# National Cultures, Safety Culture and Severe Accidents

**Najmedin Meshkati**

Professor
Department of Civil/Environmental Engineering
Department of Industrial & Systems Engineering
Vitrebi School of Engineering

Professor
School of International Relations
University of Southern California
Email: meshkati@usc.edu

IAEA Workshop on Global Safety Culture: National Factors Relevant to Safety Culture
*IAEA, Vienna, April 8, 2014*

# Outline

- Introduction/My story
- The premise and personal observations on the impact of National Culture on Safety Culture
- Five Severe Accidents
- Conclusion – Closing Remarks

# My life story…..

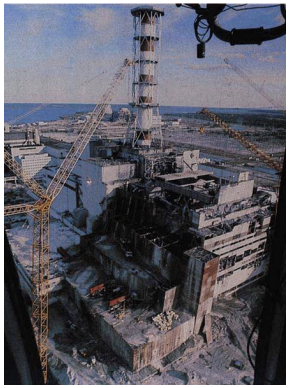
**Three Mile Island**

March 28, 1979

**Bhopal**

December 3, 1984

**Chernobyl**



April 26, 1986

**BP Refinery**

March 23, 2005

**BP Deepwater Horizon**

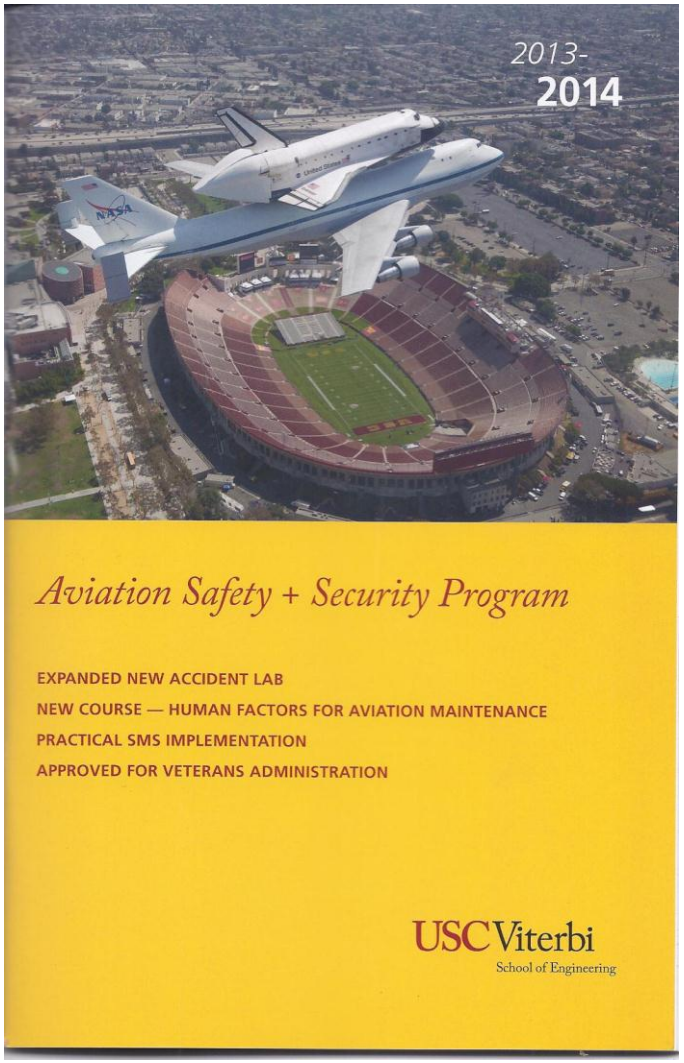
April 20, 2010

**Fukushima**

March 11, 2011

# Teaching and Conducting Research on Human Factors in Aviation Safety

since 1989





University of Southern California

USC Viterbi
School of Engineering

**Dr. Najmedin Meshkati**

Professor Najm Meshkati

Dr. Najmedin (Najm) Meshkati is a (tenured) Professor of Civil/Environmental Engineering and Industrial & Systems Engineering at the Viterbi School of Engineering, University of Southern California (USC). He was a Jefferson Science Fellow and Senior Science and Engineering Advisor, Office of Science and Technology Adviser to the Secretary of State (2009-2010). He was a member of the National Academy of Engineering/National Research Council's Committee on the Analysis of Causes of the BP Deepwater Horizon Explosion, Fire, and Oil Spill to Identify Measures to Prevent Similar Accidents in the Future (2010-2011).

Dr. Meshkati is an elected Fellow of the Human Factors and Ergonomics Society, an AT&T Faculty Fellow in Industrial Ecology, a two-times NASA Faculty Fellow (Jet Propulsion Laboratory, 2003 and 2004), and a recipient of the *Presidential Young Investigator Award* from the National Science Foundation (NSF) in 1989. He is the 2007 recipient of the *Oliver Keith Hansen Outreach Award* from the Human Factors and Ergonomics Society (HFES) and was honored by the HFES for his "scholarly efforts on human factors of complex, large-scale technological systems...[and] efforts to enhance public awareness of critical human factors issue [and] the benefits it brings to humankind."

Dr. Meshkati is the only full-time USC faculty member who has continuously been conducting research on human factors and aviation safety-related issues (e.g., cockpit design, pilot error, and runway incursions) and teaching in the USC 60-year old internationally renowned Aviation Safety and Security Program, for the past twenty-two years. During this period, he has taught in the "Human Factors in Aviation Safety" and "System Safety" short courses. From 1992 to 1999, he also was the Director and had administrative and academic responsibility for the USC Aviation Safety, as well as for the Transportation Safety, and Process Safety Management programs. For the last two decades, he has worked with numerous aviation safety professionals from all over the world, taught aviation safety short courses for private and public sector organizations, including the US Navy and US Air Force.

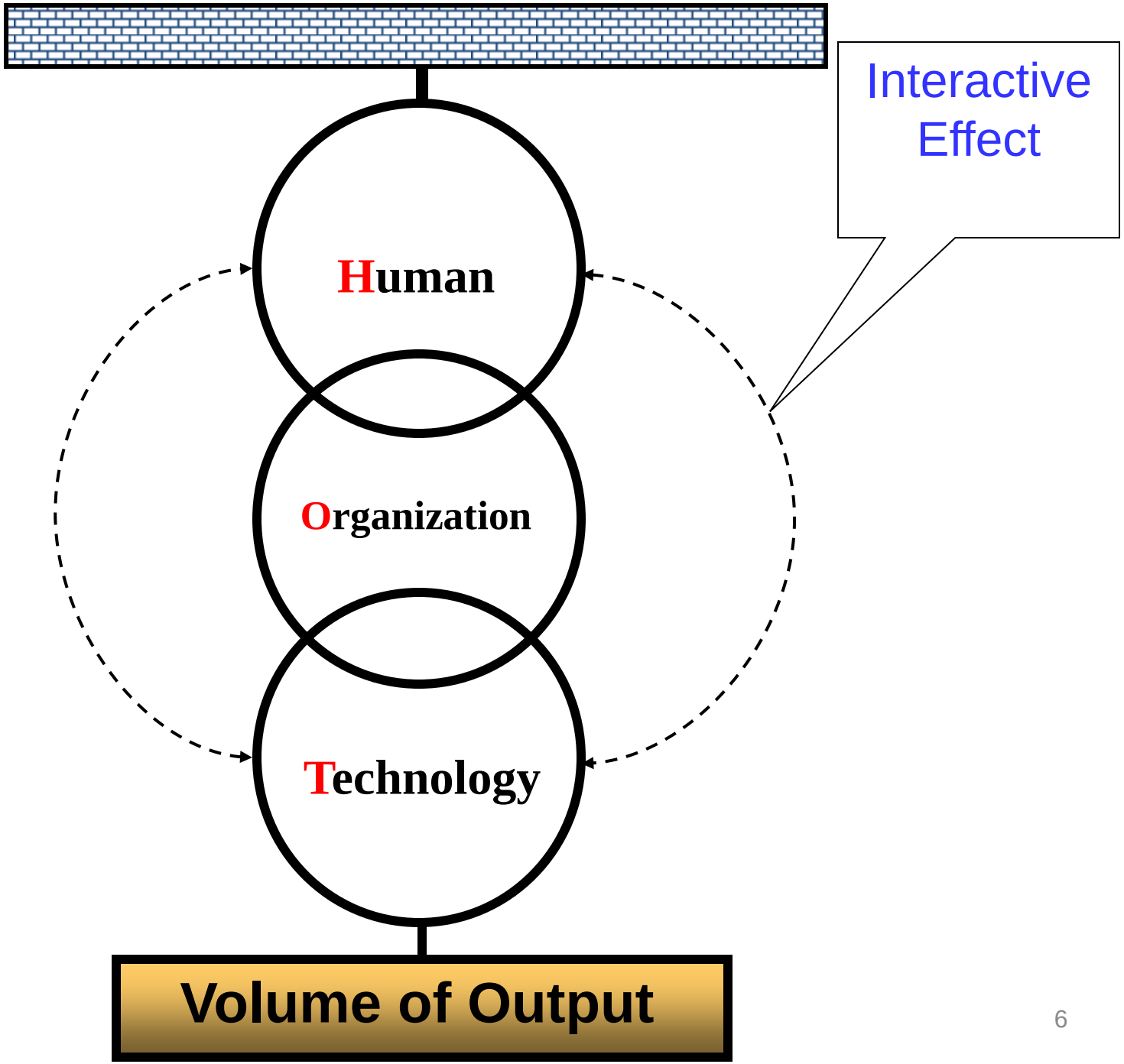
In response to a formal request by the Chief of Aviation Risk Management and Training Systems of the U.S. Forest Service from USC for Dr. Meshkati's advisement, he became the primary Human Factors and Safety Culture Technical Advisor for the agency's Center for Aviation Risk Management (November 2007). A major area of Dr. Meshkati's research since the tragic accident in Tenerife in 1977, for which he has been considered a world's expert, deals with runway incursions. He has been studying the (common) causes of the runway incursion accidents at Tenerife and the Milan Linate airport and lecturing about major contributing human factors causes of runway incursions at other major airports. His research on runway safety at USC have been prominently featured multiple times in the "Face to Face, Eye to Eye", which is the latest training video production by the FAA Runway Safety Office. It is the latest video in the "Runway Safety Collection" DVD which contains four movies to "provide a close look at what the risk is and how to avoid a runway incursion and ultimately an accident." He was one of the 25 "experts" who participated in the Government Accountability Office's study entitled, "*Aviation Runway and Ramp Safety: Sustained Efforts to Address Leadership, Technology, and Other Challenges Needed to Reduce Accidents and Incidents*" (GAO-08-29, November 2007).

