
HF Management, Organization & Incident/ Accident
Industry Applications & Social Psychology
Corrective, Preventative & Training & Conclusion
Investigation RCA & Analysis
INTRO - History of HF & ICAO
Human Error & Human Performance
ICAO COSCAP


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INTRO - History of HF & ICAO
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Human & Organizational Factors
in
Incident & Accident Investigation

HOFIAI Course & Workshop

2nd Nov. – 19th Nov. 2018

ICAO

Hosted by: COSCAP – SA


WELCOME CANDIDATES
Capt. Gabriele 'Gabe' Ascenzo
Instructor/Facilitator/Mentor/Learner
ICAO

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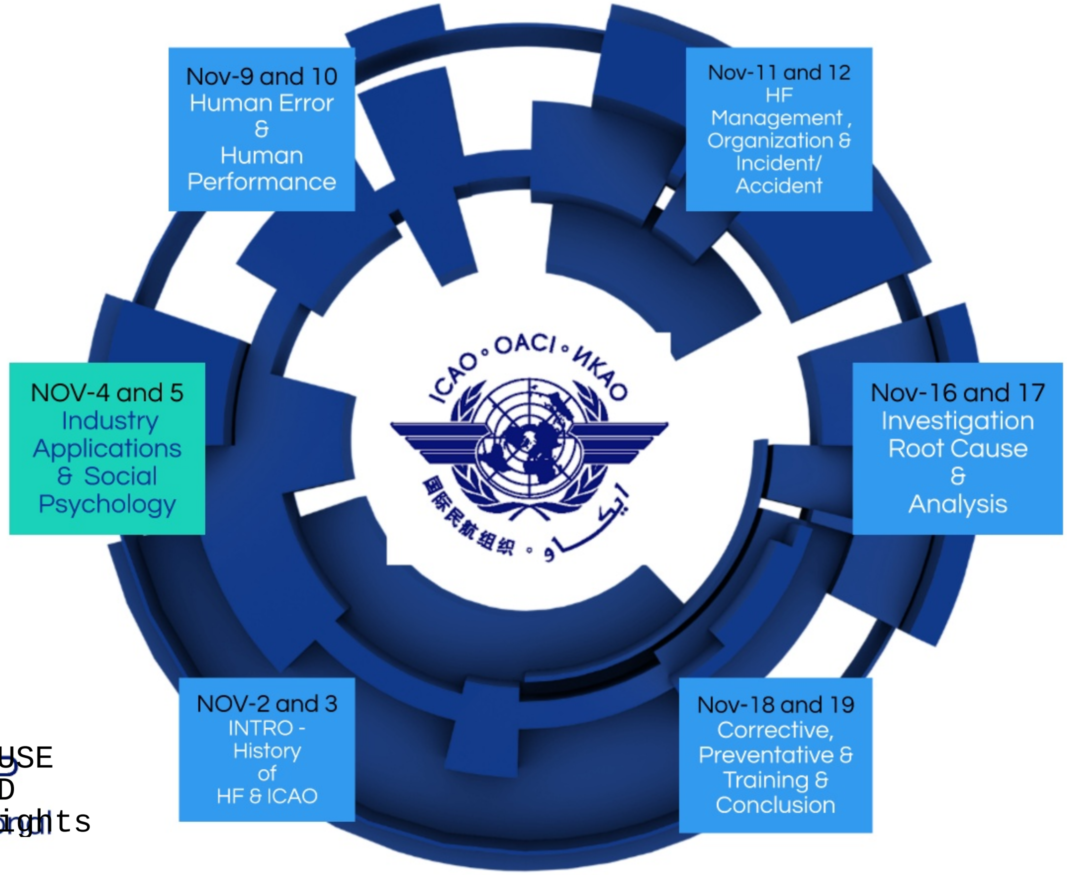
Human and Organizational
Factors in Incident &
Accident Investigation
02 Nov - 19 Nov



