path in link with :

- **Ternarity**

(Two centers Earth and ?)

- **Transition from Pluri to Ternarity**

- **Self-learning aptitude to face dangerous situations**

2.3. DEFINITION OF SAFETY

Variation of common meanning

- **Why are there so many accidents ?**
- **What to should we do to ameliorate safety ?**

Definition

- **Safety of a system is founded on the organisation of :**
  3 sets of garanties: Physical, Mathematical, Political
  ordered in an integrated set of fuzzy datas (or sharp datas, necesserarily convincing for prevention and protection of accidents.

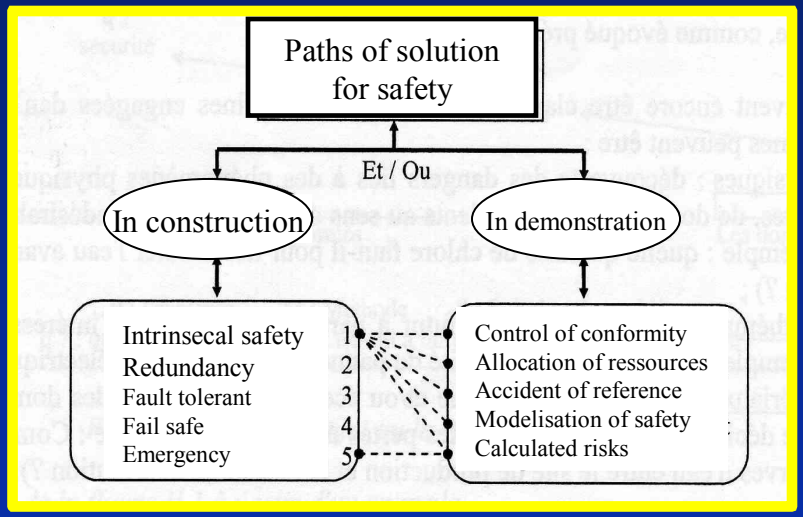
- **Accidents of ? : The support exploration system which is unavoidably exposed to danger.**

2.4. FROM DEFINITION TO MODELISATION

What are we expecting ?