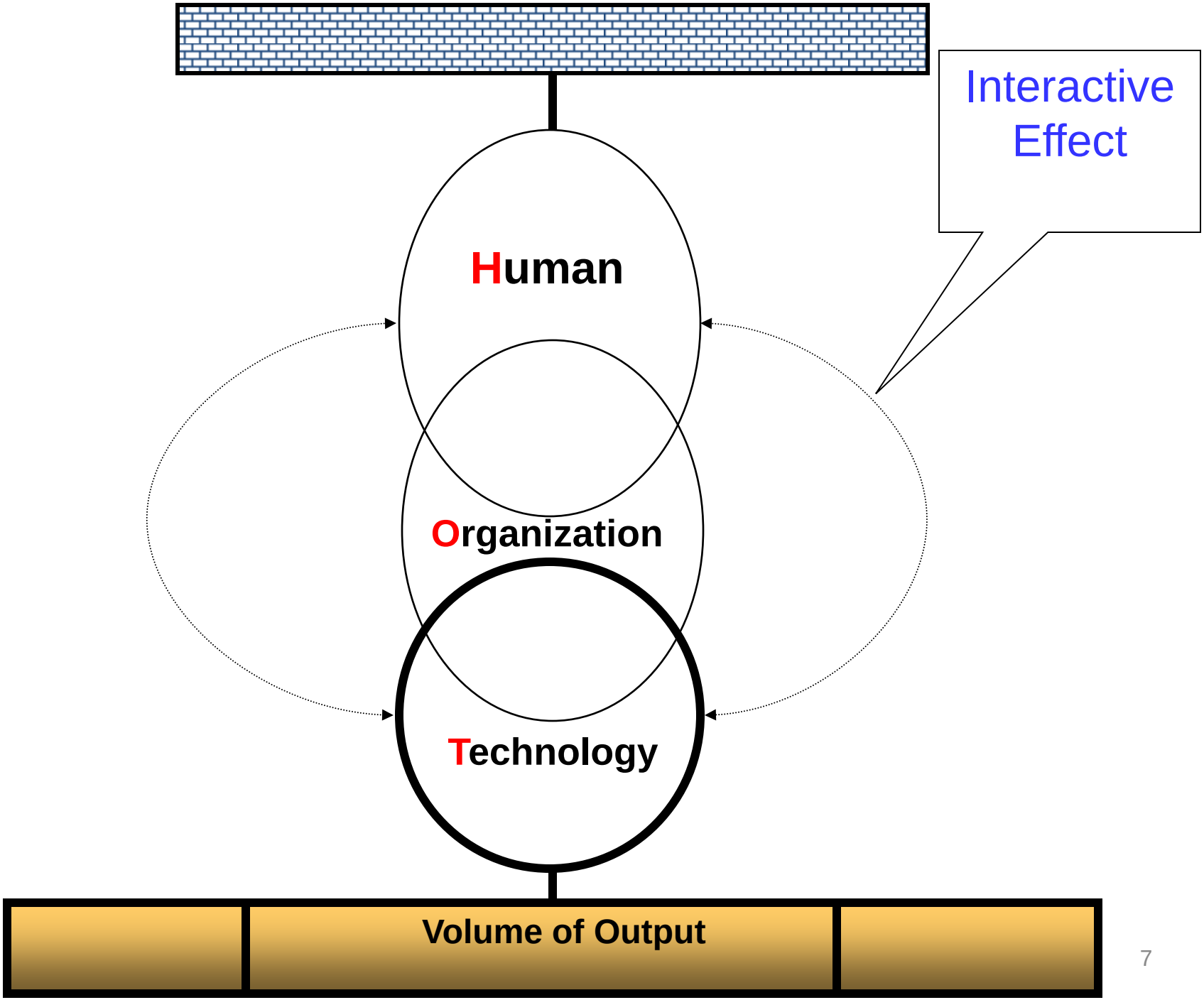
Dr. Meshkati has consulted for many domestic and international technological organizations on aviation (and other four modes of transportation), petrochemical, and nuclear safety; design, evaluation, human factors, and safety culture-related matters. His views on aviation safety have been cited and referred to in many major national newspapers and major international trade magazines, such as the *New York Times, Los Angeles Times, USA Today, Anchorage Daily News, Wall*

# My Premise

The ‘HOT’ Model, Safety Culture
&
Major Subsystems of a Complex, Large-scale Technological System

(e.g., a nuclear power plant, an aviation system)