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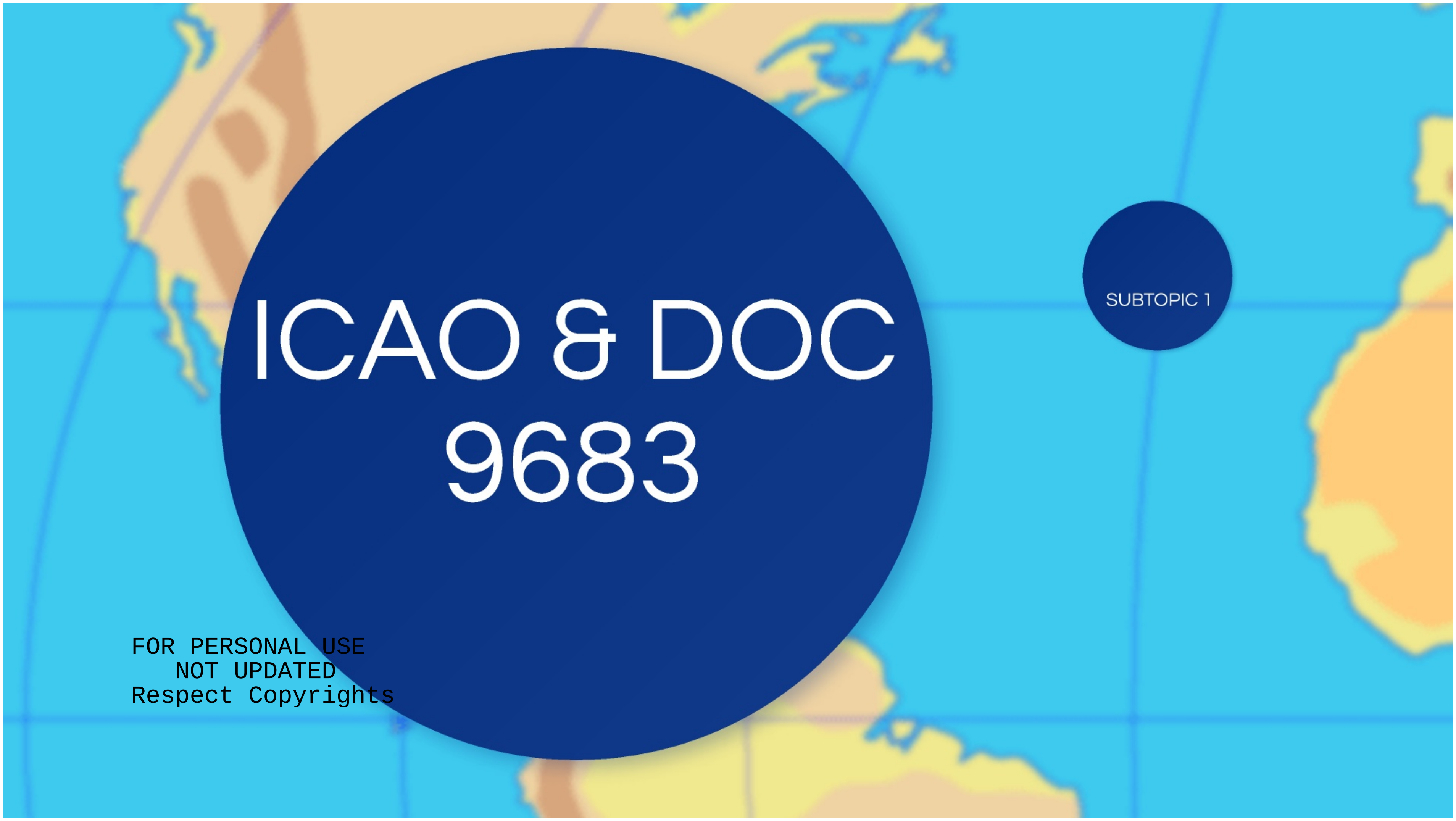
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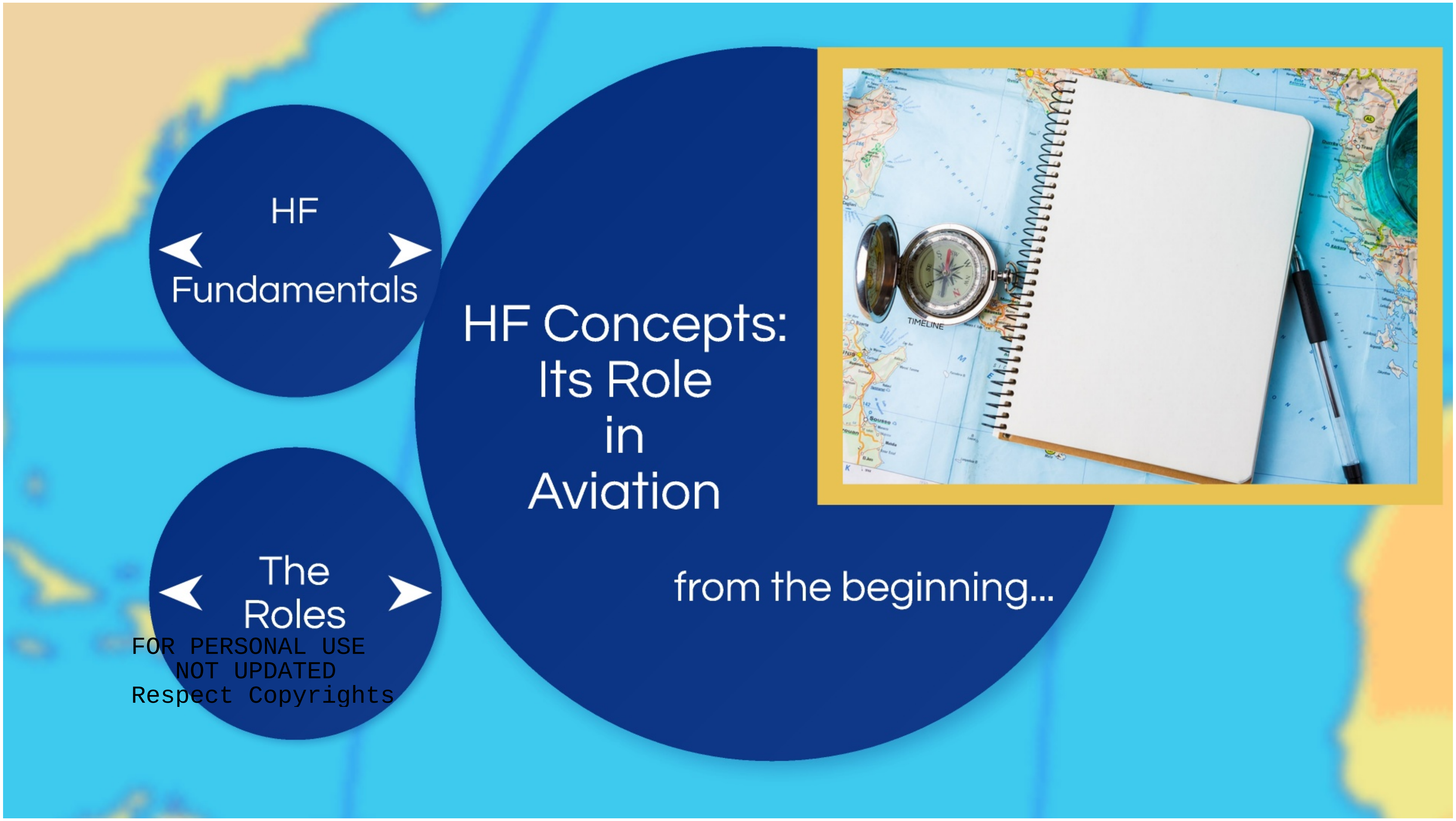
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HF Concepts:
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in
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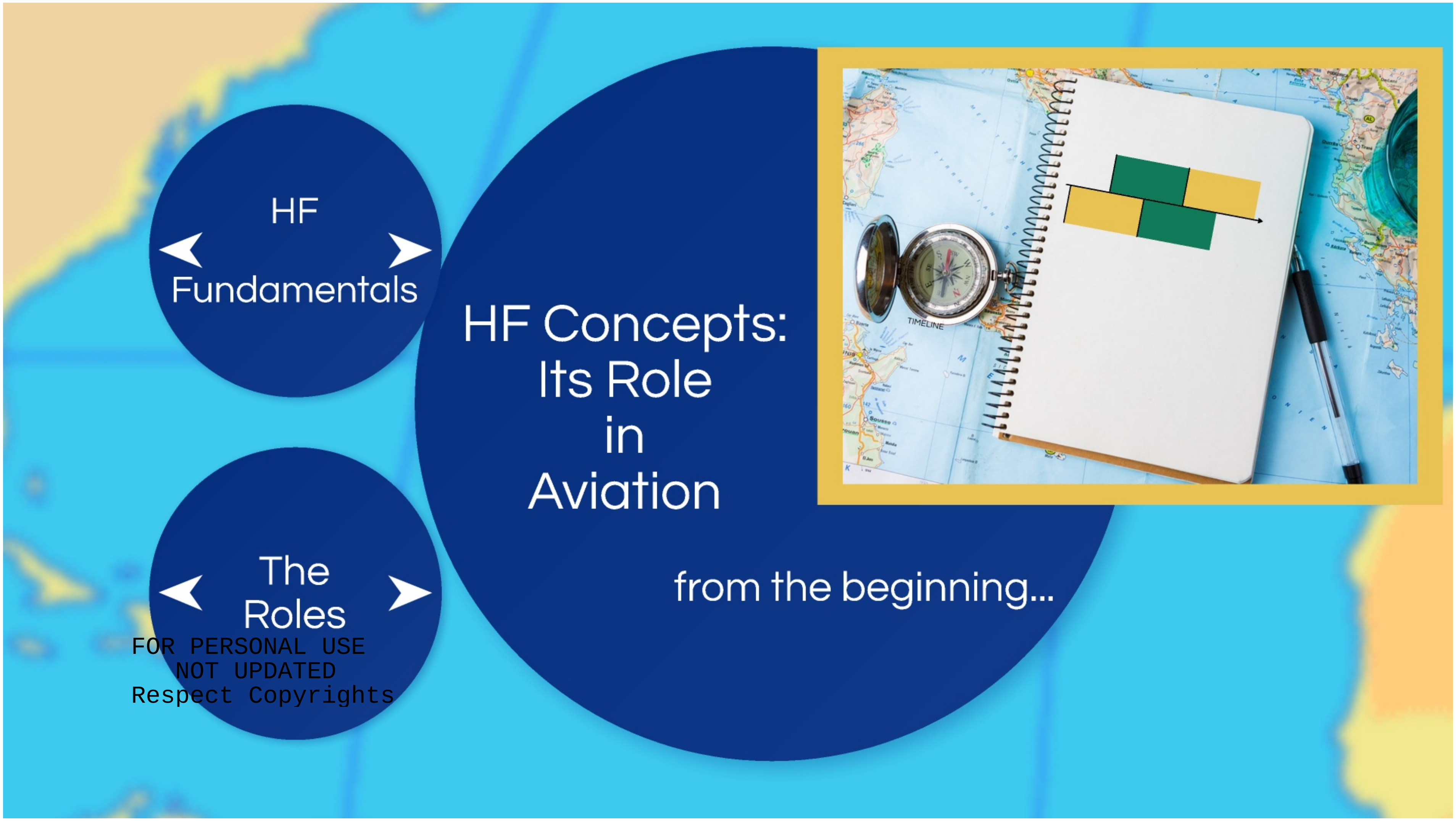
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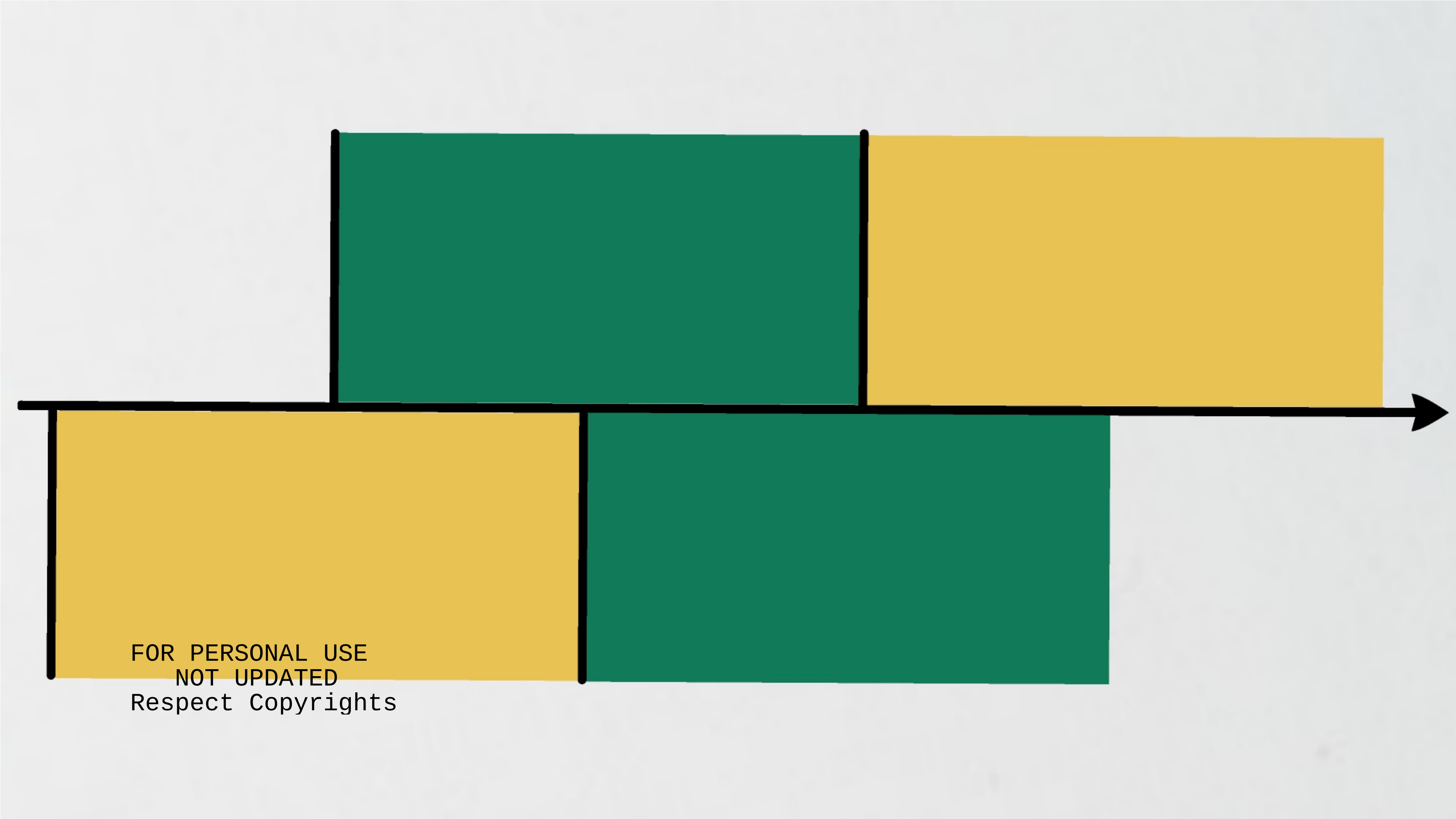
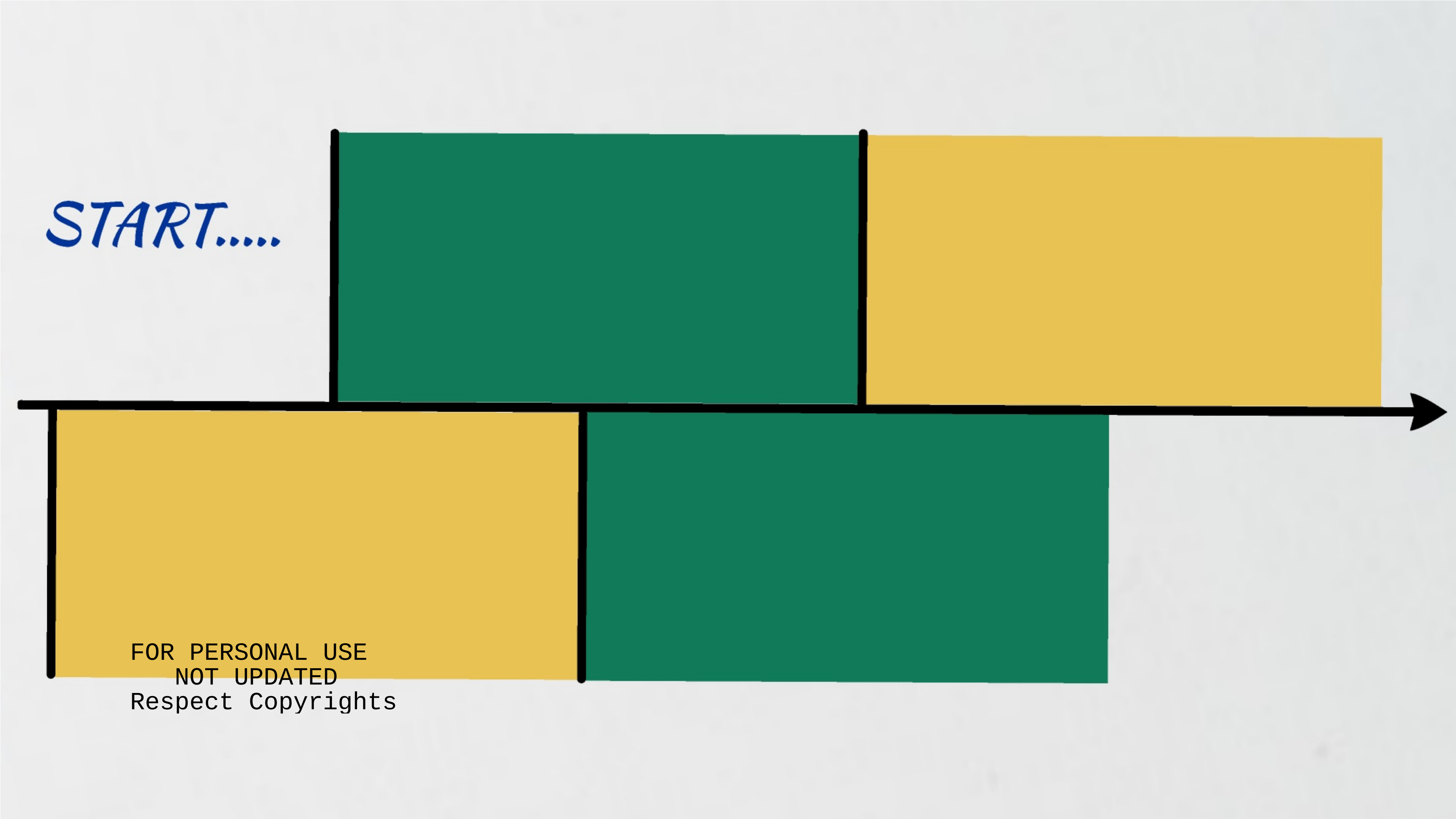



START.....