1. Definition
2. Modelisation
3. **Paths of solution for safety of the crew**

3. RESULTS OF MODELISATION



FIRST STEP

Safety culture

↕ ↕ ↕

ACTORS SYSTEM

1. DEFINITION

Resiliency

SAFE EXPLORATION SYSTEM

↕ ↕ ↕

autonomous and cognitive

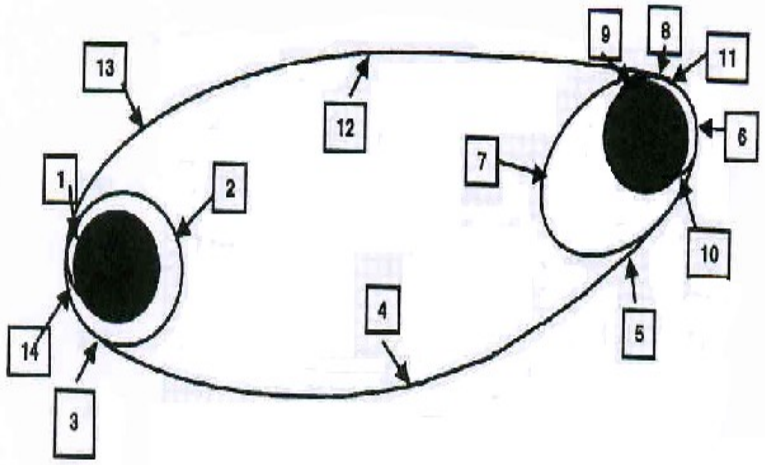
2. MODELISATION

PART 4

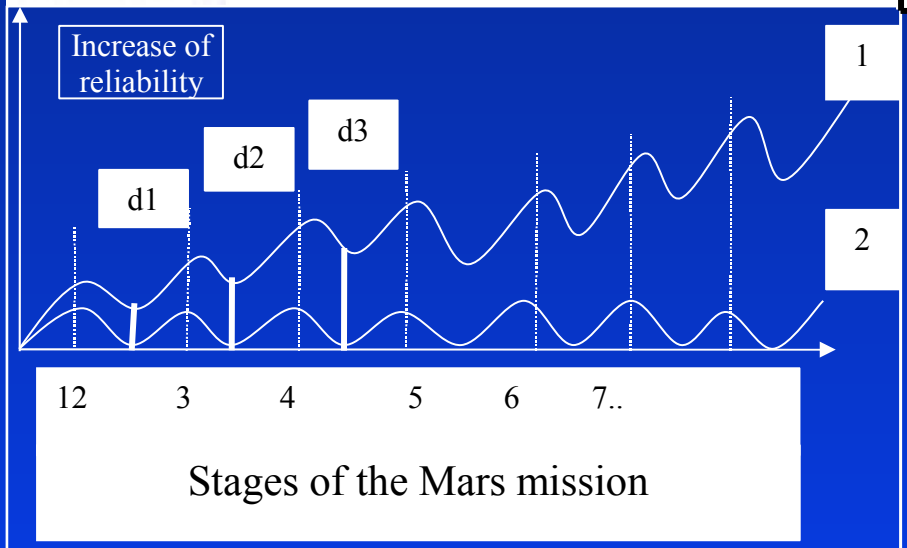
TOWARD THE REFERENTIAL FROM PLURI TO TERNARITY RELIABLE COMMUNICATION

4.1.BIRTH AND RE-BIRTH OF RELIABILITY

From NASA DRM scénario 1999



1. Launch
2. Earth LEO orbit
3. LEO to Mars Transfer Orbit
4. Mars Transfer Orbit to Mars Orbit
5. Transition to Mars orbit
6. Mars Aerocapture
7. Mars orbit
8. Landing on Mars
9. Mars surface stay
10. Ascent from Mars
11. Mars Orbit to Earth Transfer Orbit
12. Earth transfer
13. Earth orbit
14. Earth Re-entry and landing



1. Increasing curve of Un-reliability **(Where we can be afraid from Un-reliability pics)**

2. Theoritical renewal of reliability (Security of security) Mars X Mars

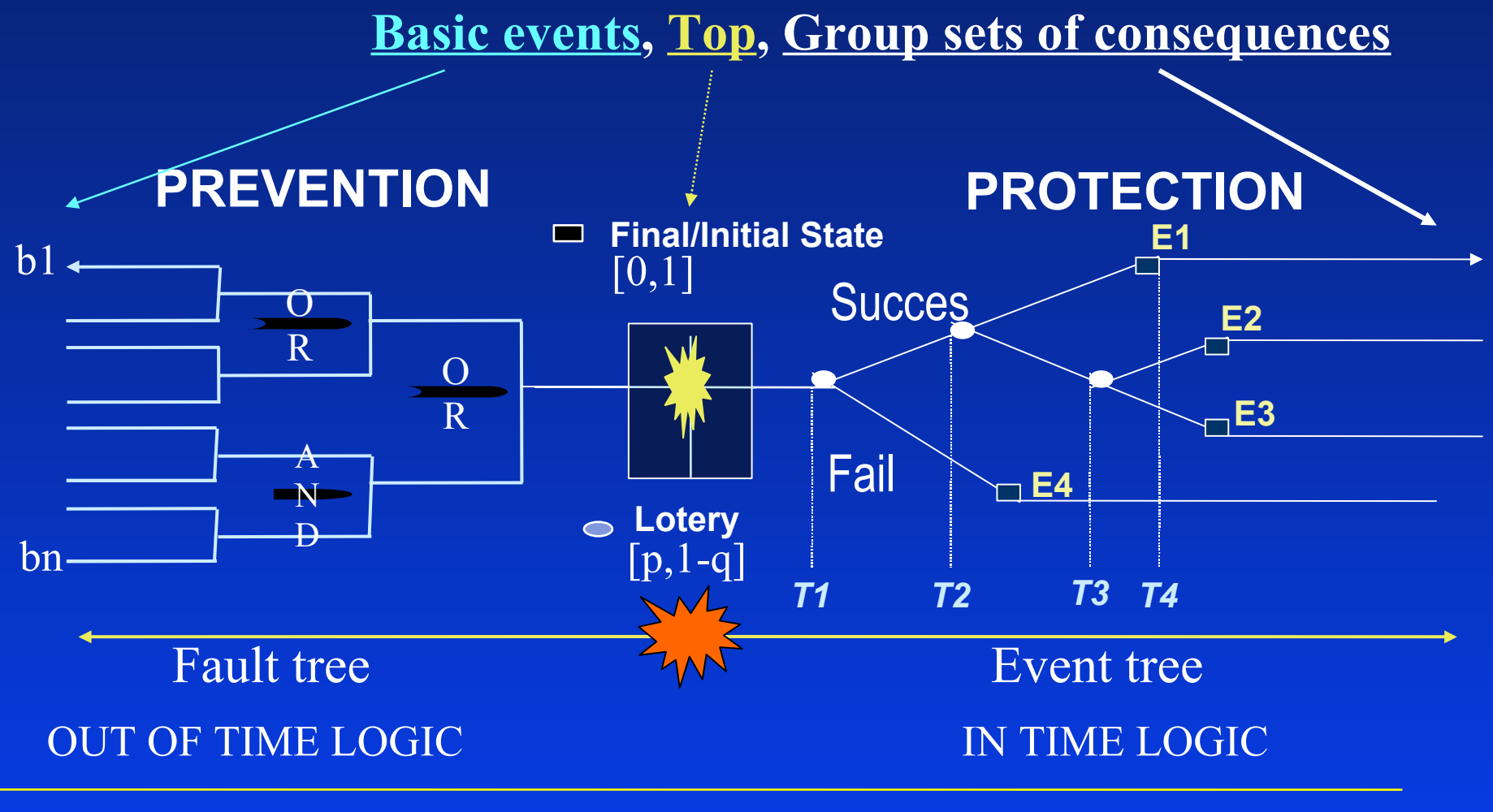
d1, d2, d3 show the gap and deviation which must be conterbalanced with adaptated answers (Theoritical <--> Practical)