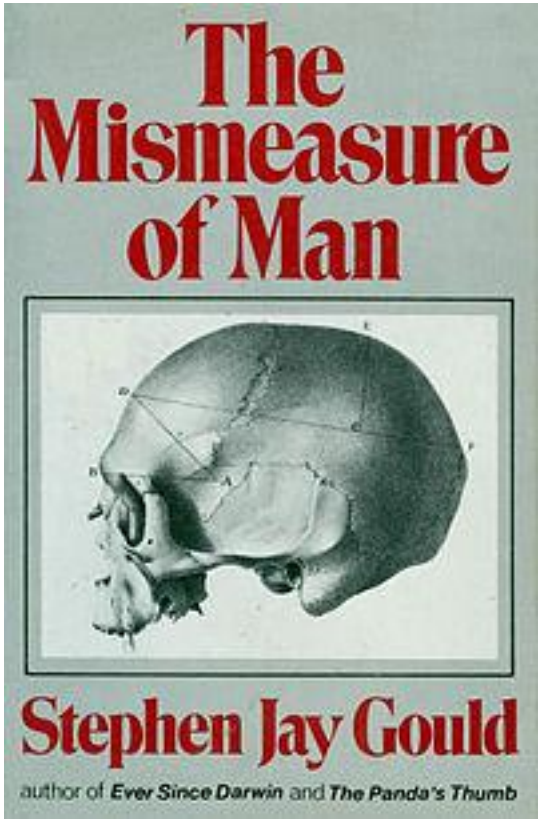

Interactive Effect
Human
Organization
Technology
Volume of Output


Interactive Effect
Human
Organization
Technology
Volume of Output

# Personal Observations on National and Safety Culture

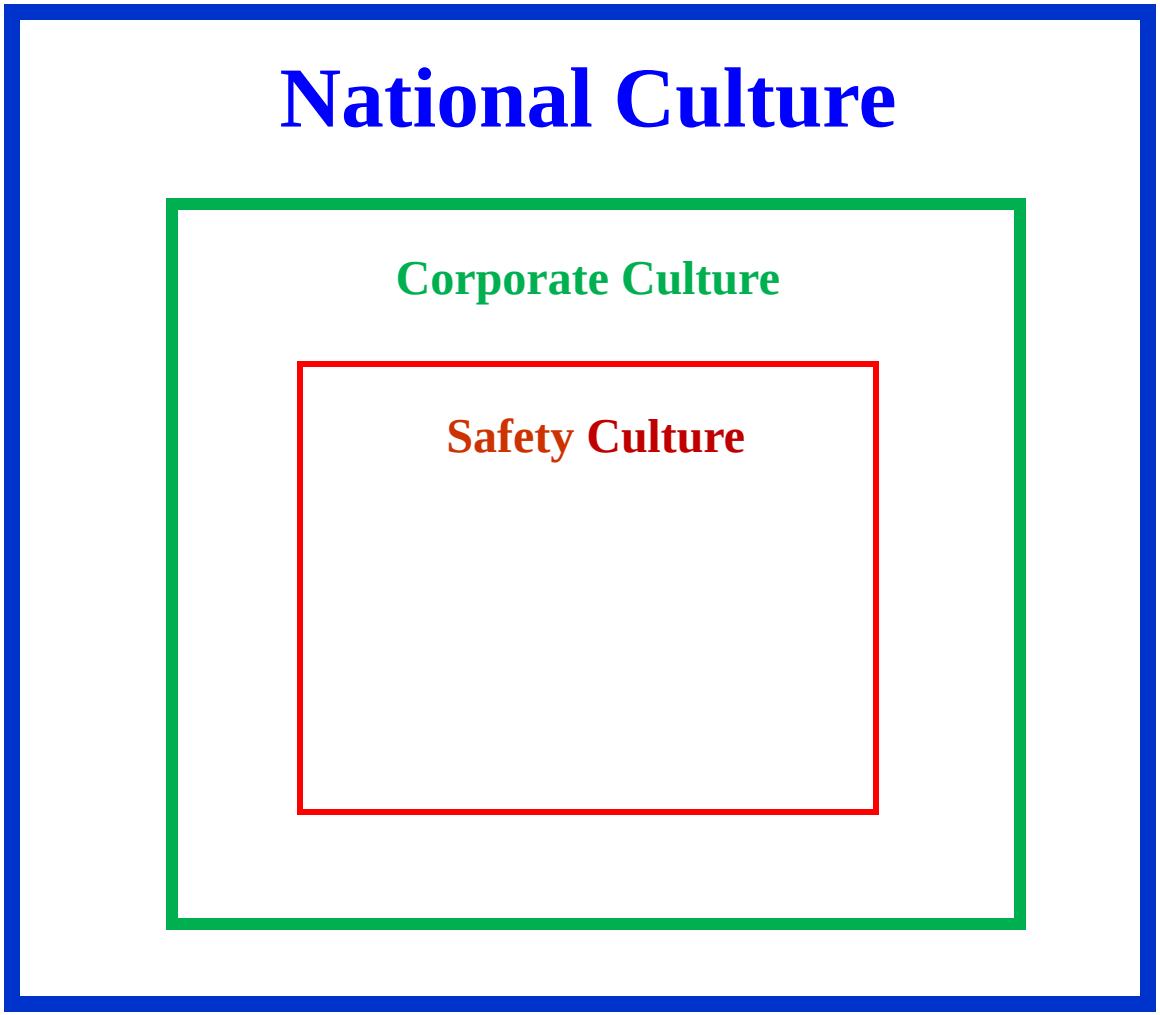
# Culture, Facts and Theories

Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

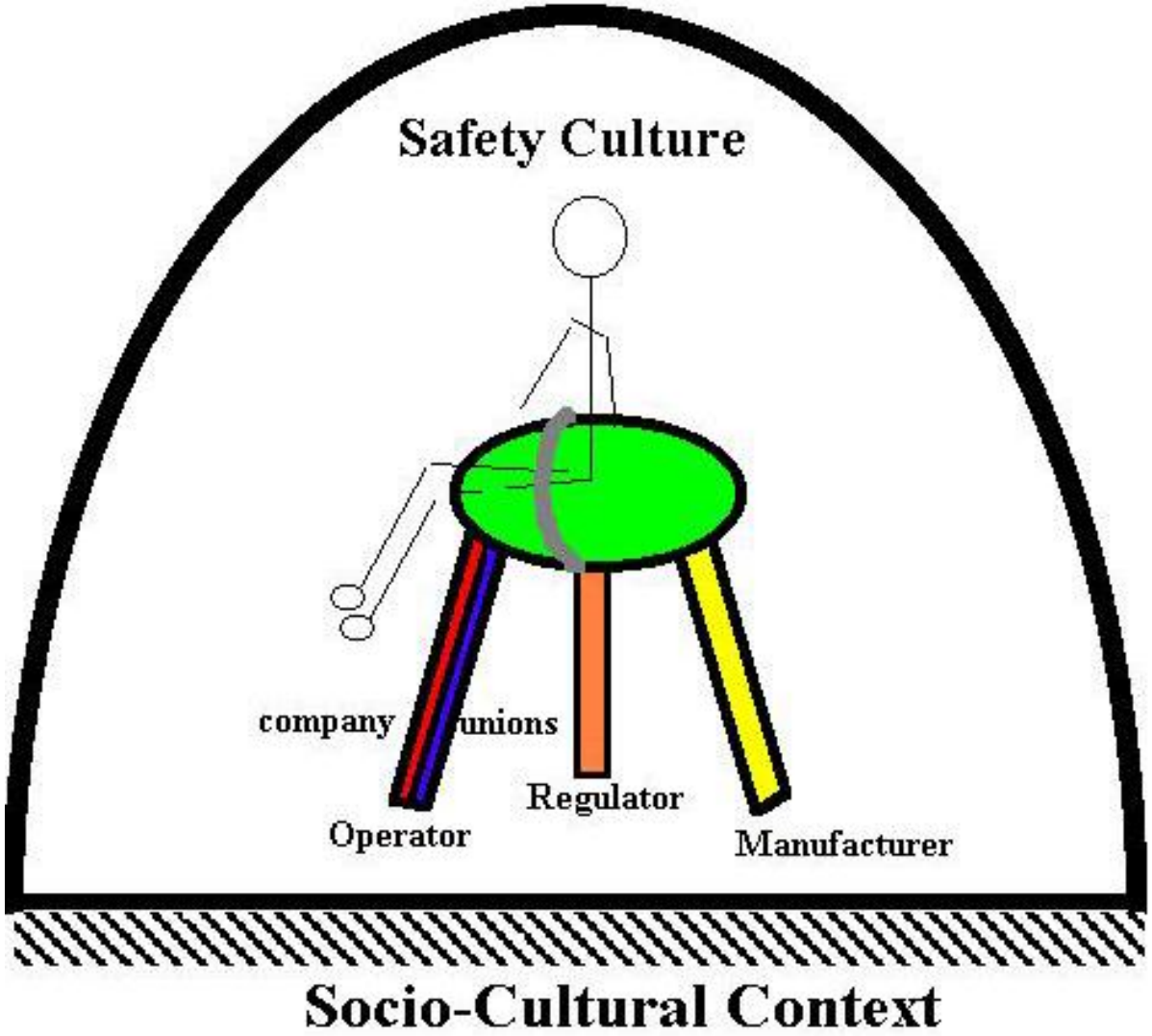



(The late) Professor Stephen Jay Gould, renowned Harvard University professor of geology, biology, and the history of science (*The Mismeasure of Man*, 1981, p. 22).

# National, Corporate, & Safety Culture(s)

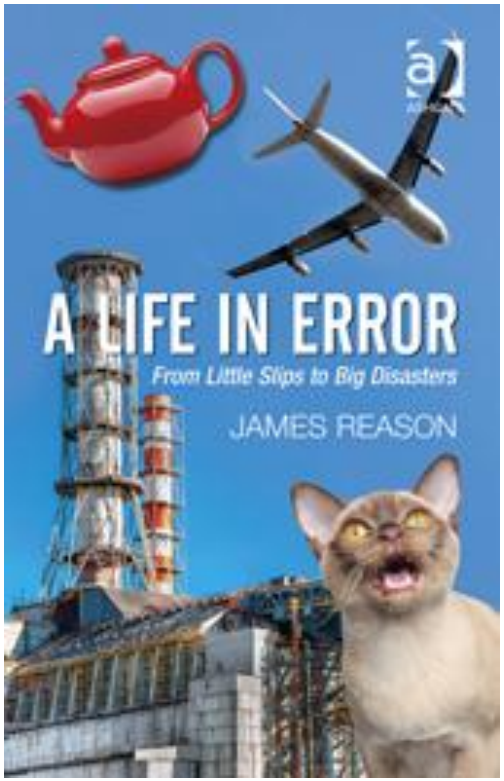


# Foundation of the Safety Culture



# Safety Culture as a Root-Cause of a System's Common Mode Failure

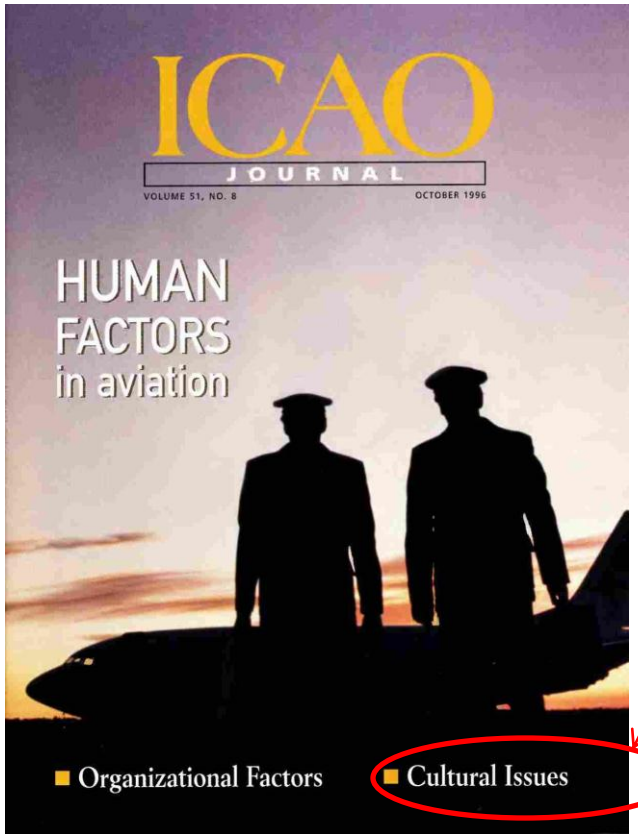
- Because of their diversity and redundancies, the defense-in-depth will be widely distributed throughout the system.
- As such, they are only collectively vulnerable to something that is equally widespread. The most likely candidate is safety culture.
- It can affect all elements in a system for good or ill.




Professor James Reason, *A Life in Error*, 2013, Page 81

# International Civil Aviation Organization Journal

## (Oct 1996)






### Cultural factors influencing safety need to be addressed in design and operation of technology

*Human factors training is becoming a powerful tool in improving aviation safety, but it must take into account the cultural differences that exist between different parts of the world if it is to become fully effective.*

NAJMEDIN MESHKATI
UNIVERSITY OF SOUTHERN CALIFORNIA
(UNITED STATES)

*According to research findings, new technology should be designed in a way that accommodates human factors, including cultural considerations.*

EXPECTATIONS that international operations will continue to account for an increasing share of air transport activity worldwide underscores the importance of designing aircraft and air traffic control (ATC) technology with human factors, including cultural factors, in mind.

A recent University of Texas study of national culture and flight-deck automation, involving 5,705 pilots from a number of nations, found a "disturbing ... lack of consensus in automation attitudes, both within and between nations." It concluded that there is a need for development of a clear philosophy for the design of automation. More recently, the U.S. Federal Aviation Administration (FAA) human factors study team identified several "vulnerabilities" in flight crew management of automation and situational awareness. These evidently were caused by interrelated deficiencies in the aviation system, such as inadequate understanding and consideration of cultural differences in design, training, operations and evaluation. The FAA recommended further study of such factors as pilot understanding of systems capabilities, and how organizational and cultural background influence how pilots decide whether and when to rely on automation.

ICAO has recognized the importance of cultural issues in aviation safety, and has acknowledged that the effectiveness of human factors training may be diminished or even negated by the context of a situation. ICAO's human factors and flight safety programme also has shown that safety deficiencies remediable by human factors training in North America may not be addressed at all by training elsewhere. It has also been suggested that North American approaches to crew resource management (CRM) training may not be applicable in many cultures. The challenge, then, is how to measure significant cultural differences and reflect them in training.

The Boeing Co. reported in 1987 that 65.4 per cent of all jet transport accidents since 1959 could be attributed to flight crew error. Also, 37 of 75 accidents involving U.S. airlines between 1978 and 1990 were found to be a result of flight crew actions; the U.S. National Transportation Safety Board (NTSB) found a total of 302 errors associated with these accidents.

Cultural parameters, a dormant but probably the most subtle human factors subset in technology utilization, should be the focus of more attention in aviation safety. Cultural factors contributed significantly to the crash of Avianca Flight 052 near New York in January 1990; the NTSB determined that the probable cause was flight crew failure to manage the Boeing 707's fuel load and to communicate an emergency situation to ATC before fuel exhaustion.

