HUMAN FACTOR AND ERGONOMICS AS HOLISTIC APPROACH TO THE DESIGN OF A PROCESS PLANT

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1.0 INTRODUCTION

Major change in industrial demand will come from the fact that industry will need to solve problems not only related to "what" it operates on, but also and increasingly to "how" it operates.
While "hard" disciplines can resolve the "what" issues it is "soft" disciplines that can tackle the "how" problem.
Management of complexity, costs and risks will lead to a "mixed" partly hard, partly soft new disciplines.

2.0 "HARD DISCIPLINES"

Hard technologies will only provide part of the solution: a proper Plant design and automation can improve productivity ; safety, process control & mathematical modeling can improve quality but these technologies will not bring full benefits unless we are capable of integrating them in the "corporate culture" of all the companies participating to the extended supply chain that engineer build & operate the plant.

3.0 "SOFT DISCIPLINES"

The human factors approach holds that human errors is the main cause of accidents by the design of the plant, of the workplace and tasks that do not consider human limitations can significantly contribute to releasing the hazard.
All the major engineering and construction companies maintain active safety programs. These programs have similar approaches and components although each is unique in its applications. All of these companies have shown significant improvement and are well under the average experienced in the industry.
Typical essential elements of most safety programs are, training, responding to regulation, motivation, planning investigation and incident analysis during construction & plant start up. But these during plant operations will not prevent possible accident.

The problem arise from the fact that during plant design the designer perspective is dominant and only after plant construction we switch to the reliability analyst's perspective evaluating human performance on a given environment:

- Rules and procedures which, if followed will keep people safe are developed
- Incidents happen because of worker error: failure to follow the rules
- Training and motivation to gets people following the rules

Our idea is that the two perspectives have to merge moving beyond a worker-centered model to a work system centered model.
To design work systems that support the actors in coping with the effects of their actions plants/equipment malfunctions improving the potential of the safety of the work system in a dynamic environment.

"Rasmussen's approach recognizes that people adapt to the circumstances and suggests that helping them to develop & apply their judgment will be more successful than simply following rules" (See Table1)

When it comes to preventing Hazardous events in process industries, analyzing and pinpointing control points are crucial to avoid catastrophe. One obvious control point is the operator .
Predicting human error to prevent hazards but developing processes to manage abnormal situations that can lead to loss of control is of paramount importance as well.

4.0 THE HOLISTIC APPROACH

An holistic approach encompassing the :

- Ergonomy
- Human Reliability Analysis (HRA)
- Technology
- Computer aided training (simulators)

Is a possible the solution

4.1 Reduced manning scenario as basis of design during the engineering phase is an useful tool to identify and implement technologies that can help operating people to better manage hazard (see fig. n°1) , to take more informed decisions decreasing probabilities of errors when close to the edge between hazard and safe zone and when an irreversible loss of control happens to support operators on taking actions prevent the propagation through loss of control to injury (see fig. n° 2 & 3).

1 PERSON SCENARIO ANALYSIS DUTIES DURING NORMAL OPERATIONS

	DUTIES	Freq. of use factor
1.	Continual monitoring of key operating variables for deviation from the norm	2
2.	Monitoring for malfunction of process equipment or control system elements (by video cameras)	1
3.	Detection and interpretation of alarms	1
4.	Prompt access, display, and control of pertinent data during up-set conditions	0
5.	Proper implementation of emergency procedures (request for help from outside)	0
6.	Proper implementation of start-up, shut-down procedures	0
7.	Special surveillance of systems affected by current maintenance operation	0
8.	Direction and guidance of field operators during equipment switch over	0
9.	On-line ability to check system calibration and performance	1
WORK LOAD FACTOR TOTAL		**5**

Note : In our Practice the maximum frequency of use of factor by one Operator is 5

1 PERSON SCENARIO ANALYSIS DUTIES DURING UPSET

	DUTIES	Freq. of use factor
1.	Continual monitoring of key operating variables for deviation from the norm	3
2.	Monitoring for malfunction of process equipment or control system elements (by video cameras)	1
3.	Detection and interpretation of alarms	2
4.	Prompt access, display, and control of pertinent data during up-set conditions	2
5.	Proper implementation of emergency procedures (request for help from outside)	1
6.	Proper implementation of start-up, shut-down procedures	1
7.	Special surveillance of systems affected by current maintenance operation	0
8.	Direction and guidance of field operators during equipment switch over	0
9.	On-line ability to check system calibration and performance	0