Fundamentals

HF in Aviation

Industry Interfaces

Practical Applications

....FINISH

1.2.4 Given the diversity of factors potentially affecting human performance, not surprisingly, human error has been recognized as a major factor in virtually all aviation accidents and incidents since the beginning of aviation. Understanding the context for human error then remains one of aviation's biggest challenges. If the reasons why humans err can be understood, better strategies can be developed for avoiding errors, controlling and recovering safely from them. The study of Human Factors is fundamental to understanding the context in which normal, healthy, qualified, well-equipped and motivated personnel commit human errors — some of which are fatal.

1.2.5 Traditionally, human errors in aviation have been tied to operational personnel, such as pilots, controllers, mechanics and dispatchers. Contemporary views on safety argue for a broadened perspective that focuses on safety deficiencies in the entire aviation system, which is fertile ground for so many life-threatening errors, rather than limiting analysis to individual performance. The safety system includes many facets beyond the cockpit such as company supervision and training, equipment manufacture and maintenance, infrastructure including airports and air traffic services, regulatory effectiveness, and the influence of professional associations and unions. Such factors are all well described in the *Human Factors Training Manual* (Doc 9683).

2.2.1 The human is the most flexible, adaptable and valuable element of the aviation system, but it is also the most vulnerable to influences that can adversely affect its performance.

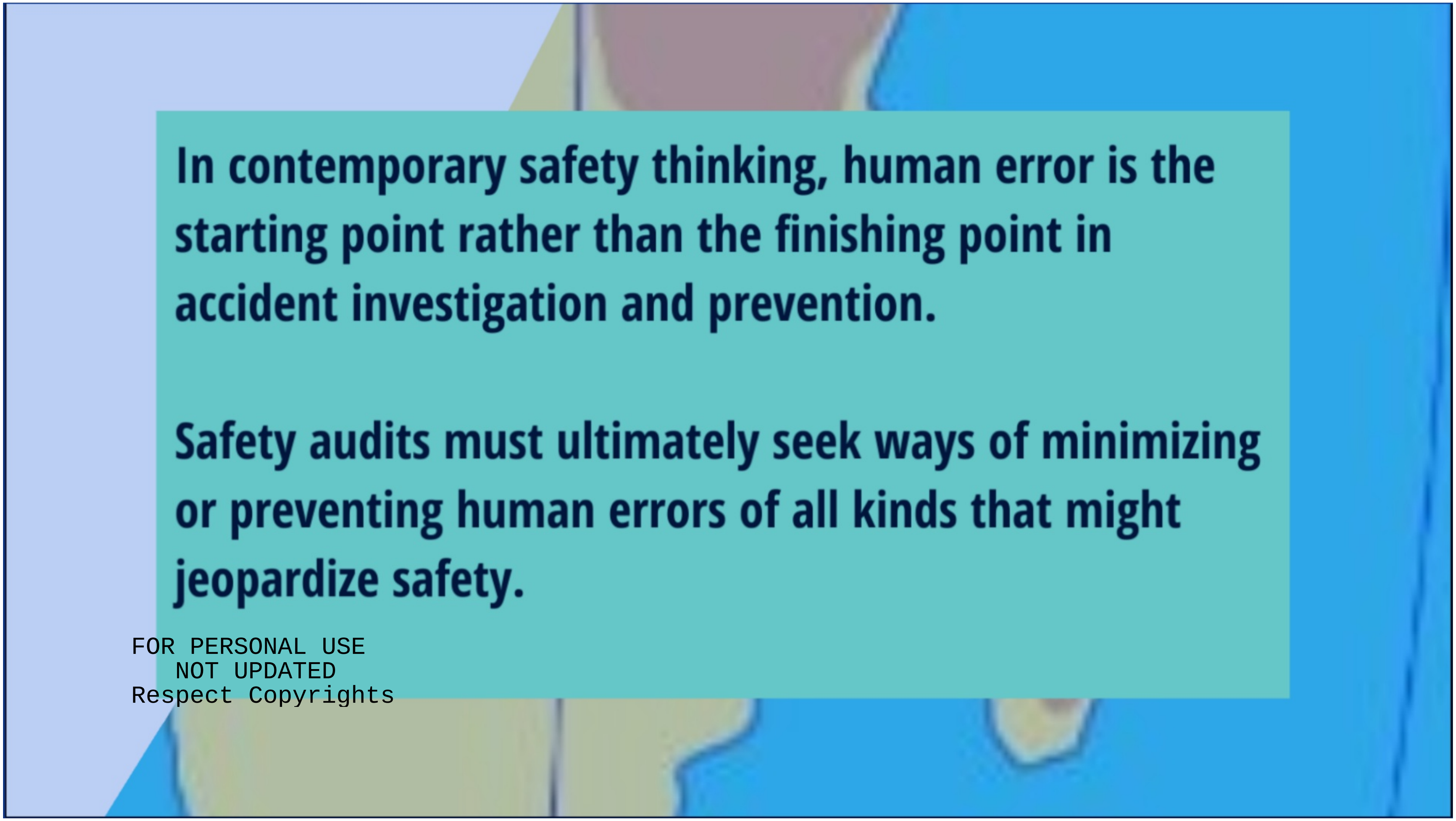
With the majority of accidents resulting from less than optimum human performance, there has been a tendency to attribute them merely to “human error”.

However, the term human error is of little help in accident prevention.

While it may indicate WHERE a breakdown in the system occurred, it provides no guidance as to WHY it occurred.

An error attributed to humans in the system may have been design-induced or facilitated by inadequate training, faulty procedures, or a poor concept or layout of checklists or manuals.

Furthermore, the term "human error" conceals the underlying factors that need to be brought to the fore if accidents are to be prevented.


In contemporary safety thinking, human error is the starting point rather than the finishing point in accident investigation and prevention.
Safety audits must ultimately seek ways of minimizing or preventing human errors of all kinds that might jeopardize safety.

Human Factors in Aviation

Human Factors is a science in its own right. (In the modern age is usually also associated with Non Technical Skills – HF/NTS.) It has evolved from the early Cockpit Resource Management (CRM) in the 1980s, to Crew Resource Management in the 1990s – also CRM but now with a recognition that is was more than just pilots involved with the safe operation of an aircraft – to today's requirement to integrate HF/NTS into SMS.

Personnel in aviation are highly trained in Technical skills – flying or maintaining aircraft – but it is the cognitive ability of successful HF/NTS that allows them to be highly proficient in the employment of these skills.

HF/NTS includes understanding and awareness of;

Communication
Leadership (and 'followship')
Teamwork
Stress
Fatigue
Alcohol and Other Drugs
Situational Awareness
Decision making
Airmanship
Threat and Error Management
...(others – this is not an exhaustive list)

The civil aviation community has fully embraced the need for change and have made significant contributions in the form of anecdotal experiences to provide context to the complex human behaviours described in various documents.

Human Factors knowledge and application comprises of many disciplines covering the full range of individual and team human characteristics that manifest themselves within aircraft operational roles.


Questions?
Thank You....capt gabe

Next - The HF Models

Next - The HF Models

The gap between the disciplines of human factors and systems engineering with new technology is widening because of rapid and steady technological development and progress.

We need to work together to close this gap in order to form a team from human and technology, where working methods are better coordinated and interconnected.

For this, it is necessary to deal with the technical development as well as with models of cognition."

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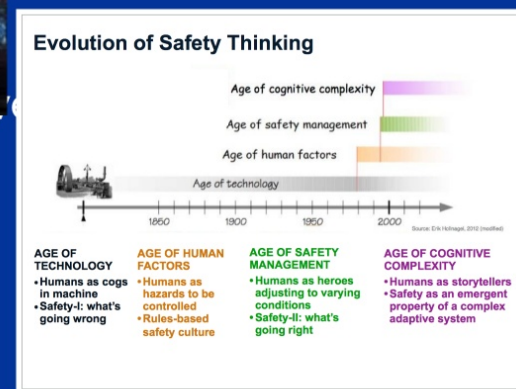

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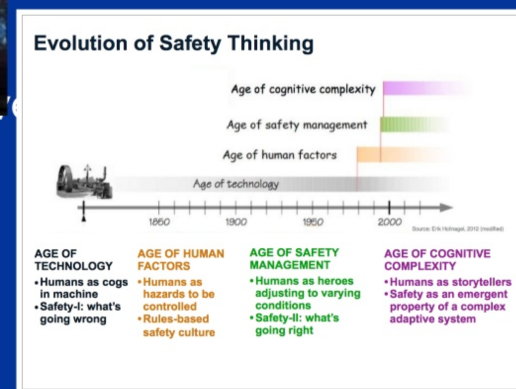

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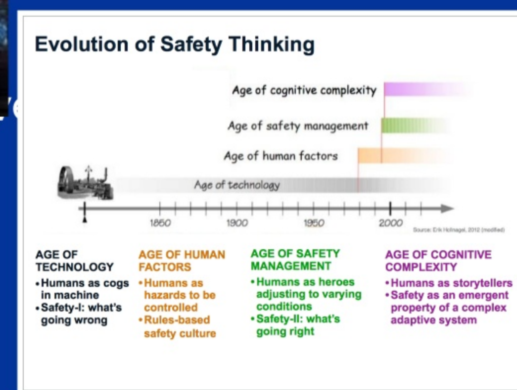