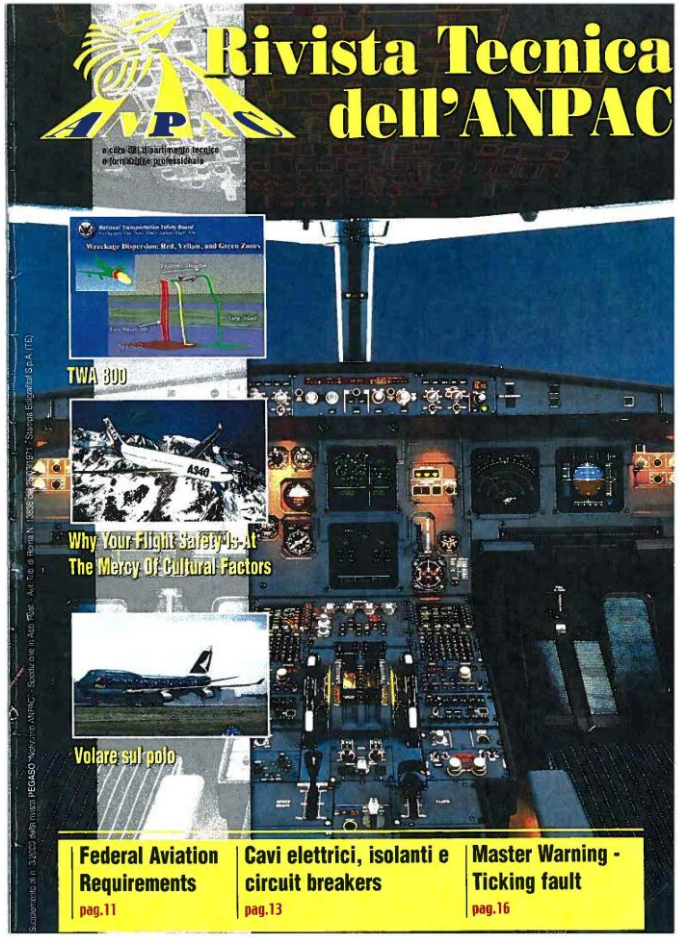
An Avianca captain testified that the first officer's use of the word "priority" rather than "emergency" may have resulted from training provided by the aircraft manufacturer, which uses "priority" in its procedures manuals. He indicated Avianca personnel thought that "priority" and "emergency" conveyed the same sense of urgency to ATC. Controllers testified that although they would do their utmost to assist a flight requesting priority, the word would not require a specific response. They also said that pilots with a fuel emergency should declare it as such.

The NTSB found that the first officer of Flight 052, who transmitted exclusively in English, never used the word "emergency," even when he radioed that two engines had flamed out. Neither did he use appropriate phraseology to communicate minimum fuel status.

# *Revista Tecnia del ANPAC* – (2000)

(Nazionale Piloti Aviazione Commerciale)

# National Commercial Pilots Association Italy




RIVISTA TECNICA DELL'ANPAC - Anno 1, Numero 2 Pagina 25

## Why Your Flight Safety Is At The Mercy Of Cultural Factors

*Dr. Najmedin Meshkati*

November 29, 2000

**Najmedin Meshkati**, Ph.D., CPE
Office Tel: (213) 740-8765; Fax: (213) 744-1426
Email: meshkati@usc.edu
URL: http://www-bcf.usc.edu/~meshkati/

*Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.*

[Dr. Stephen Jay Gould, renowned Harvard University professor of geology, biology, and the history of science (Gould, 1981, p. 22).]

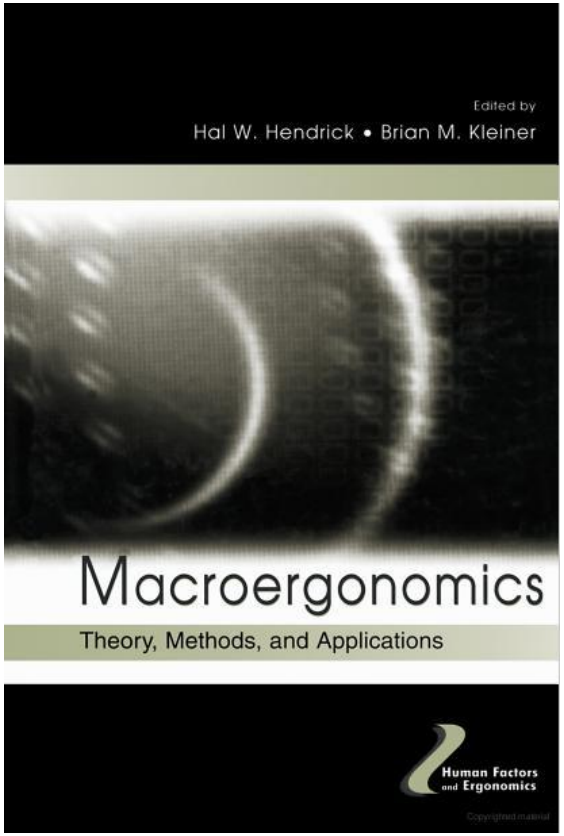
### Introduction

Whenever you fly an aircraft, seat in the cockpit or in the cabin, or land in a "foreign" airport your flight safety is at the mercy of cultural factors. Attesting is the above succinct epigraph, which only provides the first compelling reason. It may be anathema to many scholars and practitioners of "hard" sciences and other engineering-dominated fields, but recent rigorous research has proven that even *scientific* theories, facts, and practices -- which determine and govern aviation systems' operations -- are strongly culturally based. For instance, according to a recent article in *The New York Times* (May 23, 2000), an attempt to ban communication in French between pilots and air traffic controllers at Charles de Gaulle airport near Paris lasted only 15 days primarily due to cultural factors, and more specifically because of "stubborn Gallic pride that persists among French pilots and air controllers." As all non-French speaking seasoned pilots who have approached

# *Macroergonomics: Theory, Methods, and Applications*

Edited by Hal W. Hendrick, Brian Kleiner

(2002)

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## Macroergonomics and Aviation Safety: The Importance of Cultural Factors in Technology Transfer

Najmedin Meshkati
*University of Southern California*

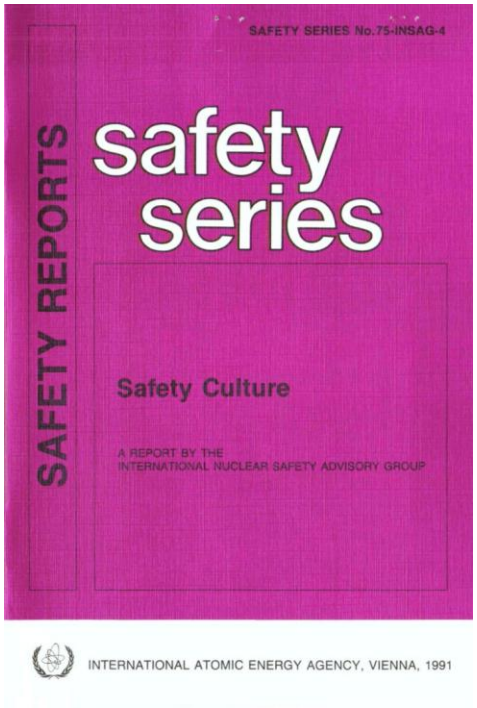
*Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.*
—Dr. Stephen Jay Gould, renowned Harvard University professor of geology, biology, and the history of science (Gould, 1981, p. 22)

### INTRODUCTION

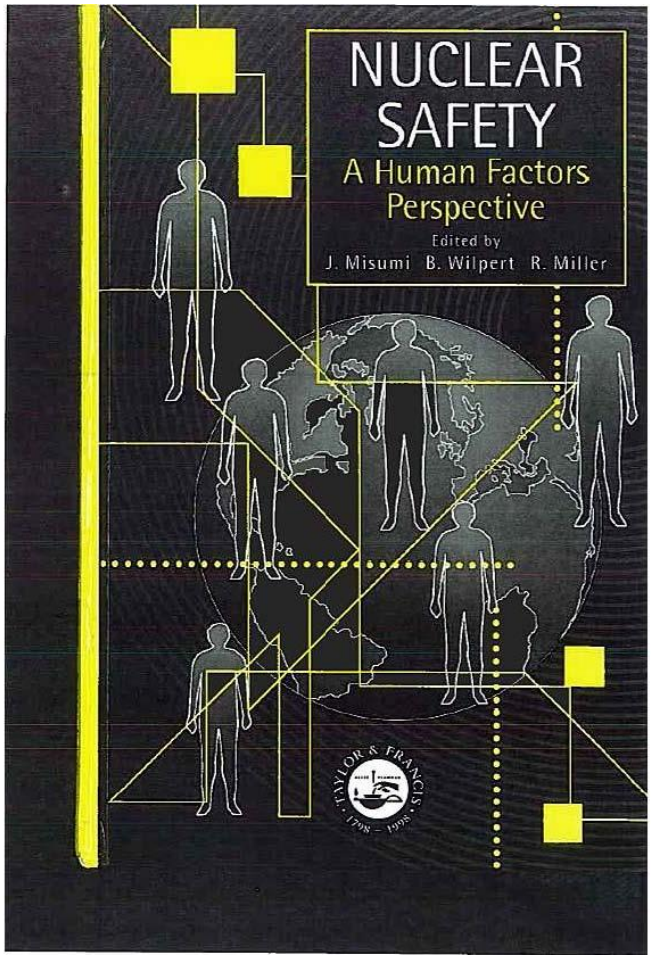
Whenever you fly an aircraft, either sitting in the cockpit or back in the passenger cabin, land at a "foreign" airport and your flight safety is likely to be at the mercy of macroergonomic considerations. These considerations include systematic incorporation of cultural factors in work system design and operation. The above succinct epigraph, which provides the first compelling reason, is also a testament to this contention. It may be anathema to many scholars and practitioners of "hard" sciences and other engineering-dominated fields, but recent rigorous research has proven that even *scientific* theories, facts, and

# Dr. Hans Blix
# The Director General's Forward

"The report is intended for use by governmental authorities and by the nuclear industry and its supporting organizations. Prepared by a highly authoritative body, it should help to promote Safety Culture. **It is intended to stimulate discussion and to promote practical action at all levels to enhance safety**."



