Safety : Not one model but many

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Two main ideas

• Not one model of safety but many
• Safety solutions are successful compensatory mechanisms of degraded conditions of work
NOT ONE MODEL BUT MANY
Risks in human activities

- Medical risk (total)
  - Grafts
  - Scheduled Surgery
  - Emergency
  - ICU
  - Oncology

- Satellite's launch
- Space missions
- Professional Fishing

- Rotary wings
- Chartered Flight
- Civil Aviation
- Trams, Tubes
- Railways
- Nuclear Industry
- Oil industry (total)
- Chemical Industry (total)
- Fire fighting
- Off shore
- Drilling

- Anesthesiology
  - ASA 1-2
- Radiotherapy
- Blood transfusion
- Biology

- Hymalaya mountaineering
- Professional Fishing

- 10^{-2}
  - Very unsafe
- 10^{-3}
  - Unsafe
- 10^{-4}
  - Safe
- 10^{-5}
  - Ultra safe
- 10^{-6}
  - Fatal risk

- No system beyond this point
A first example

Professional deep-sea fishing as practiced by 20 to 24-meter trawlers (vessels usually manned by five fishermen, for fishing tours of four to fourteen days) 20-27 meters

Studying the fishing skippers’ decision-making process by placing them in situations of conflict between production and safety.

Information: weather report, failures, damage to the fishing gear, occupational accidents, information on previous fishing tour, fax from colleagues on quantity of catch, selling price of prawn auction prices, localisation of colleagues, fixed expenses,..

What are the elements considered in priority by captains for making decision on continuing fishing Vs giving up in extreme fishing conditions?

Are they varying for crafts-type concerns, with a skipper-owner who runs his own vessel Vs Non crafts-type concerns, either with a skipper paid to run a vessel belonging to a company, or crews on payroll aboard a fleet of vessels belonging to larger firms?

Morel, Chauvin, Safety Science 2007
Morel, Amalberti, Chauvin, Human Factors 2008
Morel, Amalberti, Chauvin, Safety Science, 2008
Are fishermen insensitive to safety aspects?

NO... of course... they hope getting safer.

They ask for better tools for traffic collision avoidance (with cargos), and safer bridge working conditions for sailors (on trawlers).
Another example

Civil aviation

- 1994, A310: YR-LCA, Tarom A310, lost control during final approach on Paris Orly airport. Flight 381 was approaching to Paris-Orly runway 26 and the captain was at the controls. He decided to perform an automatic approach and landing. Before lining up with the runway, the aircraft adopted an unusual position due to a crew’s wrong comprehension of an order given to the autopilot. Recovery came two long minutes after the plane entered into quasi loopings.

- 1995, A310: Tarom flight ROT 371 took off from Bucharest-Otopeni runway 08R for a flight to Brussels. The crew was distracted and forgot monitoring aircraft attitude. The plane banked progressively, and when the crew realized the problem, they were unable to recover, 60 fatalities.

What do you think the international Authorities have decided afterwards?

A third model

HRO High-Reliability Organisations

- Fire fighting
- Group Intelligence
- Give priority on team work, leadership and adaptation to unexpected conditions
- Lessons drawn from accident analyses are primarily about ways in which the situation has been managed and could be managed better in future. (Recovery rather than Prevention)
- Five characteristics of High Reliability Organizations responsible for the "mindfulness" that keeps them working well when facing unexpected situations.
  - Preoccupation with failure
  - Reluctance to simplify interpretations
  - Sensitivity to operations
  - Commitment to resilience
  - Deference to expertise
Three Contrasted Safety models

**ULTRA RESILIENT**
- **Context**: Taking risks is the essence of the profession.
- **Cultural trait**: Fighter spirit, cult of champions and heroes
- **Safety model**: Power to experts
  - ‘Give me best chances and safest tools to survive in these adverse conditions and make exploits’
- **Safety training**: Learning through shadowing, acquiring professional experience, “training for zebra”, working on knowing one’s own limitations.

**HRO model**
- **Context**: Risk is not sought out, but it is inherent in the profession.
- **Cult**: of group intelligence and adaptation to changing situations.
- **Safety model**: Power to the group,
  - Ability of the group to organize itself (roles), to provide mutual protection to its members, to apply procedures, to be suspicious of excessively routine simplification of the situation, to adapt, perceive changes in the context and make sense of it.
- **Training**: in teamwork to gain knowledge of the capacity of the group and adaptability in terms of applying procedures to suit the context.