Next - The
HF Models
Factors influencing
Employee Performance
Mission, Vision and Values
Reward System
Leadership & Supervision
CRM
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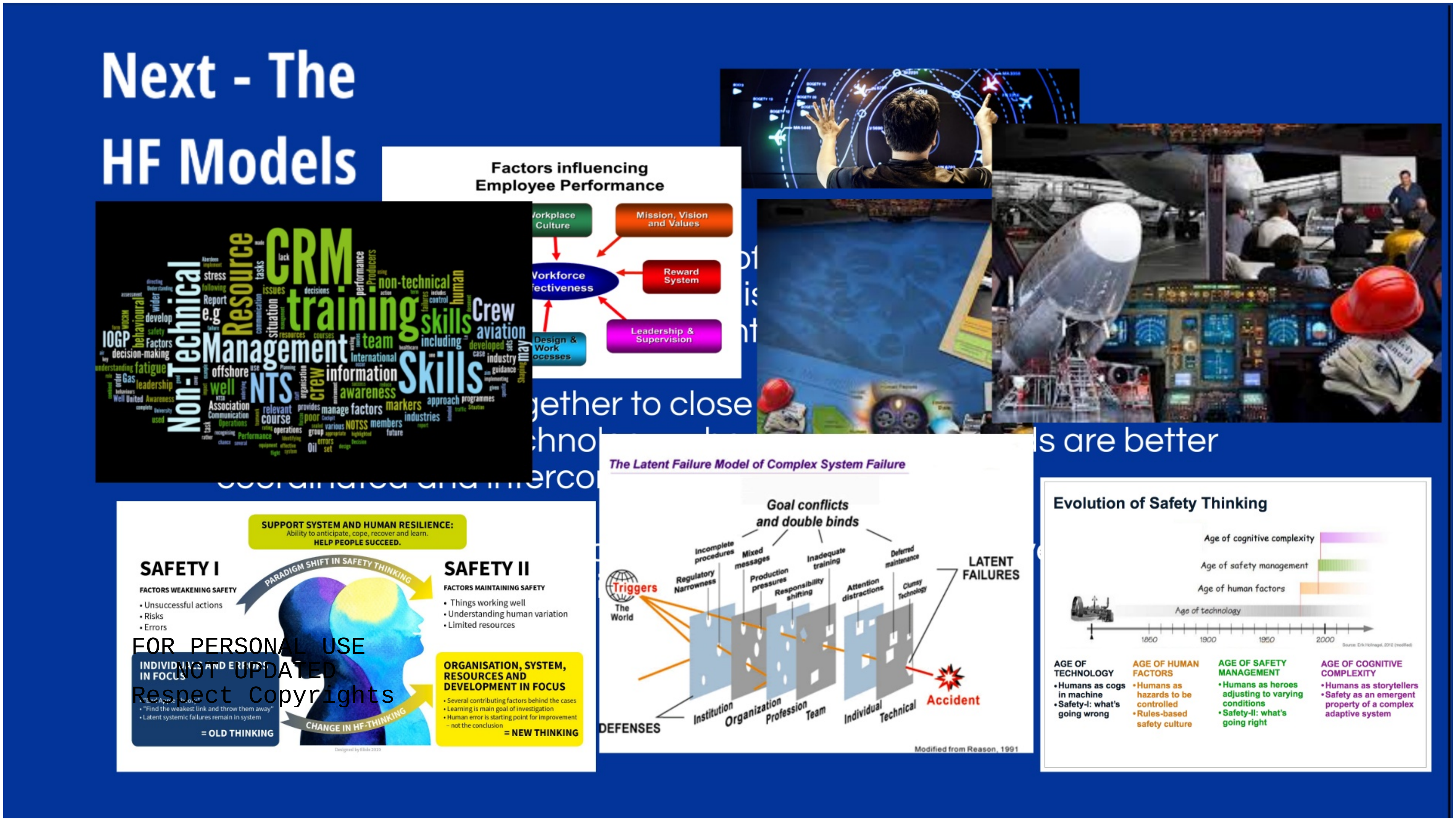
SUPPORT SYSTEM AND HUMAN RESILIENCE:
Ability to anticipate, cope, recover and learn.
HELP PEOPLE SUCCEED.
SAFETY I
FACTORS WEAKENING SAFETY
• Unsuccessful actions
• Risks
• Errors
PARADIGM SHIFT IN SAFETY THINKING
SAFETY II
FACTORS MAINTAINING SAFETY
• Things working well
• Understanding human variation
• Limited resources
ORGANISATION, SYSTEM, RESOURCES AND DEVELOPMENT IN FOCUS
• Several contributing factors behind the cases
• Learning is main goal of investigation
• Human error is starting point for improvement – not the conclusion
= NEW THINKING
• "Find the weakest link and throw them away"
• Latent systemic failures remain in system
= OLD THINKING
CHANGE IN HF-THINKING
Evolution of Safety Thinking
Age of cognitive complexity
Age of safety management
Age of human factors
Age of technology
1850
1900
1950
2000
AGE OF TECHNOLOGY
• Humans as cogs in machine
• Safety-I: what's going wrong
AGE OF HUMAN FACTORS
• Humans as hazards to be controlled
• Rules-based safety culture