# The Cultural Context of Nuclear Safety Culture:
# A Conceptual Model and Field Study
## (1999)




CHAPTER FOUR

The cultural context of nuclear safety culture: a conceptual model and field study

NAJMEDIN MESHKATI
*University of Southern California, Los Angeles*

The two general components of safety culture are 'the necessary framework within an organisation and the attitude of staff at all different levels in responding to and benefiting from the framework.' Also, the requirements from individual employees for achieving safety culture at installations are 'a questioning attitude, a rigorous and prudent approach, and necessary communication.' Recent studies have highlighted the critical role of cultural factors in the safety of nuclear power plants.This chapter contends that an organisation's safety culture, as a system composed of behaviours, practices, policies, and structural components, cannot flourish or succeed without interactions and harmony with its environment – the societal or national culture. In other words, safety culture should be considered in the context of national culture. It is concluded that the necessary conditions for creating and nourishing safety culture in a technological system include (but are not limited to):

- an understanding of systems-related factors affecting human performance;
- determination of the extent to which systems-related factors interact with factors of organisational culture and the national culture;
- promotion of a questioning attitude and openness in the organisation;
- development of conducive regulations and a supportive regulatory environment.

Human and organisational factors play a vital role in the safety of large-scale technological systems (Meshkati, 1988; 1989a, b, c; 1991a, b). Fortunately, this fact has been almost universally recognised by the nuclear industry around the

# Culture and Accident Causation

## Swiss Cheese Model

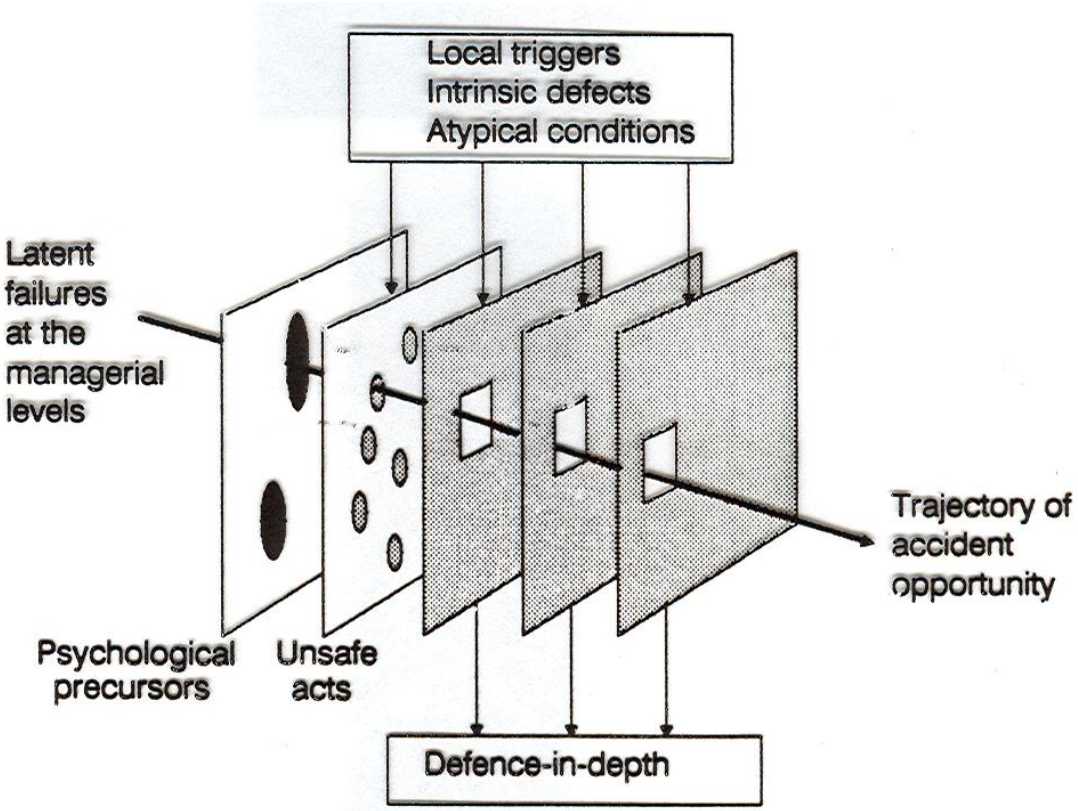
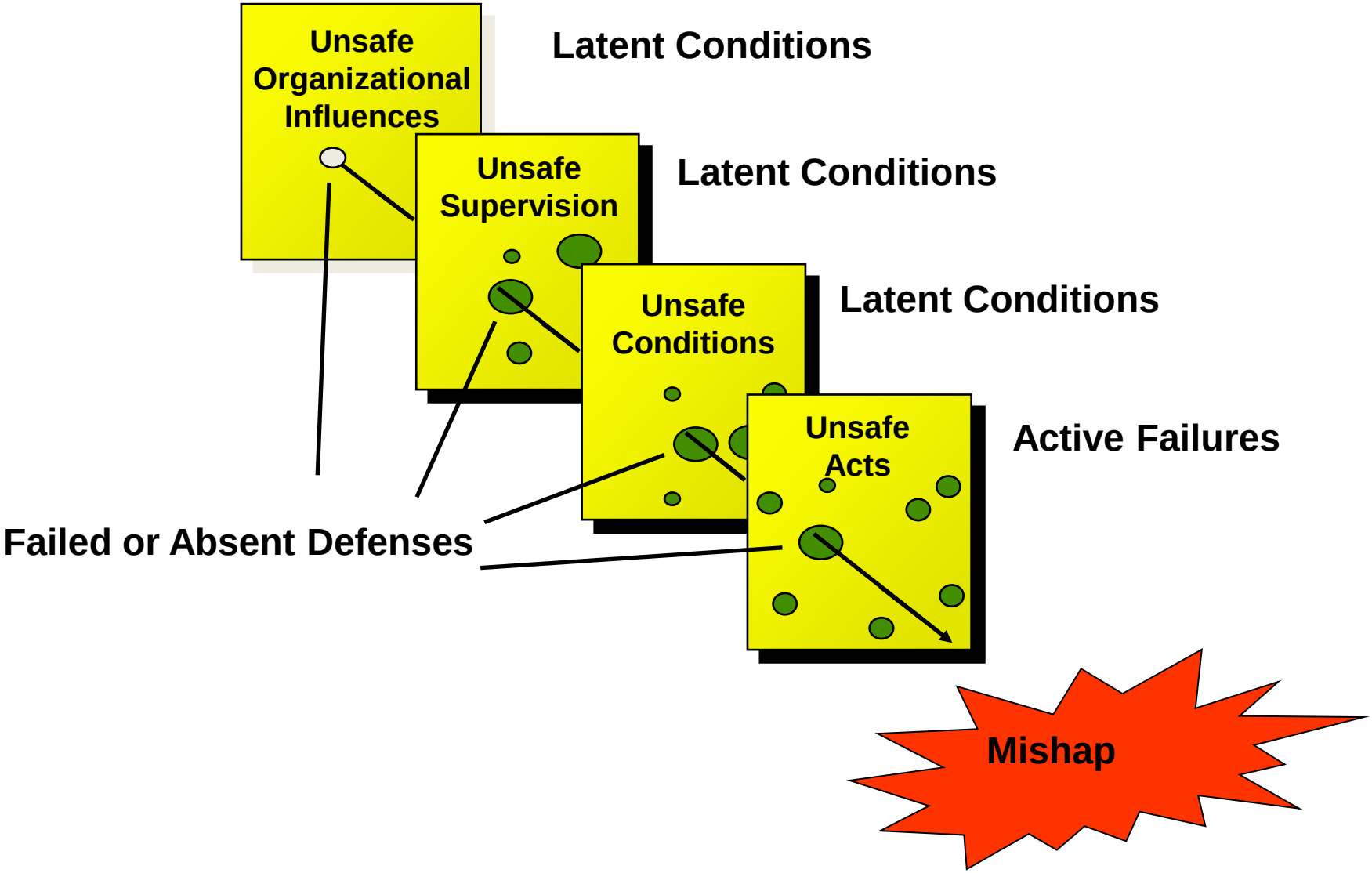
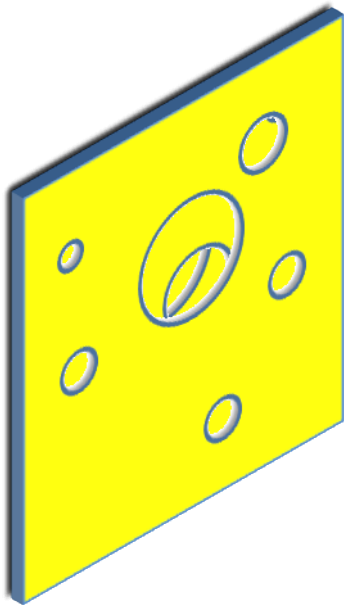



Figure 7.8. The dynamics of accident causation. The diagram shows a trajectory of accident opportunity penetrating several defensive systems. This results from a complex interaction between latent failures and a variety of local triggering events. It is clear from this figure, however, that the chances of such a trajectory of opportunity finding loopholes in all of the defences at any one time is very small indeed.