4.2. A NEW FRAME FOR INTERDISCIPLINARITY (2)

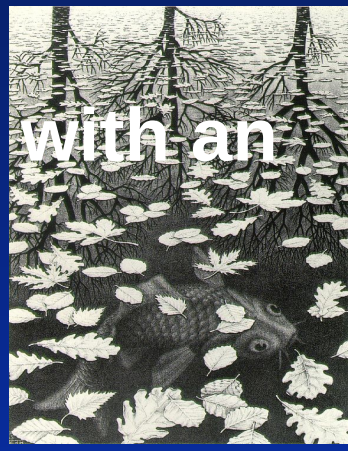
- **Simple = Easy, not to forget, problems that can be automatized**
- **Complicated = Know-how, Expertise, Expert Systems, Artificial Intelligence**
- **Complex = To solve with distributed cognition, cooperation and autonomy**

4.3. ONTOLOGY OF SAFETY FOR CONTINUOUS RE-BIRTH OF RELIABILITY

Exploring principles of the un-thinkable and recognition of the living capitalized experiences



4.4. A REALITY TO BUILD TOGETHER, (HOW TO MANAGE THE WIDE RISK SPECTRUM ?)



- **To manage and stabilize the cooperation with an interdisciplinar referential**
- **To constitute a safe validation process :**
  Articulation between
  - Actors System (Human-Human)
  - Technical System (Machine-Machine)
  - Information system (Human-machine)