AGE OF SAFETY MANAGEMENT
• Humans as heroes adjusting to varying conditions
• Safety-II: what's going right
AGE OF COGNITIVE COMPLEXITY
• Humans as storytellers
• Safety as an emergent property of a complex adaptive system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The Latent Failure Model of Complex System Failure
Goal conflicts and double binds
Incomplete procedures
Mixed messages
Inadequate training
Deferred maintenance
Regulatory Narrowness
Production pressures
Responsibility shifting
Attention distractions
Clumsy Technology
LATENT FAILURES
Triggers
The World
DEFENSES
Institution
Organization
Profession
Team
Individual
Technical
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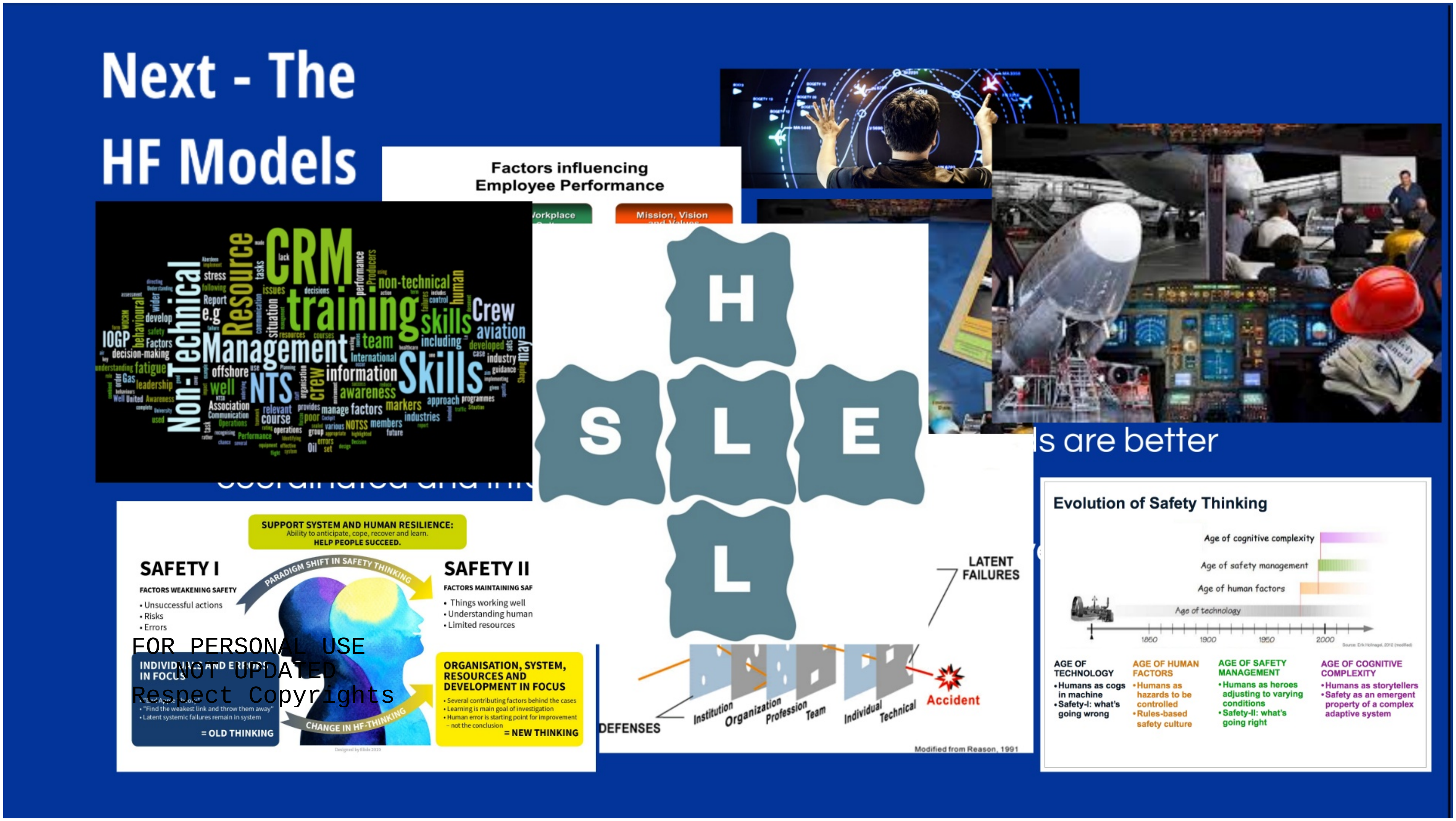
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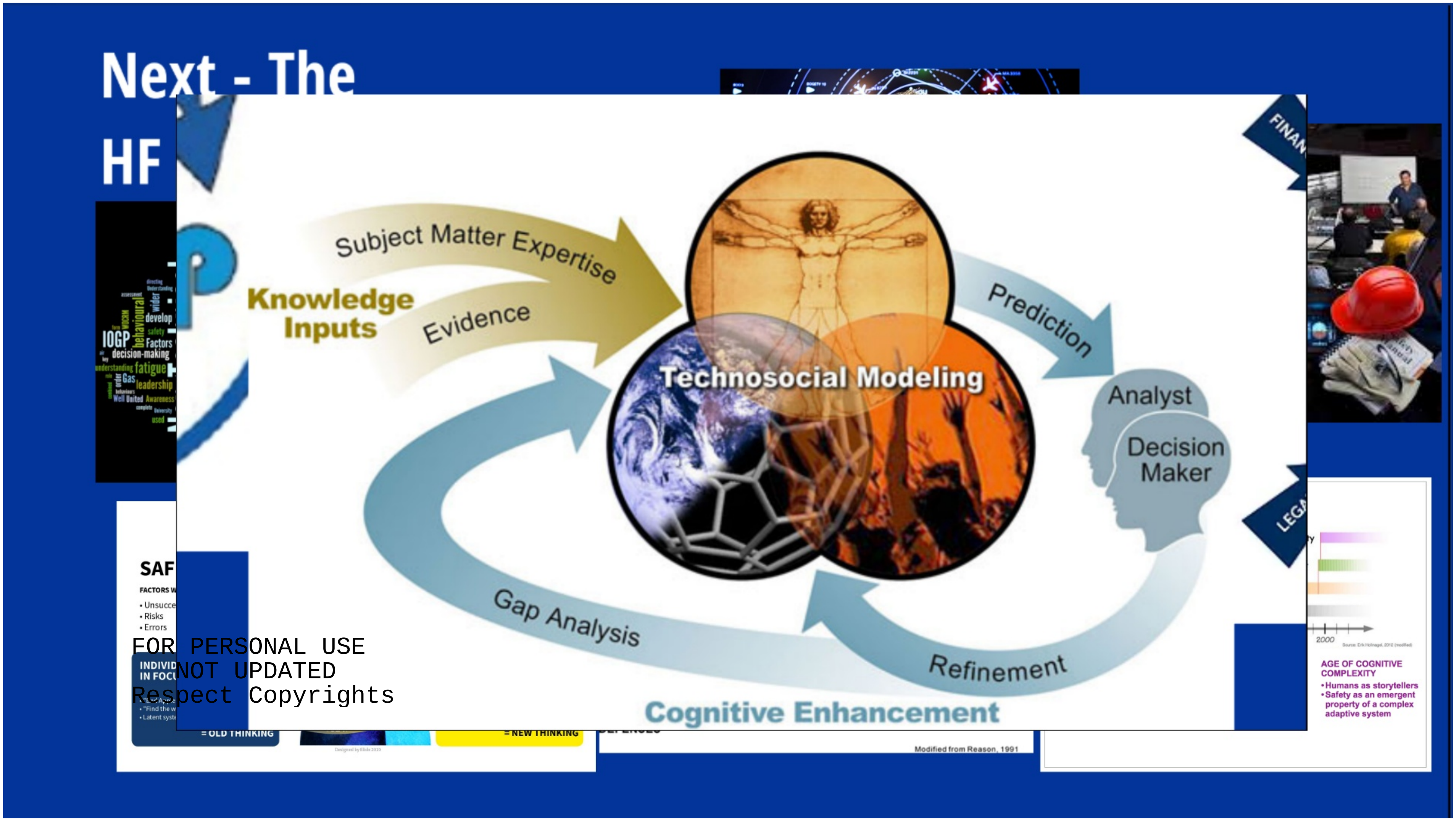
Next - The
HF
Subject Matter Expertise
Knowledge Inputs
Evidence
Technosocial Modeling
Prediction
Analyst
Decision Maker
Gap Analysis
Refinement
Cognitive Enhancement
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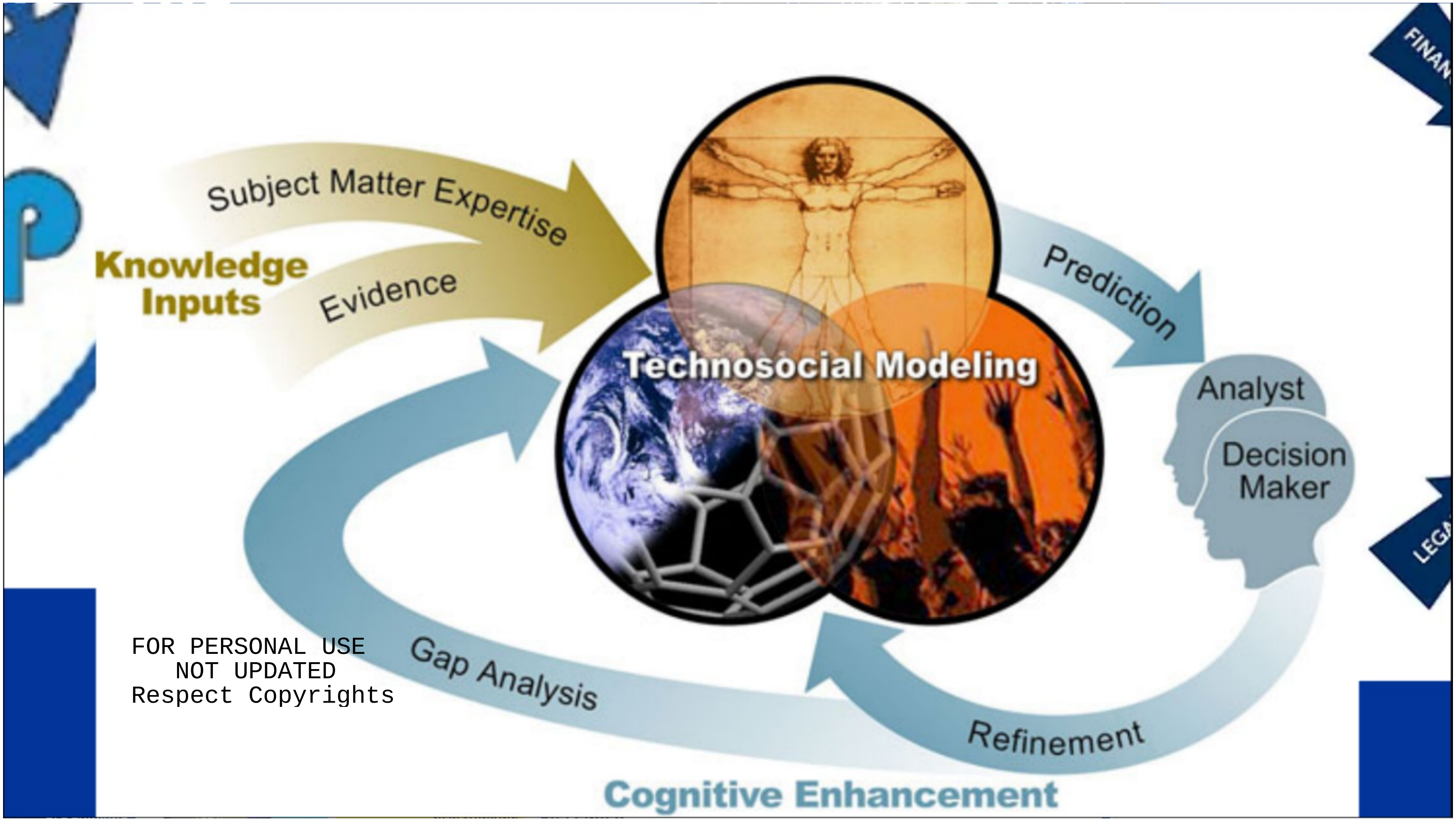
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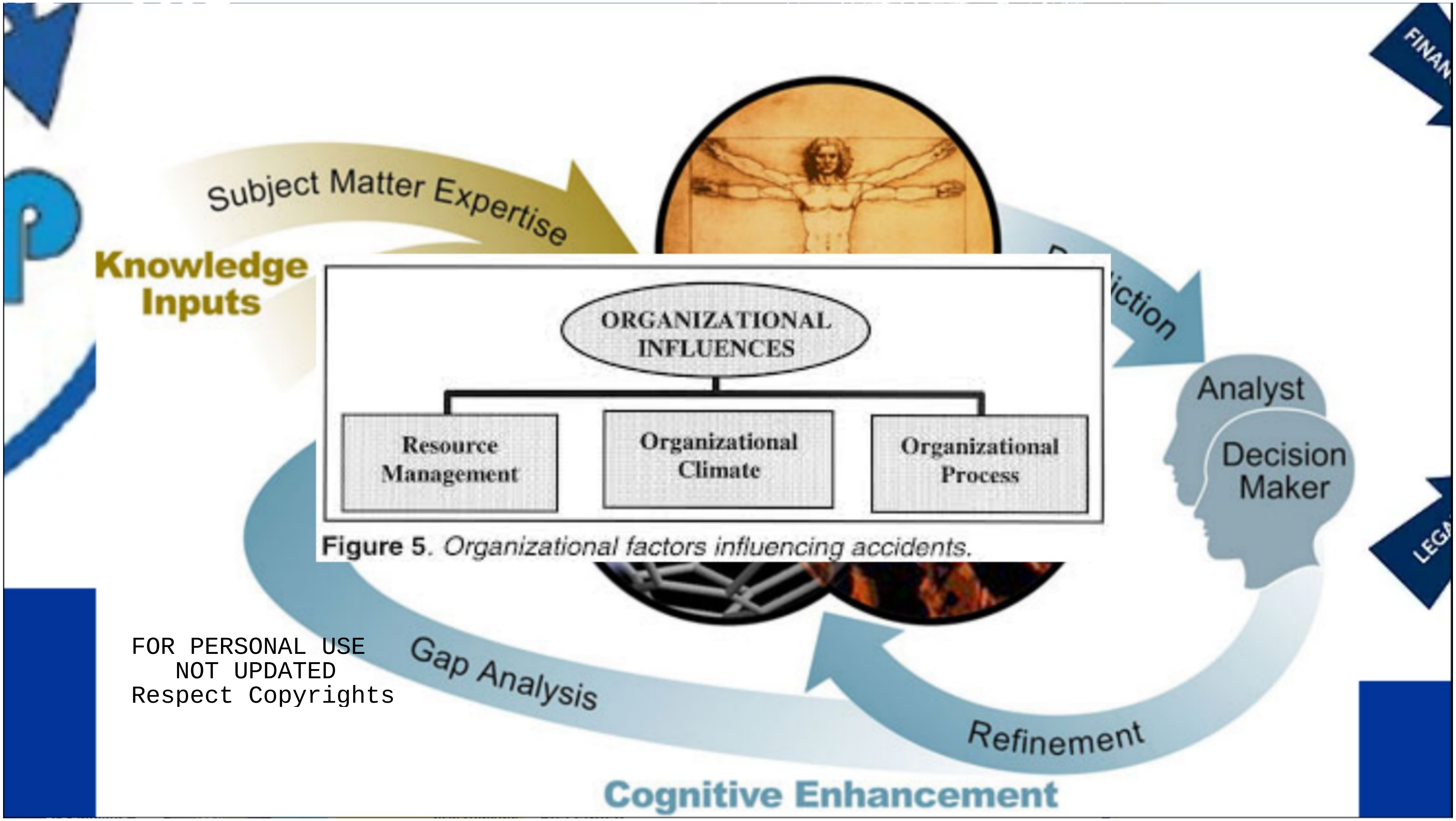
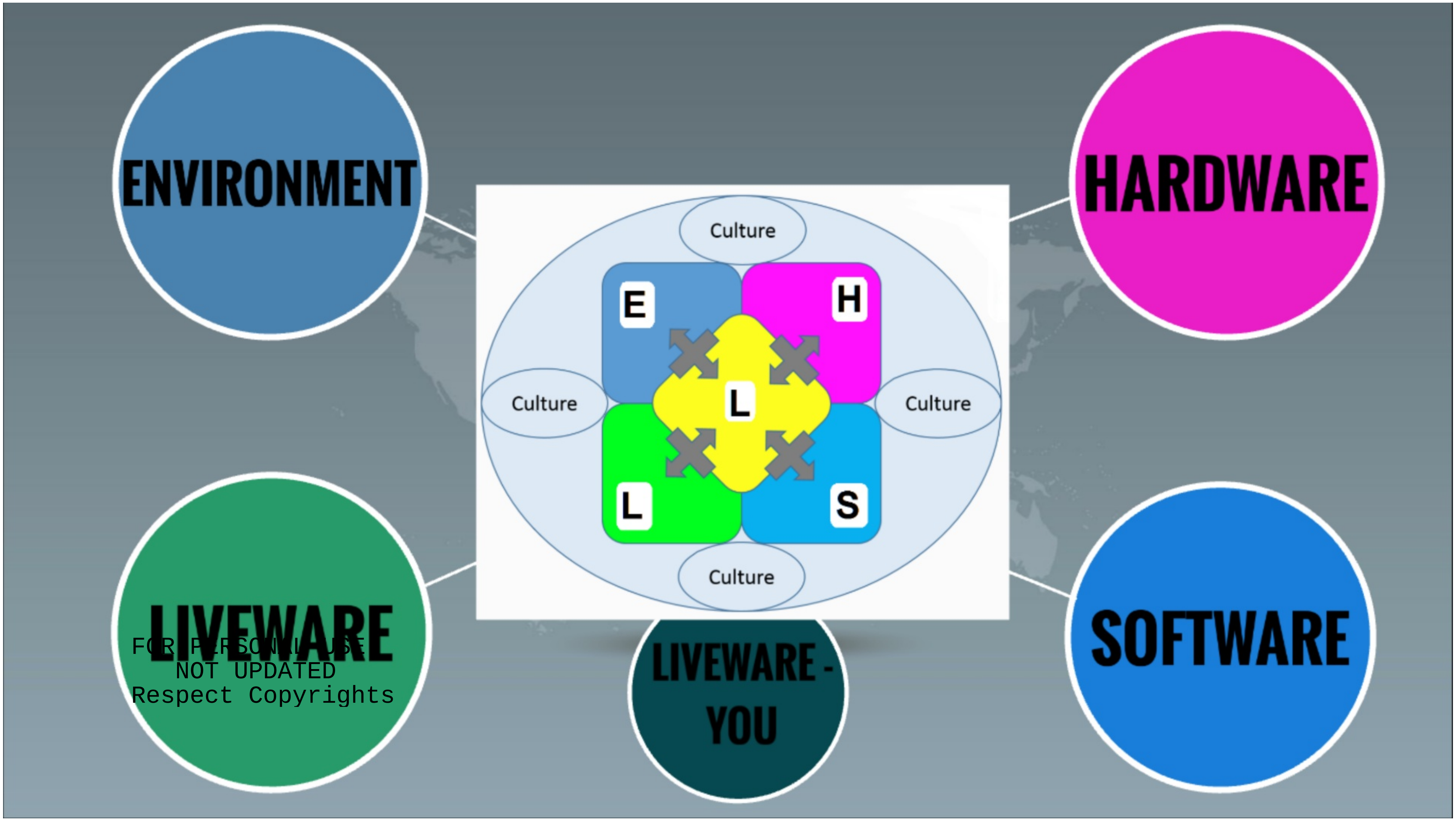