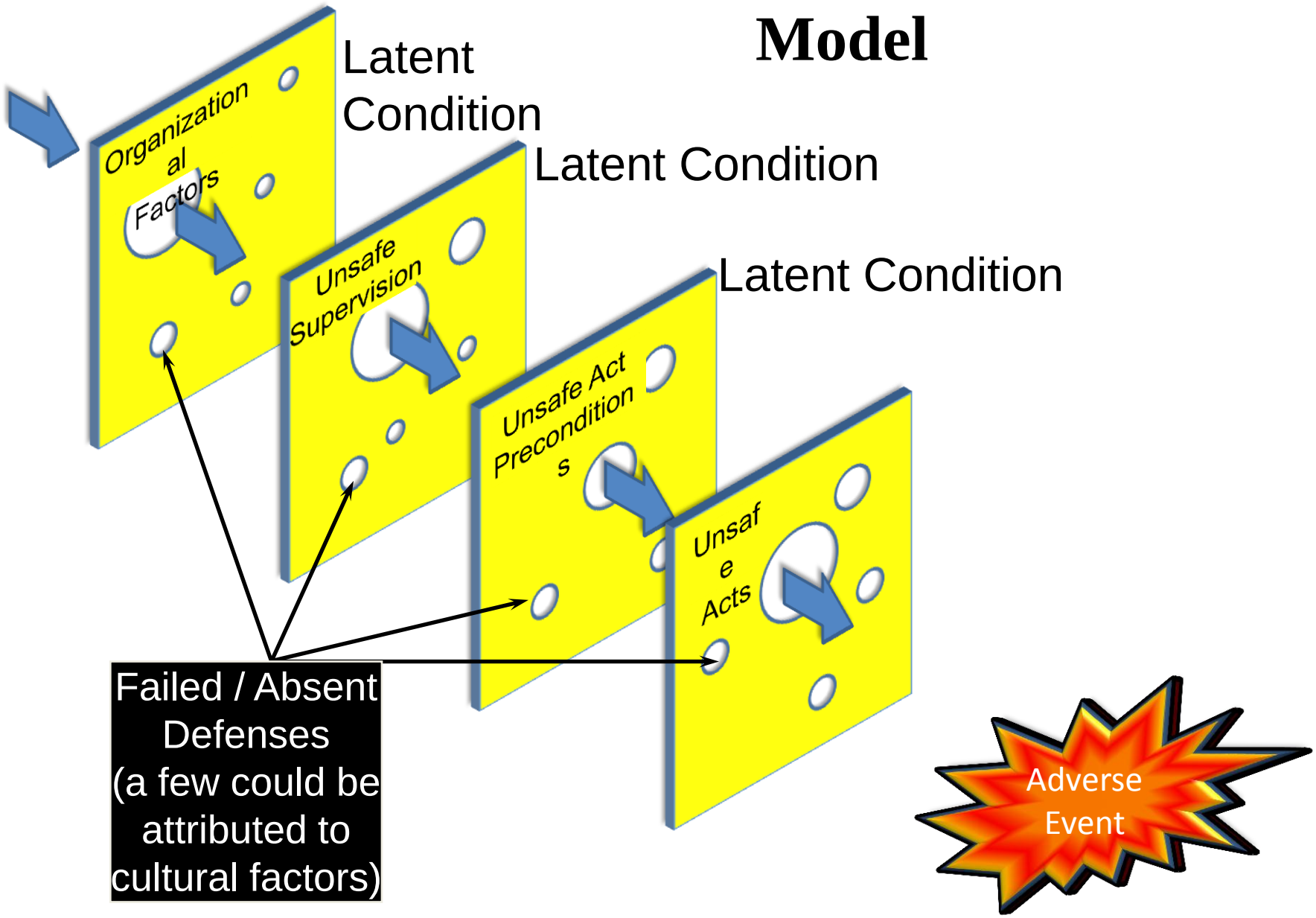
# Reason's "Swiss Cheese" Model



# Professor Reason's "Swiss Cheese" Model



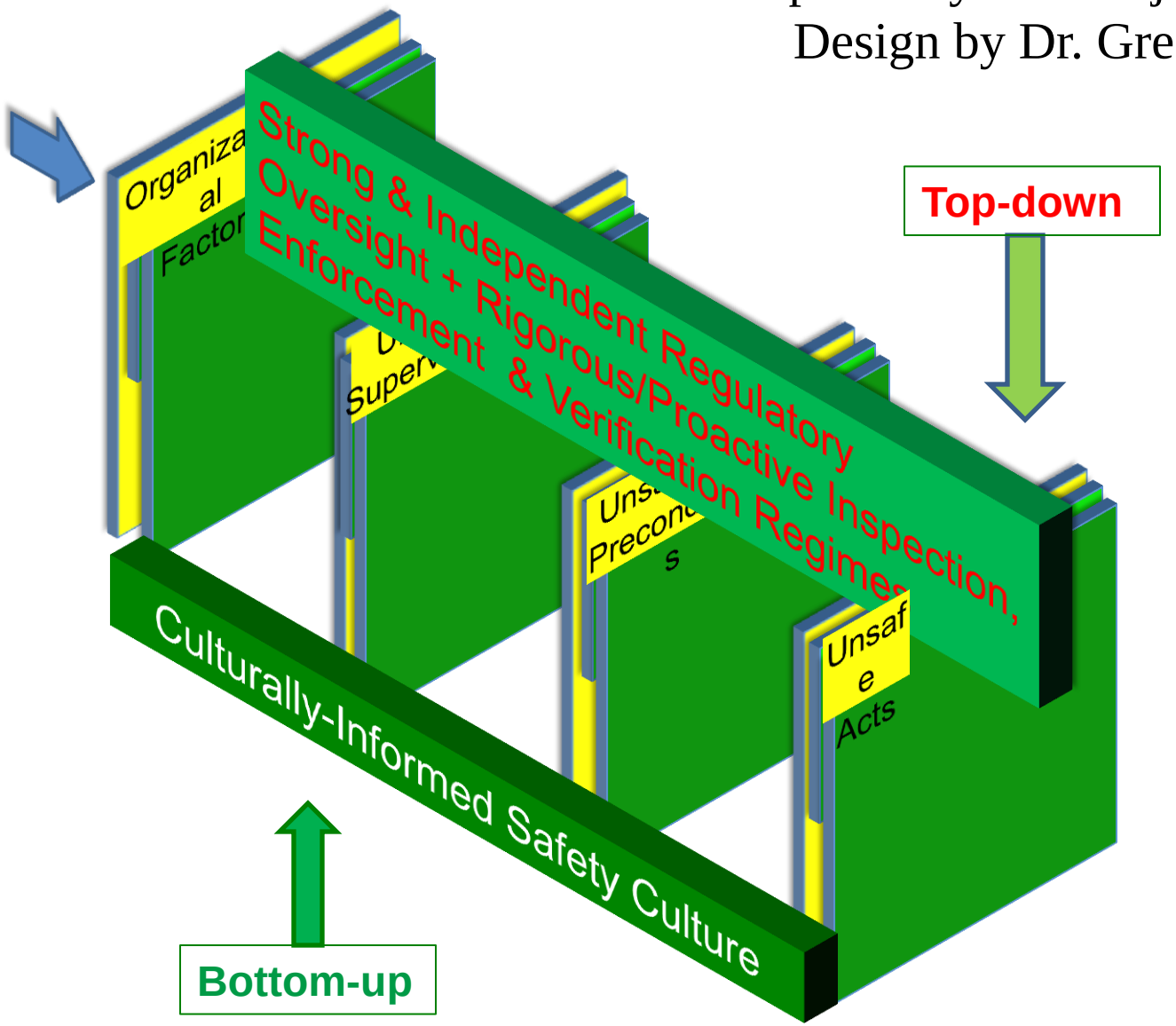
# Prof Reason's "Swiss Cheese" Model



# Double-Shielded, Fortified "Swiss Cheese" Model

Proposed by Prof Najm Meshkati, USC

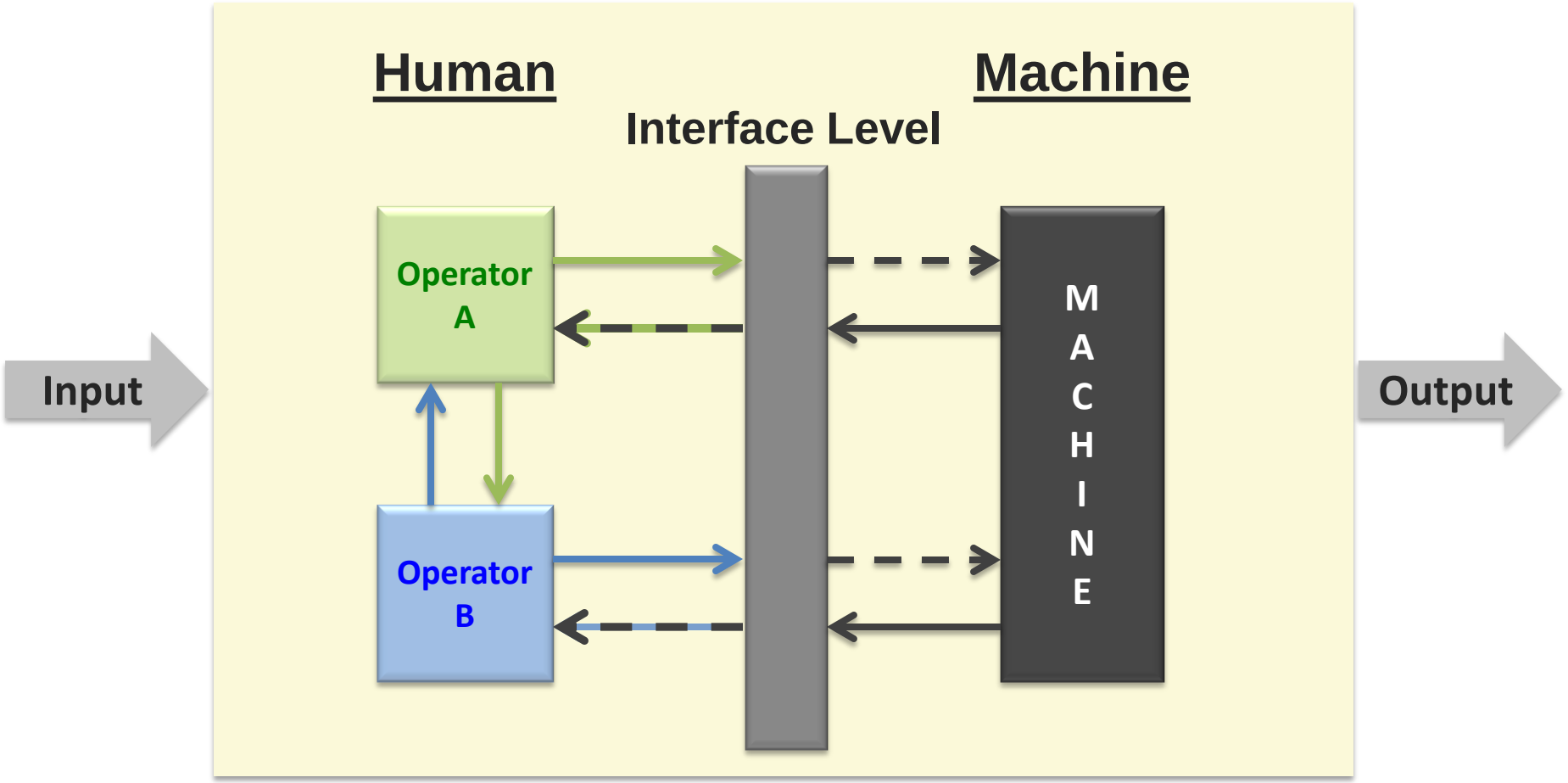
Design by Dr. Greg Placencia, USC