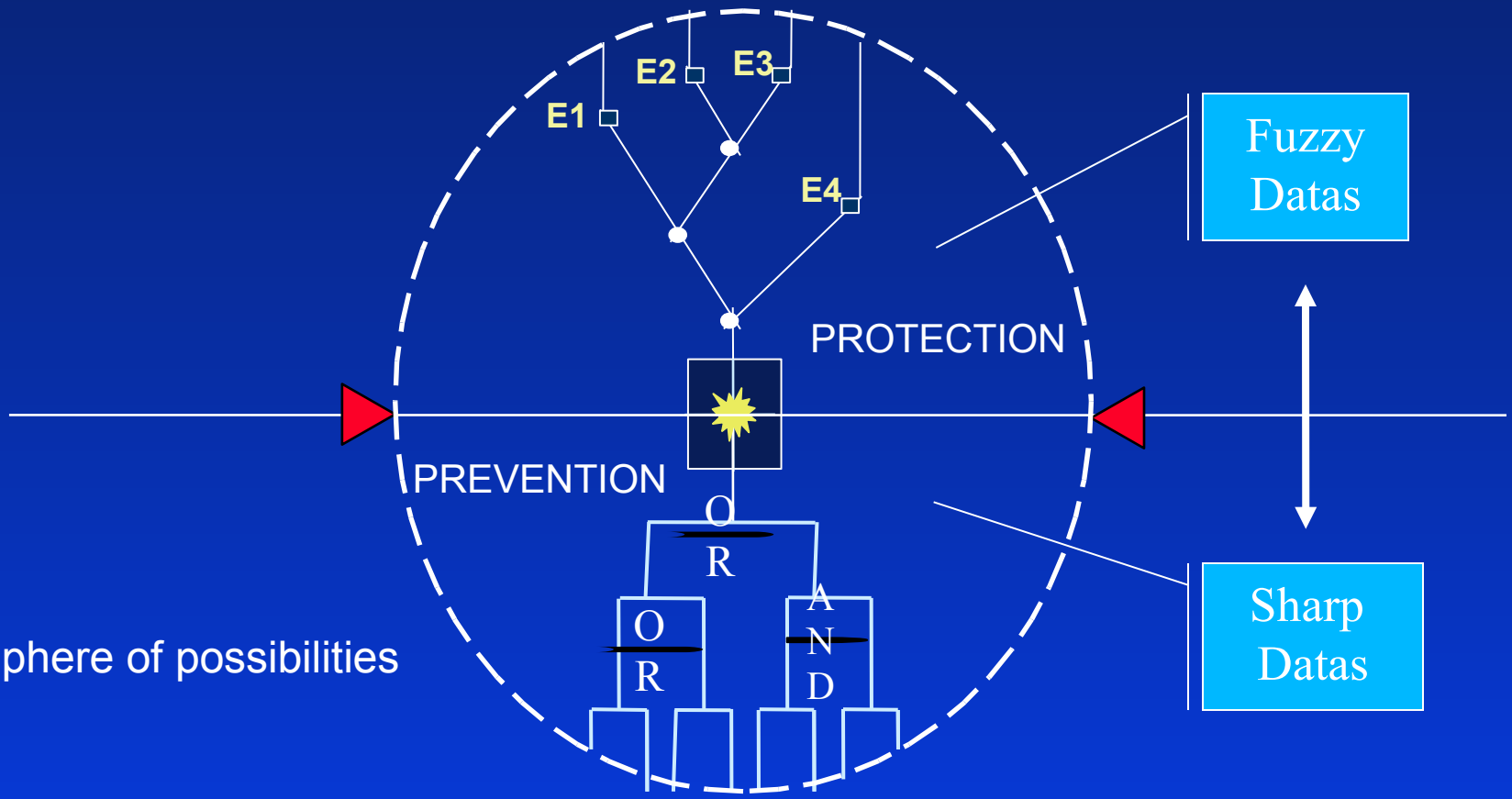
H	H
M	M
H	M

PART 5

TOWARD THE DECISIONAL INFORMATION SYSTEM FOR SAFETY (D.I.S.S.)

5.1.D.I.S.S. PRINCIPLES
ANTICIPATION OF ACCIDENTS IN REAL TIME

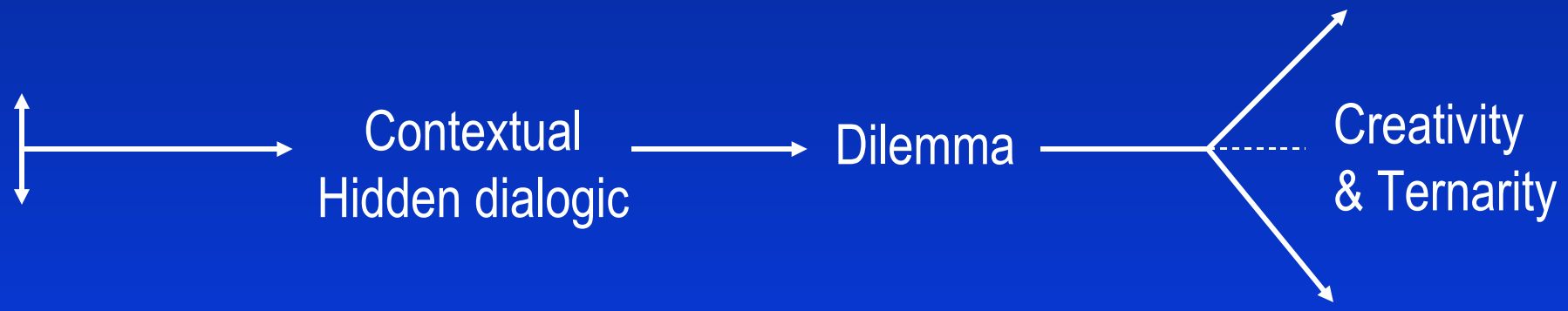
- **PAST TIME I> PRESENT TIME <I FUTURE TIME**



Self-learning process encapsuled at the heart of the exploration system

5.2. INTERACTION ORIENTED APPROACH(1)

To have an interaction oriented approach can revelled contextual hidden dialogics at each steps of the mission. This allow to see structuration (Birth) and di-sagregation (Death) of the technological system (which support the Exploration team).



5.3. ADVANTAGES

We hope to ameliorate safety for Human mission with :

1. **A reliable communication and cognition process**
2. **An embedded anticipation accident capacity**

These 2 contributions have the following advantages :

- **Interactions lead by actors Conscious and Free**
- **Organization build from individuals to the whole (relational ethic)**
- **Durable cooperation which tolerate fails and create conditions for self repair.**
- **To be able to face limits that overpass half-known or half –unknow horizon of actual knowledge**