Figure 5. *Organizational factors influencing accidents.*

S-H-E-L-L

The The SHELL Model is defined as “the relationship of human factors and the aviation environment”.

This concept has originated from the 'SHELL Model' by Edwards in 1972, which the name was derived from the initials of its components (Software, Hardware, Environment, and Liveware X 2.



ENVIRONMENT
HARDWARE
Culture
Culture
Culture
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LIVEWARE
LIVEWARE -
YOU
SOFTWARE


ENVIRONMENT
HARDWARE
LIVEWARE
LIVEWARE - YOU
SOFTWARE


ENVIRONMENT
HARDWARE
S-H-E-L-L
A conceptual Model of Human Factors
4.1 It is helpful to use a model to aid in the understanding of Human Factors, as this allows a gradual approach to comprehension. One practical diagram to illustrate this conceptual model uses blocks to represent the different components of Human Factors.
The model can then be built up one block at a time, with a pictorial impression being given of the need for matching the components. The SHEL concept (the name being derived from the initial letters of its components, Software, Hardware, Environment, Liveware) was first developed by Edwards in 1972, with a modified diagram to illustrate the model developed by Hawkins in 1975.
LIVEWARE
LIVEWARE - YOU
SOFTWARE

S-H-E-L-L

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SOFTWARE

- Non-physical, intangible aspects of the aviation system that govern how the aviation system operates and how information within the system is organised (Hawkins & Orlady, 1993 4).

- Software may be likened to the software that controls the operations of computer hardware (Johnston, McDonald & Fuller, 2001 6).

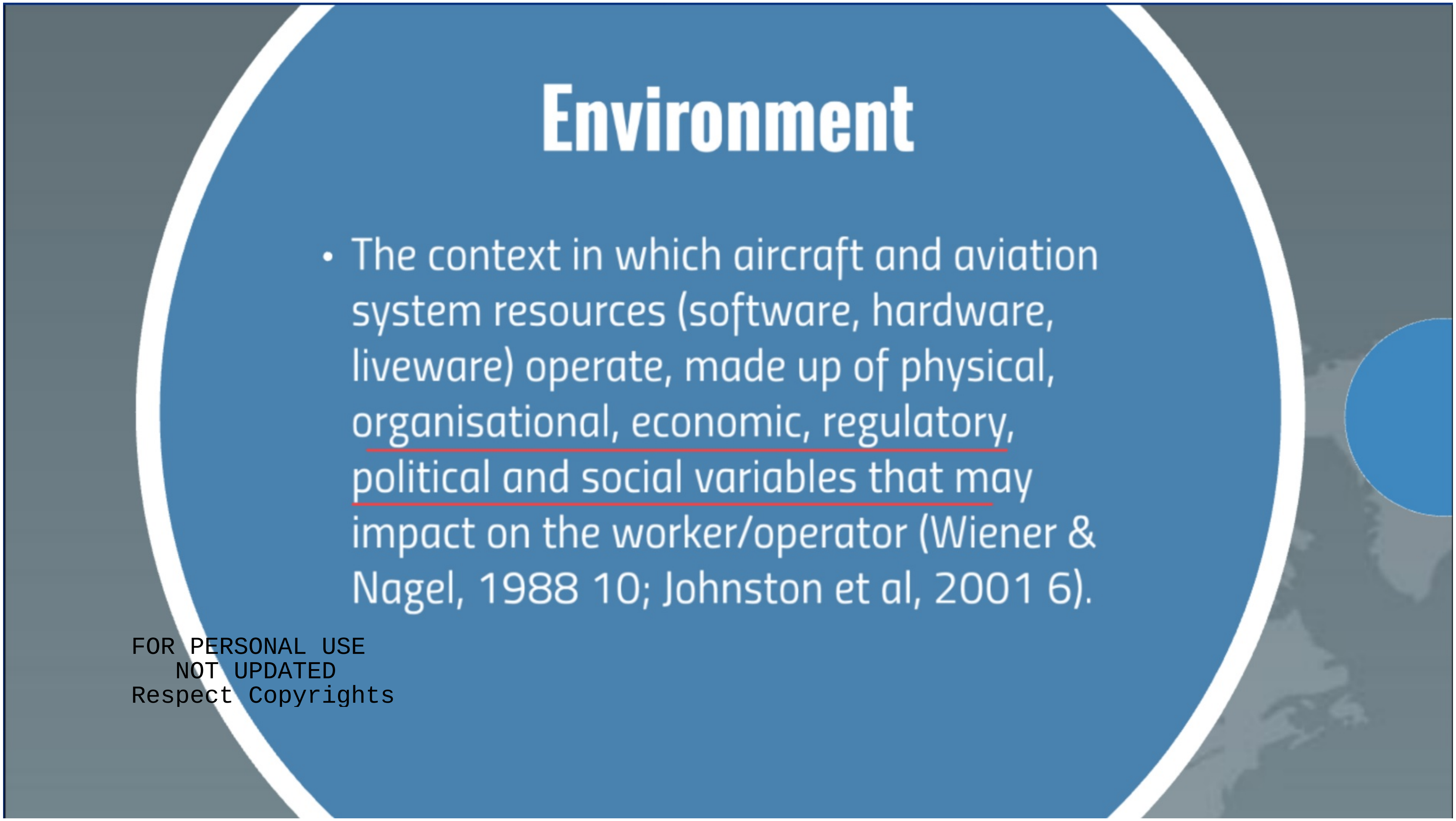
- Software includes rules, instructions, regulations, policies, norms, laws, orders, safety procedures, standard operating procedures, customs, practices, conventions, habits, symbology, supervisor commands and computer programmes.

- Software can be included in a collection of documents such as the contents of charts, maps, publications, emergency operating manuals and procedural checklists (Wiener & Nagel, 1988 10).

The Nuts and Bolts

Hardware

Physical elements of the aviation system such as aircraft (including controls, surfaces, displays, functional systems and seating), operator equipment, tools, materials, buildings, vehicles, computers, conveyor belts etc (Johnston et al, 2001 6; Wiener & Nagel, 1988 10; Campbell & Bagshaw, 2002 2). does it all come together?


Environment
• The context in which aircraft and aviation system resources (software, hardware, liveware) operate, made up of physical, organisational, economic, regulatory, political and social variables that may impact on the worker/operator (Wiener & Nagel, 1988 10; Johnston et al, 2001 6).

- Internal air transport environment relates to immediate work area and includes physical factors such as cabin/cockpit temperature, air pressure, humidity, noise, vibration and ambient light levels.

- External air transport environment includes the physical environment outside the immediate work area such as weather (visibility/turbulence), terrain, congested airspace and physical facilities and infrastructure including airports as well as broad organisational, economic, regulatory, political and social factors (International Civil Aviation Organisation, 1993 5).

Liveware

- Human element or people in the aviation system. For example, flight crew personnel who operate aircraft, cabin crew, ground crew, management and administration personnel.

- The liveware component considers human performance, capabilities and limitations (International Civil Aviation Organisation, 1993 5).

The four components of the SHELL model or aviation system do not act in isolation but instead interact with the central human component to provide areas for human factors analysis and consideration (Wiegmann & Shappell, 2003 9).

The SHELL model indicates relationships between people and other system components and therefore provides a framework for optimising the relationship between people and their activities within the aviation system that is of primary concern to human factors.

In fact, the International Civil Aviation Organisation has described human factors as a concept of people in their living and working situations; their interactions with machines (hardware), procedures (software) and the environment about them; and also their relationships with other people (Keightley, 2004 7).

According to the SHELL model, a mismatch at the interface of the blocks/ components where energy and information is interchanged can be a source of human error or system vulnerability that can lead to system failure in the form of an incident/accident (Johnston et al, 2001 6).

Aviation disasters tend to be characterised by mismatches at interfaces between system components, rather than catastrophic failures of individual components (Wiener & Nagel, 1988 10).