WORK LOAD FACTOR TOTAL **10**

1 PERSON SCENARIO ANALYSIS DUTIES DURING LEAKS OR FIRES

	DUTIES	Freq. of use factor
1.	Continual monitoring of key operating variables for deviation from the norm	1
2.	Monitoring for malfunction of process equipment or control system elements (by video cameras)	3
3.	Detection and interpretation of alarms	1
4.	Prompt access, display, and control of pertinent data during up-set conditions	1
5.	Proper implementation of emergency procedures (request for help from outside)	3
6.	Proper implementation of start-up, shut-down procedures	2
7.	Special surveillance of systems affected by current maintenance operation	0
8.	Direction and guidance of field operators during equipment switch over	0
9.	On-line ability to check system calibration and performance	0

WORK LOAD FACTOR TOTAL **11**

5.0 CONCLUSION

We think that engineers in the next future will see technology in a broad and logical way related to culture and society.
To understand the interaction between technology, nature and culture is essential for the physical construction of the future plants as well as for the social construction of a sustainable future.

TABLE 1

RASMUSSEN DECISION/ACTION MODEL

Decision/action element	**Objective**	**Typical error patterns**
Initial alert	Alerting/Signal Detection of initial stages of problem	Distraction/Absent - Mindedness/ Low alertness
Observation	Observation/Data Collection from instruments	Unjustified assumptions/Familiar Associations
Identification	Identify System State	Information overload tine delay
Interpretation	Interpret what has happened and its implications	Failure to alternative causes/Fixation on the wrong cause
Evaluation	Evaluation and Selection of alternative goals	Failure to consider side effects/ Focusing on main event
Planning	Plan success path	Wrong task may be selected due to shortcuts in reasoning and stereotyped response to familiar state
Procedure Selection/ Formulation	Choosing or formulating a procedure to achieve required objective	Procedural steps omitted/reversed (particularly if “isolated”)
Execution	Executing chosen procedure	Reversals of direction of sign (up/down - left/right) when carrying out action. Habit intrusion
Feedback	Observe change of state of system to indicate correct outcome of actions	Feedback ignored or misinterpreted