**ULTRA SAFE**
- **Context**: Risk is not sought out, but it is inherent in the profession.
- **Cult**: of applying procedures and safety organized by an effective supervisory organization.
- **Safety model**: Power to the regulators of the system to avoid exposing front-line actors to unnecessary risks.
- **Training**: in teamwork to apply procedures and apportion the work even if abnormal events occur.

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**Medical risk (total)**
- Innovative medicine (grafts, oncology …)
  - ICU
  - Trauma centers
- Scheduled surgery
  - Chronic care

**Radiotherapy, Biology Blood transfusion**
- Anesthesiology ASA1

**HRO model**
- Fire Fighting
- Chartered Flight
- Civil Aviation
- Railways

**Chemical Industry (total)**
- Drilling Industry
- Processing Industry

**Professional fishing**

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**2014**
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Variation in Safety Systems

- The three safety models predict a range of variation in outcomes by a factor 4 to 10 among the best and worst performers for each category of work activity.

EXAMPLES
- RESILIENT MODEL: the risk incurred by deep-sea fishermen varies by a factor 4 to 6 among the best companies and the worst companies,
- HRO MODEL: the European Surgical Outcomes Study, an international 2012 study designed to assess outcomes after non-cardiac surgery in Europe, shows important differences of in-hospital mortality between countries ranging after adjustment for confounding variables from 2% for Finland to 17.9% for Poland.
- ULTRA SAFE: the largest safety difference regarding accident rates in civil aviation range from 0.63 crashes per one million departures in Western countries, to a rate of 7.41 crashes in African countries
Evolution (within the same cat) or Revolution (changing cat)

ULTRA RESILIENT

HRO model

ULTRA SAFE

Fatal risk

Very unsafe

Unsafe

Safe

Ultra safe

Value of Compensation strategy

Constraints ---

Constraints +++

AAA+

AAA+
A SYSTEM APPROACH OF TRADING RISKS
Toward a strategic view on medical safety – a tentative mapping exercise

ULTRA ADAPTIVE
to MARKET DEMANDS & NON STANDARDS CASES - LEARNING SYSTEMS

ULTRA SAFE

1%?

Cherry Picking
Percentage of NO GO & working situations excluded by the model

5%?

15%?

Incompatible with social risk acceptance

RESILIENCE
Betting on Individuals’ Competences /expertise

HRO
Betting on sense making
Cognitive maps, global vision
Procedures & team regulations

ULTRA SAFE SYSTEMS
Betting on Systems supervision

incompatible with market demands

NON ADAPTIVE
POOR LEARNING SYSTEMS

Little SAFE

2014
Understanding resilience

Resilience $S_t = S_i + S_m$

$S_t$ (Safety total) = $S_r$ (Safety imposed) + $S_g$ (Safety managed)

Observed Safety

<table>
<thead>
<tr>
<th>NORMS / QUALITY</th>
<th>RESILIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error avoidance</td>
<td>Surprises management</td>
</tr>
<tr>
<td>BBS/CBS/HRA</td>
<td>Based on Human expertise</td>
</tr>
<tr>
<td>Based on Technology</td>
<td>Adaptive learning systems</td>
</tr>
<tr>
<td>Regulations Constraints</td>
<td></td>
</tr>
</tbody>
</table>

Amalberti R., Springer 2012
Paradoxes of Resilience

Significant safety improvements always detrimental to $S_m$

Craftman industry

$S_t = S_i + S_m$

Safety improvement

Ultrasafe systems

$S_t = S_i + S_m$

The next challenge: Preverving $S_m$ while Improving $S_i$
A few refs to go beyond


**Morel, G. Amalberti, R. Chauvin, C.** Articulating the differences between safety and resilience: the decision-making of professional sea fishing skippers, *Human factors, 2008, 1, 1-16*

**Degos, L., Amalberti, R., Bacou, J., Bruneau, C. Carlet., J.,** *The frontiers of patient safety : breaking the traditional mold, British Medical Journal 2009;338:b2585*


**Amalberti R.** Resilience and Safety in healthcare : marriage or divorce, In Eds Erik Hollnagel, Jeffrey Braithwaite & Robert Wears, Resilience in healthcare, Ashgate Publisher 2013