Must be

Lunch Time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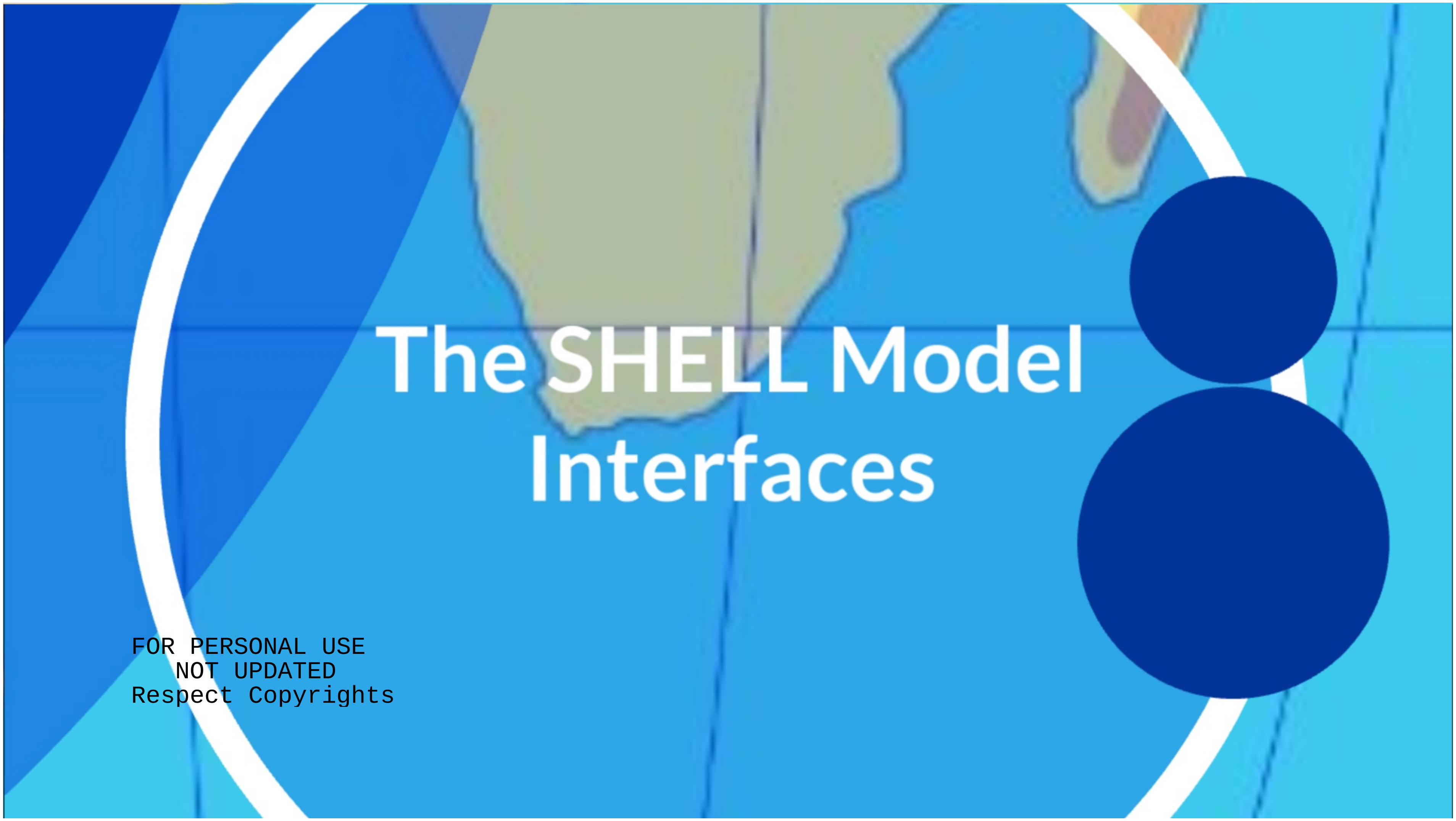

The SHELL Model
Interfaces

Liveware-Hardware.

This interface is the one most commonly considered when speaking of human-machine systems: design of seats to fit the sitting characteristics of the human body, of displays to match the sensory and information processing characteristics of the user, of controls with proper movement, coding and location.

Liveware-Hardware - cont'd

The user may never be aware of an L-H deficiency, even where it finally leads to disaster, because the natural human characteristic of adapting to L-H mismatches will mask such a deficiency, but will not remove its existence. This constitutes a potential hazard to which designers should be alert.

Liveware-Software.

This encompasses humans and the non-physical aspects of the system such as procedures, manual and checklist layout, symbology and computer programmes.

The problems are often less tangible in this interface and are consequently more difficult to resolve (for example, misinterpretation of checklists or symbology).

Liveware-Environment.

The human-environment interface was one of the earliest recognized in flying. Initially, the measures taken all aimed at adapting the human to the environment (helmets, flying suits, oxygen masks, anti-G suits). Later, the trend was to reverse this process by adapting the environment to match human requirements (pressurization and air-conditioning systems, soundproofing).

Liveware-Environment - cont'd.

Since illusions and disorientation are at the root of many aviation accidents the L-E interface must consider perceptual errors induced by environmental conditions, for example, illusions during approach and landing phases.

The aviation system operates within the context of broad political and economical constraints, and those aspects of the environment will interact in this interface.

Liveware-Environment - cont'd.

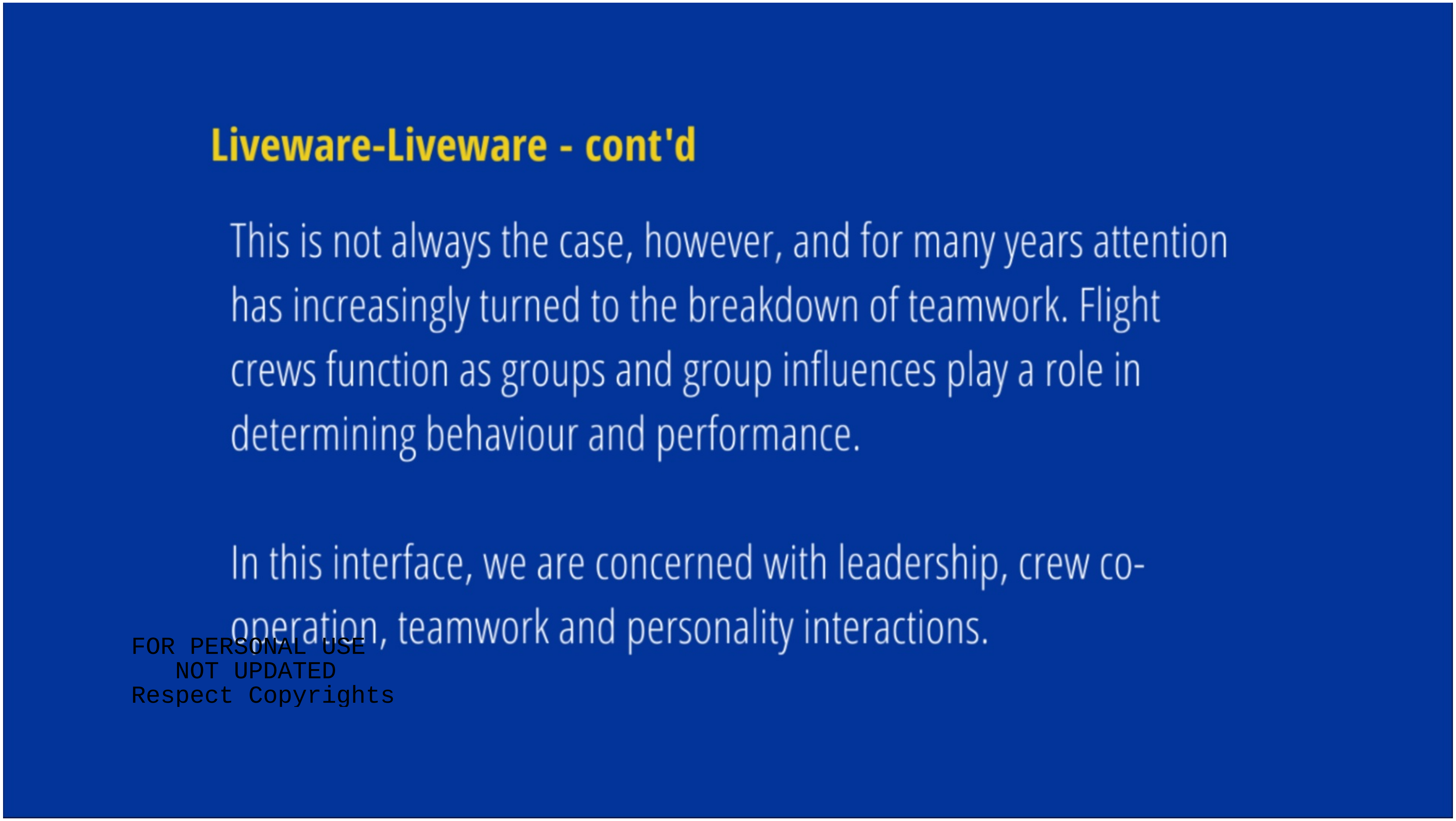
Although the possibility of modifying these influences is beyond Human Factors practitioners, their incidence is central and should be properly considered and addressed by those in management .

Today, there are new challenges, notably ozone concentrations and radiation hazards at high flight levels and the problems associated with disturbed biological rhythms and related sleep disturbance and deprivation as a consequence of large transmeridian travel.

Liveware-Liveware.

This is the interface between people. Aircrew training and proficiency testing have traditionally been done on an individual basis.

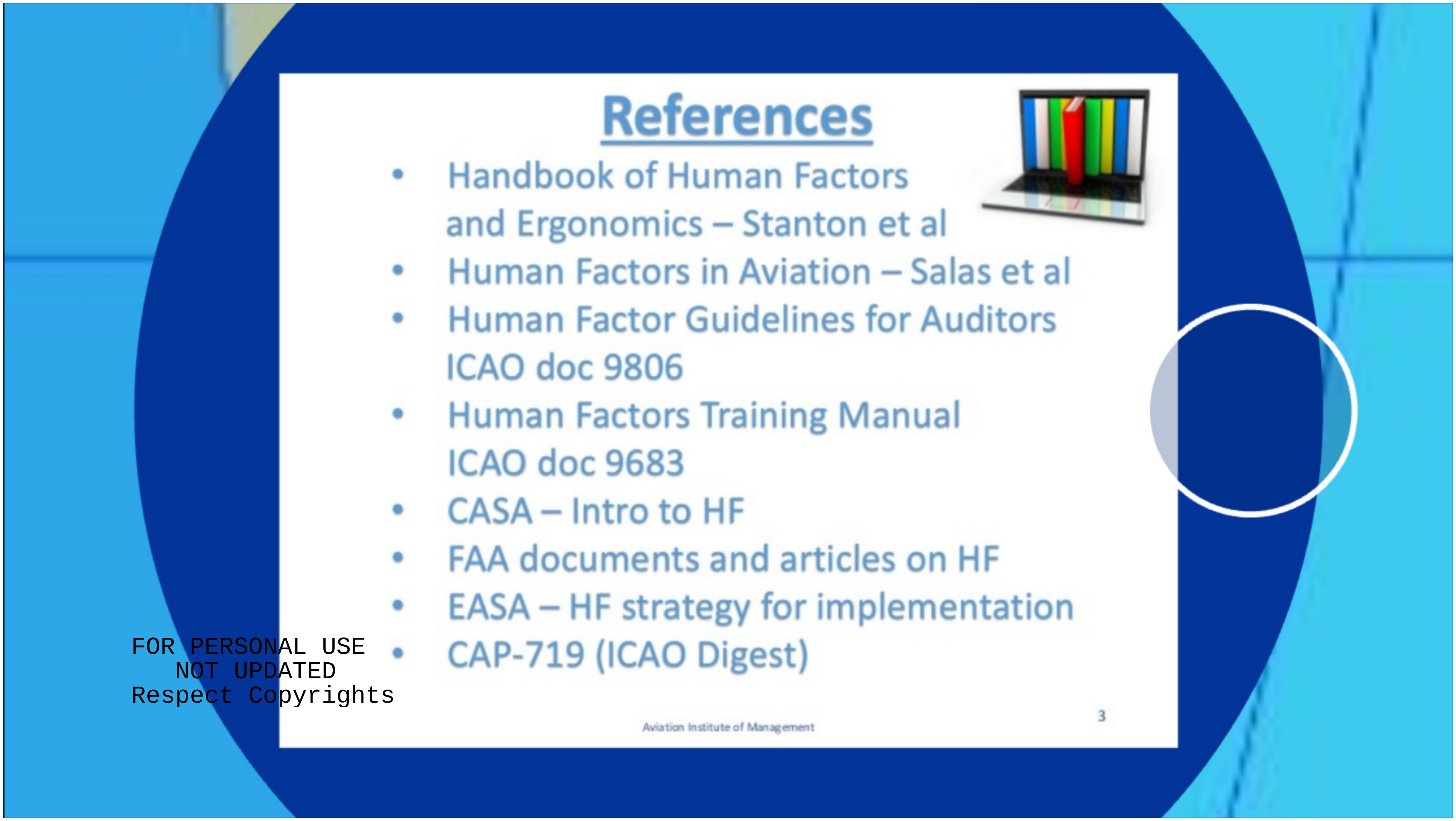
If each individual crew member was proficient, then it was assumed that the team consisting of these individuals would also be proficient and effective.