FIG. N. 1

- HOLISTIC APPROACH

1-4 PERSON SCENARIO ANALYSIS

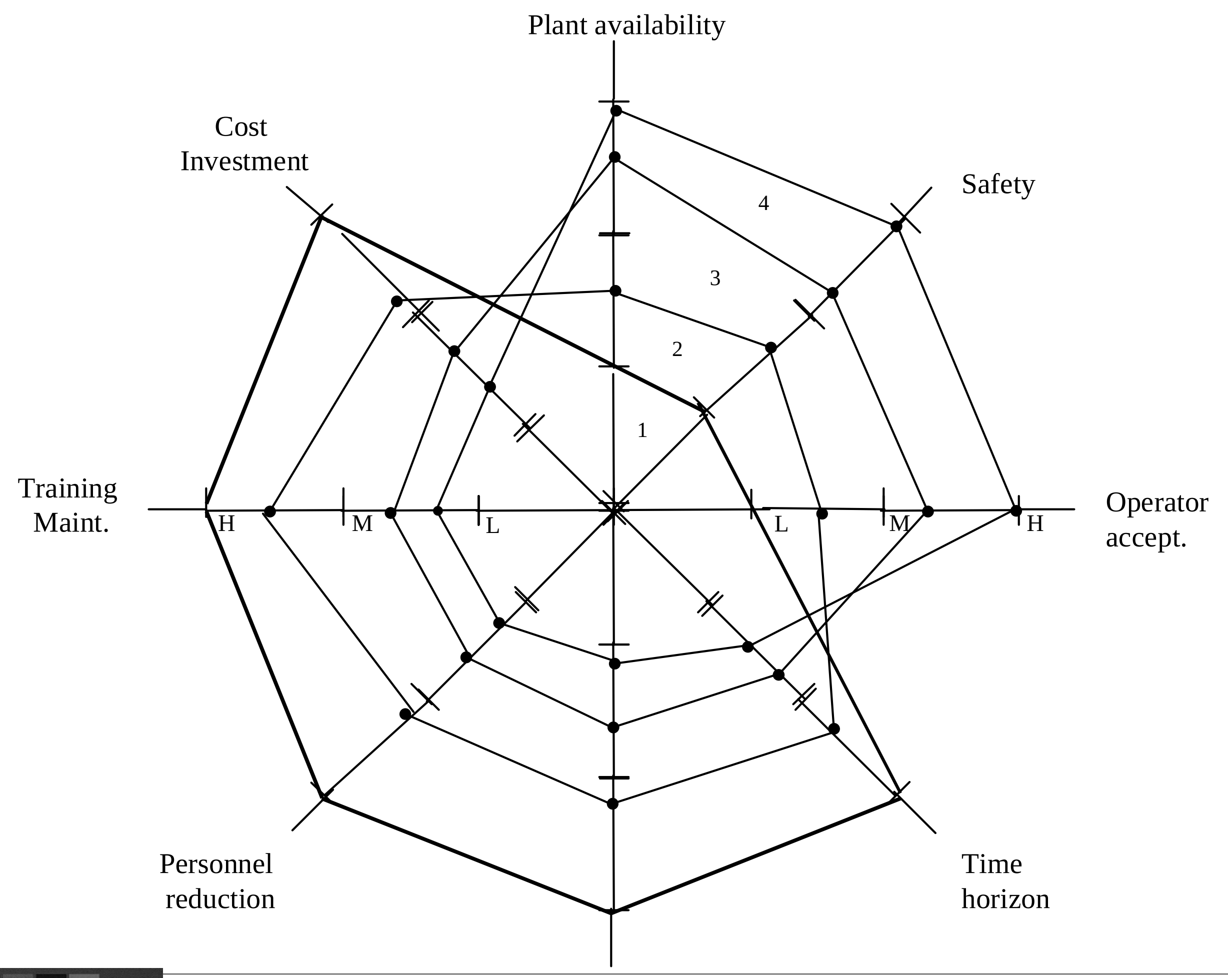


FIG. N. 2

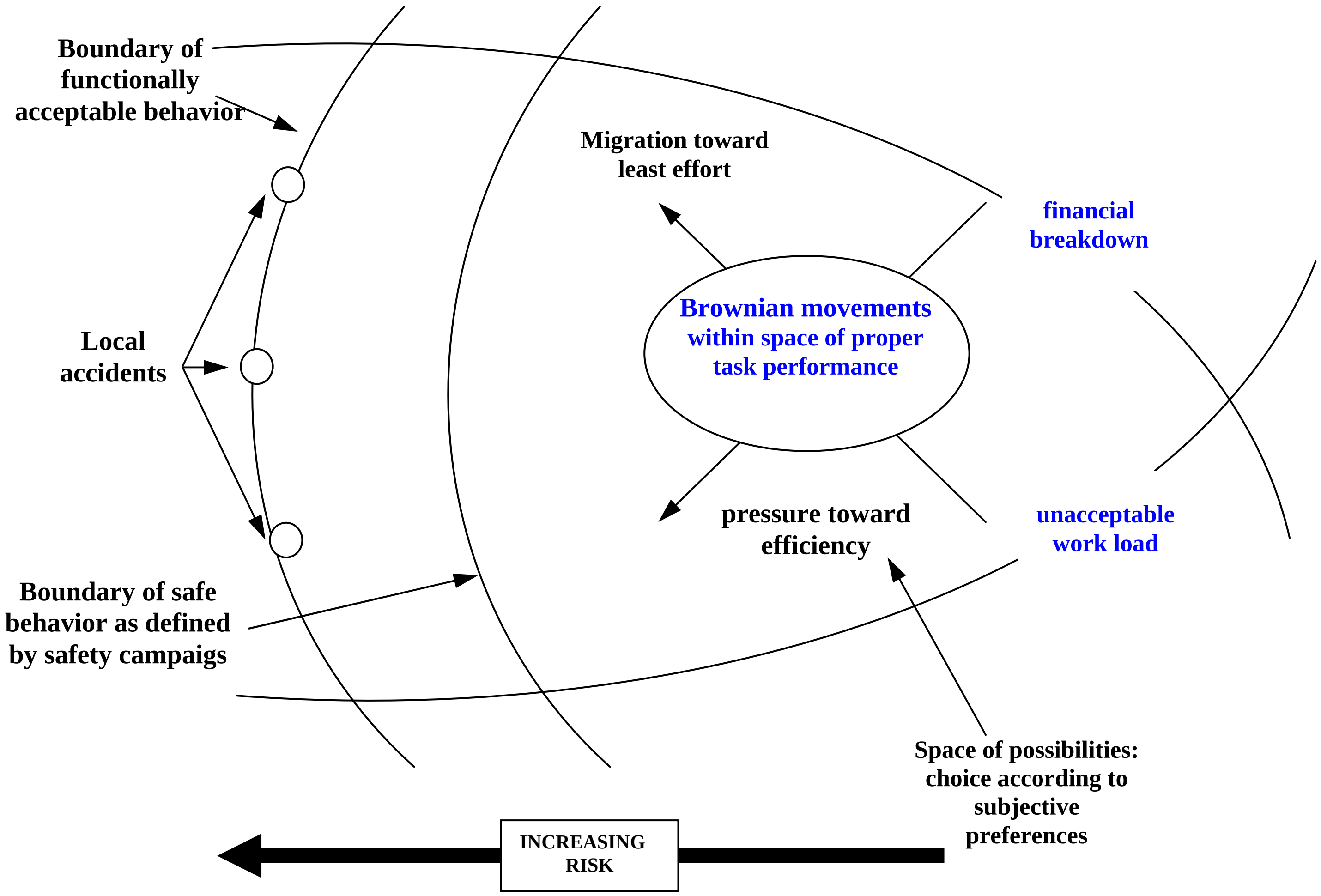
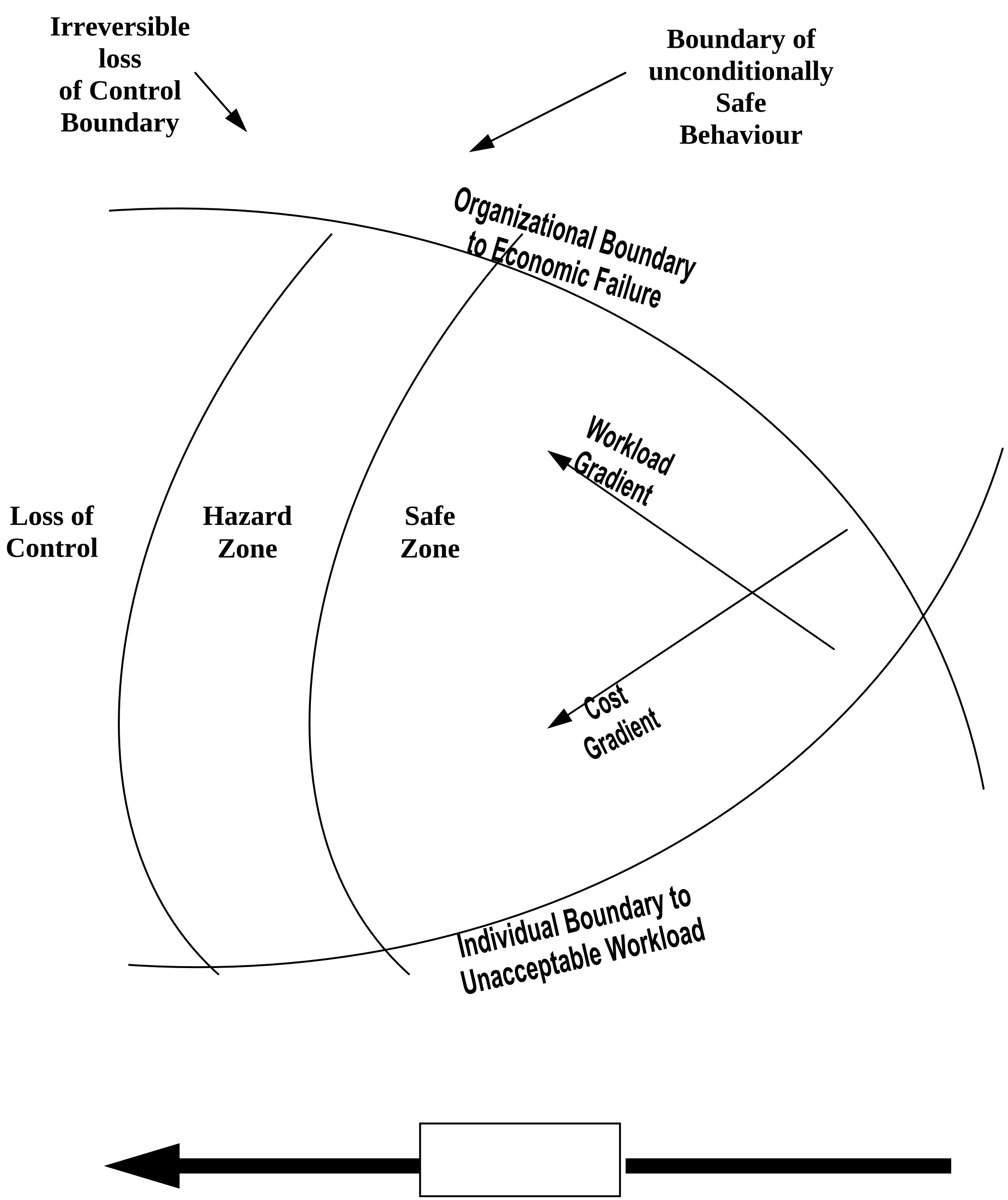

Boundary of functionally acceptable behavior
Migration toward least effort
financial breakdown
Brownian movements within space of proper task performance
Local accidents
pressure toward efficiency
unacceptable work load
Boundary of safe behavior as defined by safety campaigs
Space of possibilities: choice according to subjective preferences
INCREASING RISK

FIG. N. 3



Irreversible loss of Control Boundary
Boundary of unconditionally Safe Behaviour
Organizational Boundary to Economic Failure
Workload Gradient
Loss of Control
Hazard Zone
Safe Zone
Cost Gradient
Individual Boundary to Unacceptable Workload