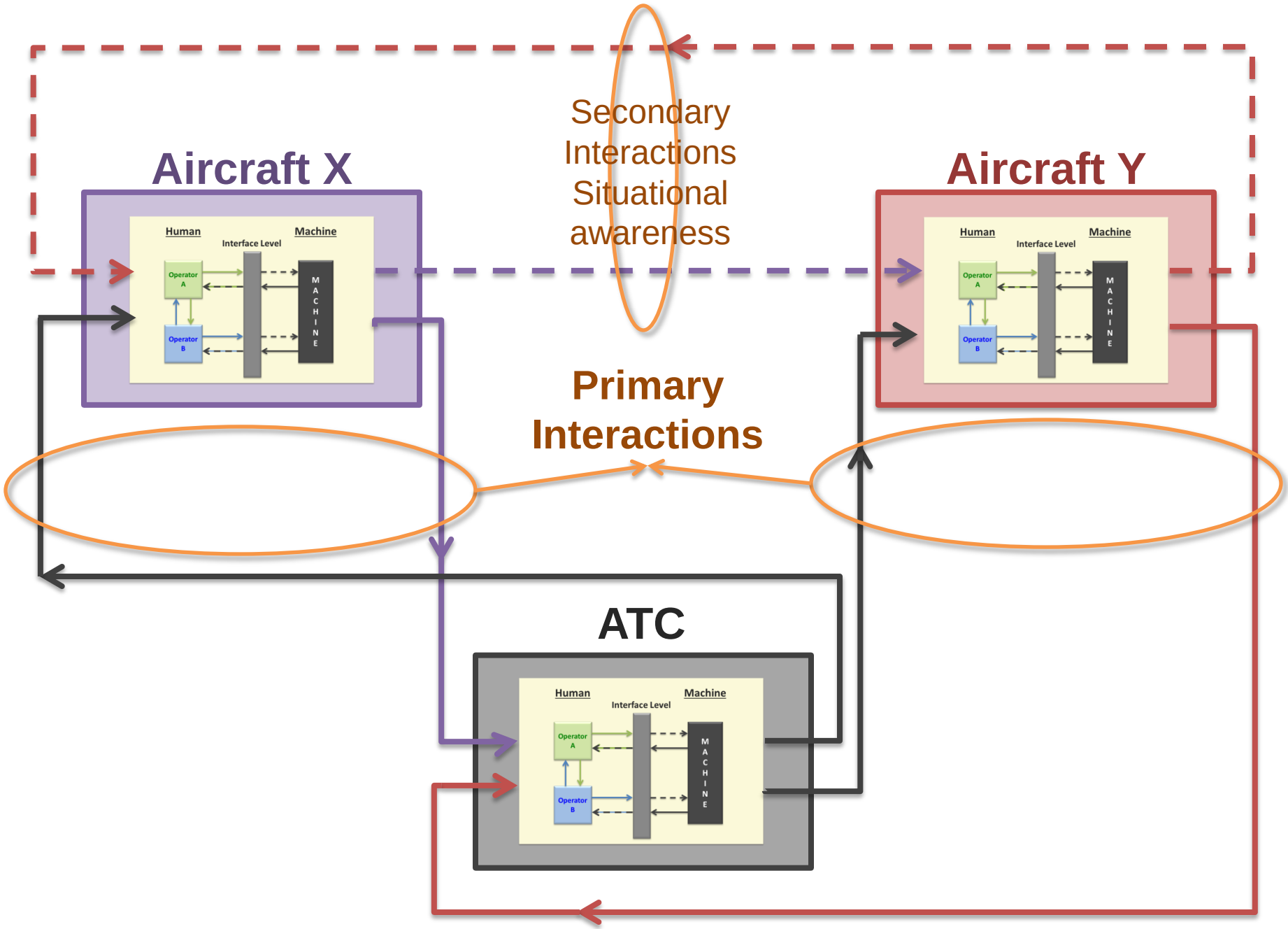


# Culture and Accident Causation

## Human-Machine System

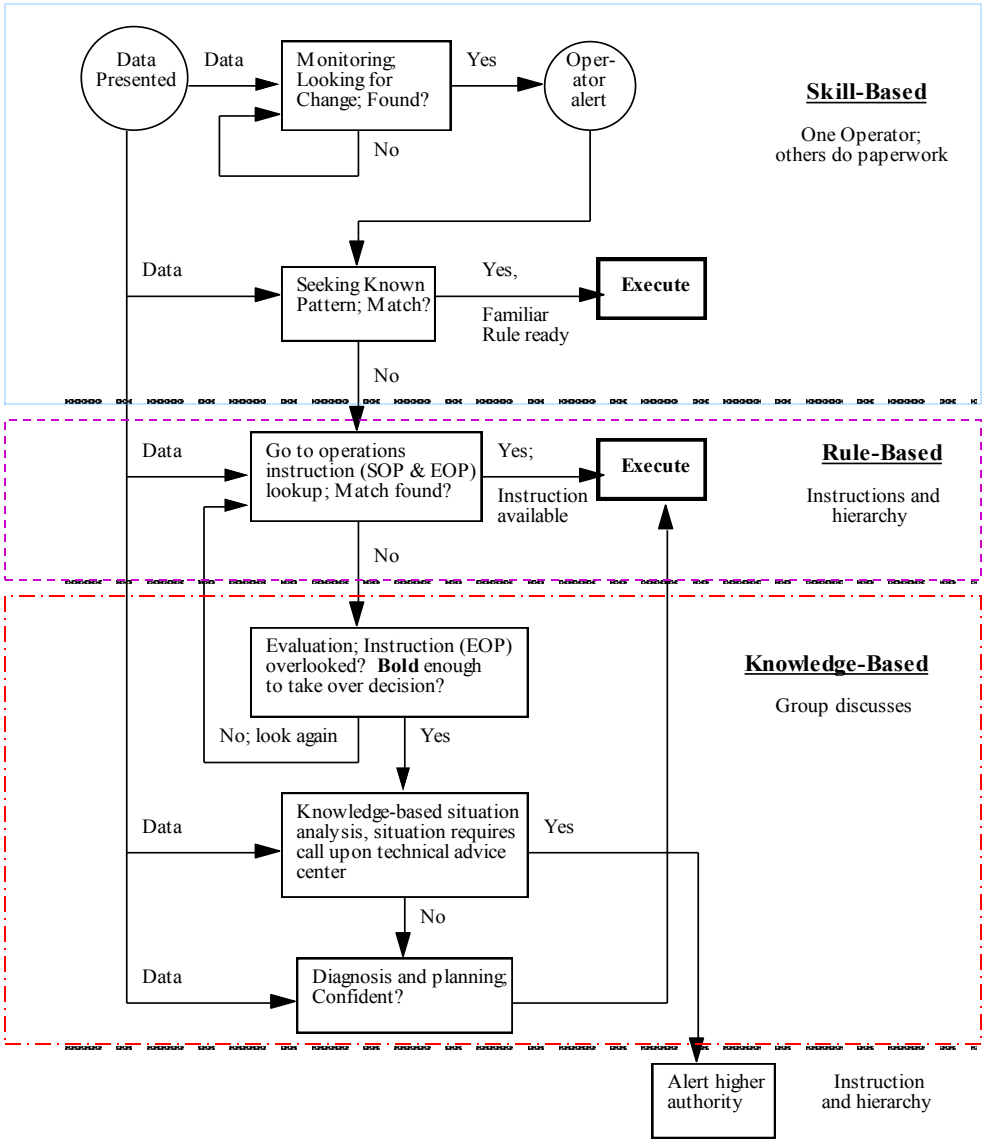
# Human-Machine System



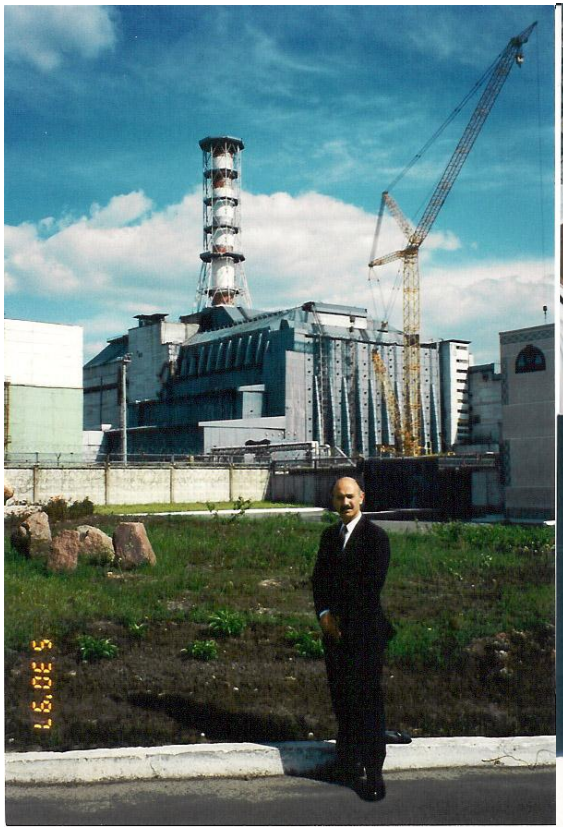

Secondary
Interactions
Situational
awareness
Aircraft X
Aircraft Y
Human
Machine
Interface Level
Operator A
Operator B
MACHINE
Primary
Interactions
ATC

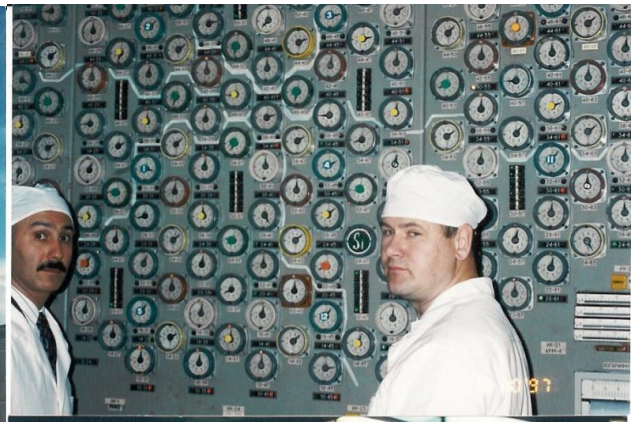
# A Model for Nuclear Power Plant Operators' Responses to Disturbances

(Based on Prof. Jens Rasmussen's SRK Framework, personal communication 1992)

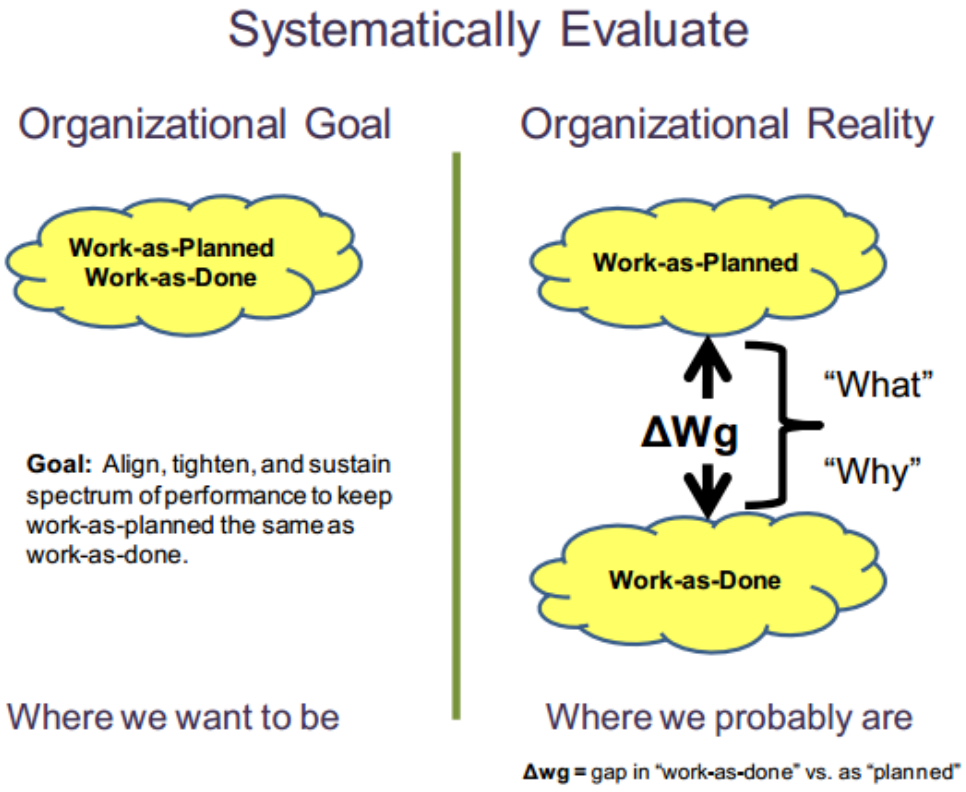


# Control Rooms of Nuclear Power Plants





# Work As Imagined Vs. Work As Done



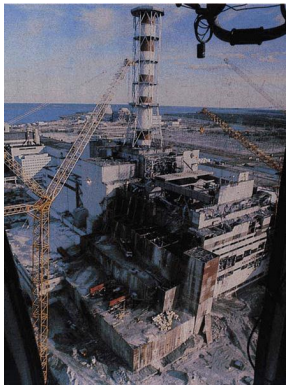

**There will always be a performance gap between "work-as-planned" and "work-as-done" work performance gap (ΔWg) because of the variability in the execution of every human activity**

Source: US Department of Energy (DOE) (2012). *Accident and Operational Safety Analysis. Volume I: Accident Analysis Techniques*. US DOE, P1-32

# My life story +
# Aviation accidents (with cultural overtones)


Three Mile Island


Bhopal


Chernobyl


BP Refinery


BP Deepwater Horizon


Fukushima

March 28, 1979

December 3, 1984

April 26, 1986

March 23, 2005

April 20, 2010

March 11, 2011


Tenerife, 1977

Avianca, 1990


Korean Air 801, 1997


Überlingen, 2002

Asiana 214, 2013

# National Culture Implicated as a Contributing Factor to 5 Severe Accidents

- **Tenerif -** Runway Incursion – Canary Island, Sprain - 1977 (583 fatalities)
- **Avianca 052** – Crash - New York – 1990 (73 fatalities)
- **Korean Air 801** – Crash - Guam – 1997 (228 fatalities)
- **The Überlingen** mid-air collision – Switzerland – 2002 (71 fatalities)
- **Asiana 214** – Crash - San Francisco -2013 (3 fatalities)

# ***Australian Aviation***, March 2014

## Writer: Geoffrey Thomas



# COMING UP SHORT

## Asiana crash shows continued need for vigilance against CRM & cultural issues

WRITER GEOFFREY THOMAS


The burnt out wreckage of HL7742 wms

Damage to HL7742's economy class cabin wms

The crash of Asiana flight OZ214 at San Francisco International Airport on July 6 2013 is a sobering wake-up call for an industry where some have been lulled into a belief that cultural factors in the cockpit had been virtually eliminated.

Asiana 777-200ER HL7742 was operating flight OZ214 from Incheon when it clipped the seawall on approach to SFO's runway 28L. The subsequent crashed killed three and injured 180 of the 307 passengers and crew on board.

Soon after a chorus of experts and commentators immediately and emphatically dismissed cultural factors as a likely cause. But the subsequent investigations have proven otherwise, raising challenging questions of the aviation industry.

Testimony by trainee captain Lee Kang-Kuk, who was pilot-flying OZ214 from the left hand seat (under the supervision of training pilot, and pilot-in-command, Captain Lee Jeong-min in the right seat), to a US National Transportation Safety Board hearing in December raises serious concerns, despite his 9,684 hours in a variety of aircraft types.

Captain Lee told the NTSB that he was "very concerned" about landing the 777 visually at San Francisco International Airport without the aid of a glide-slope indicator (ILS). At the time of the accident the airport's ILS was not operative but its PAPIs (precision approach path indicators) were working. He added that because other pilots were doing visual approaches, "he could not say he could not do" one.

But it appears that Lee is not alone in his fear of visual approaches. In an interview with Bloomberg, former Delta Airlines and Asiana Airlines (2006-11) Captain Victor Hooper said that on one approach to LAX his copilot "froze" when asked to perform a visual approach. According to the Bloomberg report Captain Hooper had to take the controls to get the aircraft back on track, and he recalled the copilot saying "I don't need to know this. We just don't do this."

Captain Hooper was also interviewed by the NTSB and said that "while all Asiana pilots he flew with were extremely competent at executing the training they were provided, there was minimal training in how to do a visual approach." He added they had limited opportunities for stick and rudder skills training but he "was sure that, given the opportunity, they would be excellent pilots."

He added, "they really needed to add in the syllabus more visual approaches where they just go down and fly around a local area and fly without auto throttles, because they count on the auto-throttles and assume they're going to work right."

According to the Bloomberg story, Ross Aimer, a retired United Airlines captain, who trained crews at Korean Air Lines for Boeing subsidiary Altech Training in 2008 and 2009, and Kenneth Musser, a former Delta pilot who flew 777s for Asiana for almost four years until 2009, both said they also noticed that many Korean pilots struggled with visual approaches.

Bloomberg also spoke with David Greenberg, the retired Delta Training Captain who was hired by Korean Air in 2000 to turn around the airline's then disastrous safety record that had made it a pariah in the industry. On the deficiencies in hand-flying he said "I observed it," but added in a portent of a much wider problem that it was not worse than with pilots elsewhere in the world.

On hand-flying, Boeing's 777 Flight Level Speed Change (FLSC) mode has come in for scrutiny. According to one 777 captain the issues revolve around the interaction between the 777's auto-flight and auto-thrust. The FLSC is not recommended for the final phases of an ILS approach but there is no guidance on a visual approach. "The FLSC allows the auto-thrust system to enter a "sleep" state if the throttles are not moved for more than 1.2 seconds," said the Captain. "The problem is that in all other auto-flight modes the auto-throttle will re-engage." The pilots of OZ214 did retard the throttles after FLSC was engaged.

The FAA became aware of this issue during the 787 certification but after consideration of all factors deemed it not a safety issue, while Boeing has noted it in its training manuals for 15 years. And in the NTSB's investigation an Asiana Airlines ground school instructor who trained Captain Lee told investigators he emphasised this issue because he had "personally experienced it."

### Candid admissions

As disturbing as the fear of flying a visual approach admission was, there was more to come in the testimony from Captain Lee, who said that he was blinded while making the approach by something shiny. But when asked why he did not wear sunglasses, he said it would have been impolite for the training captain not to see his eyes. He added it was very important in their culture.

Asked why he did not break off the approach as he was pilot in command





**Asiana crash shows continued need for vigilance against CRM & cultural issues**

# Do you agree?

## "Culture Eats Systems for Breakfast"

On the Limits of Management Based Regulation

By:

Professor Neil Gunningham and Mr. Darren Sinclair

The Australian National University

National Center for OHS Regulation, July 2009