Liveware-Liveware - cont'd
This is not always the case, however, and for many years attention has increasingly turned to the breakdown of teamwork. Flight crews function as groups and group influences play a role in determining behaviour and performance.
In this interface, we are concerned with leadership, crew co-operation, teamwork and personality interactions.

Liveware-Liveware - cont'd

CAP 720 (previously Human Factors ICAO Digest No. 2) describes current industry approaches to deal with this interface, and concerns cockpit resource management (CRM) and line-oriented flight training (LOFT) programmes.

Staff/management relationships are also within the scope of this interface, as corporate climate and company operating pressures can significantly affect human performance. CAP 720 also demonstrates the important role of management in accident prevention.


References
Handbook of Human Factors and Ergonomics – Stanton et al
Human Factors in Aviation – Salas et al
Human Factor Guidelines for Auditors ICAO doc 9806
Human Factors Training Manual ICAO doc 9683
CASA – Intro to HF
FAA documents and articles on HF
EASA – HF strategy for implementation
CAP-719 (ICAO Digest)
Aviation Institute of Management
3

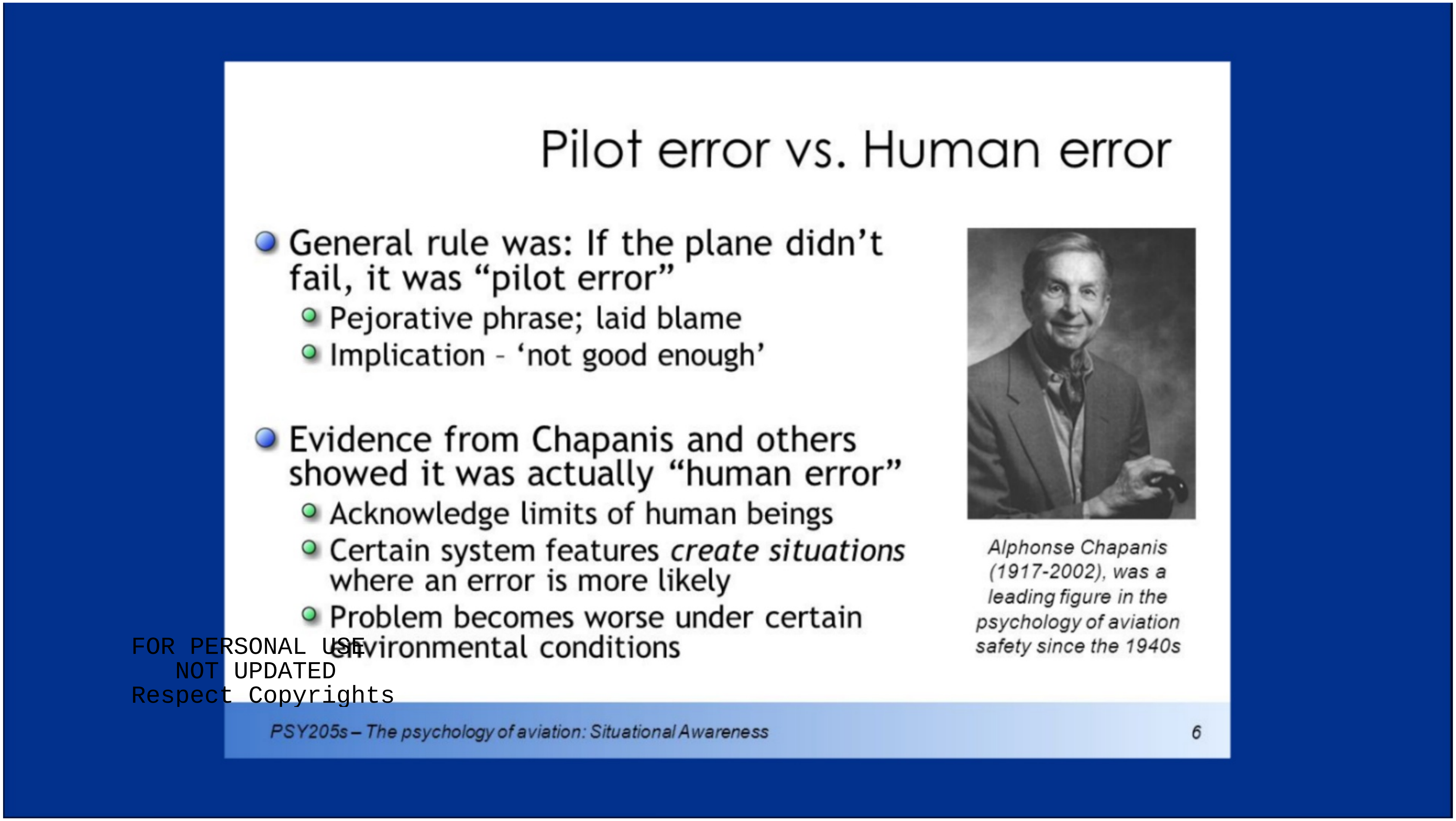
Interface Actions and Mismatch

Interface Actions and Mismatch

Interface Actions and Mismatch

Interface Actions and Mismatch

Interface Actions and Mismatch


Pilot error vs. Human error
General rule was: If the plane didn't fail, it was "pilot error"
Pejorative phrase; laid blame
Implication – 'not good enough'
Evidence from Chapanis and others showed it was actually "human error"
Acknowledge limits of human beings
Certain system features *create situations* where an error is more likely
Problem becomes worse under certain environmental conditions
Alphonse Chapanis (1917-2002), was a leading figure in the psychology of aviation safety since the 1940s
PSY205s – The psychology of aviation: Situational Awareness
6

You are in the center of your universe

You are in the center of your universe

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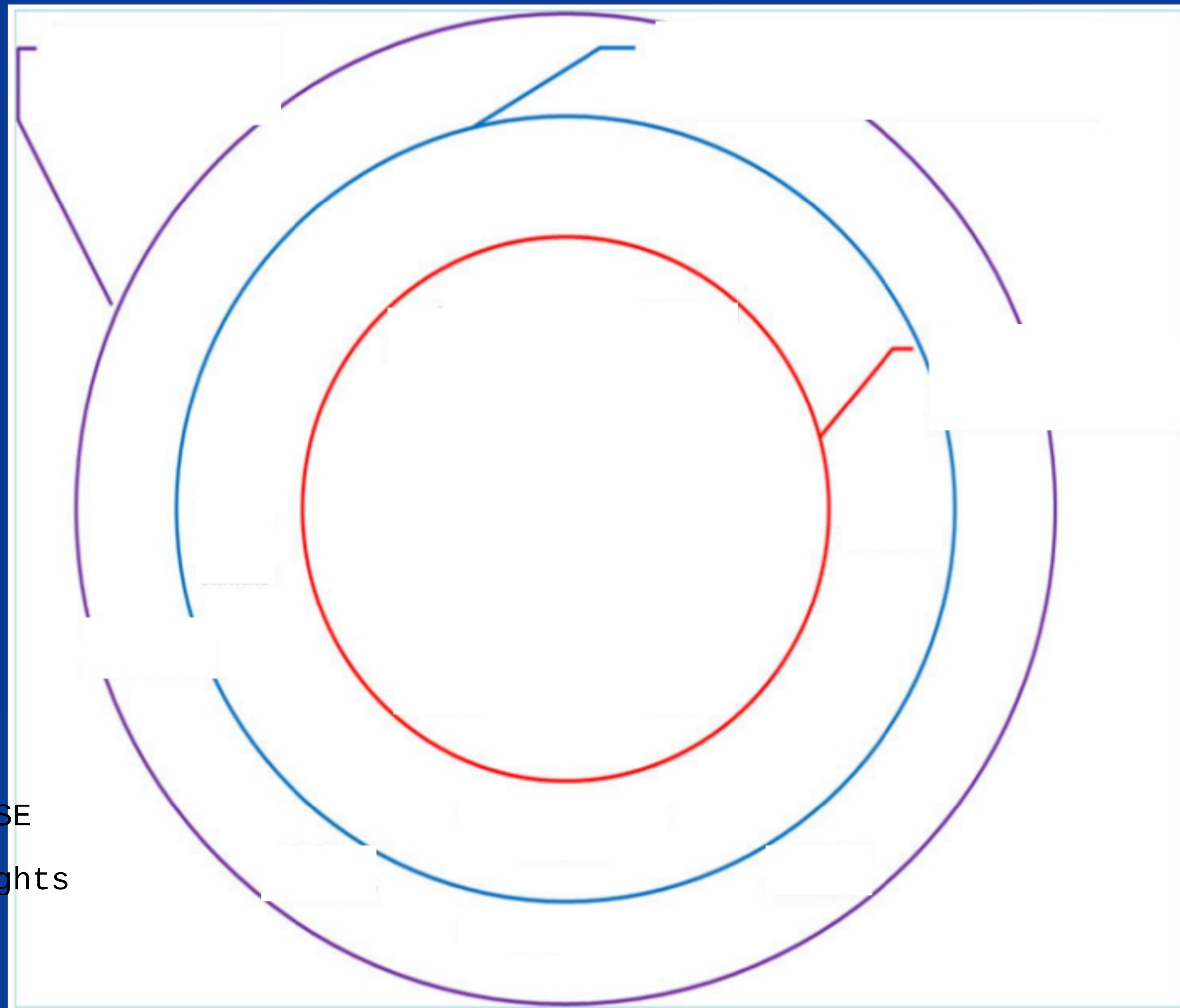

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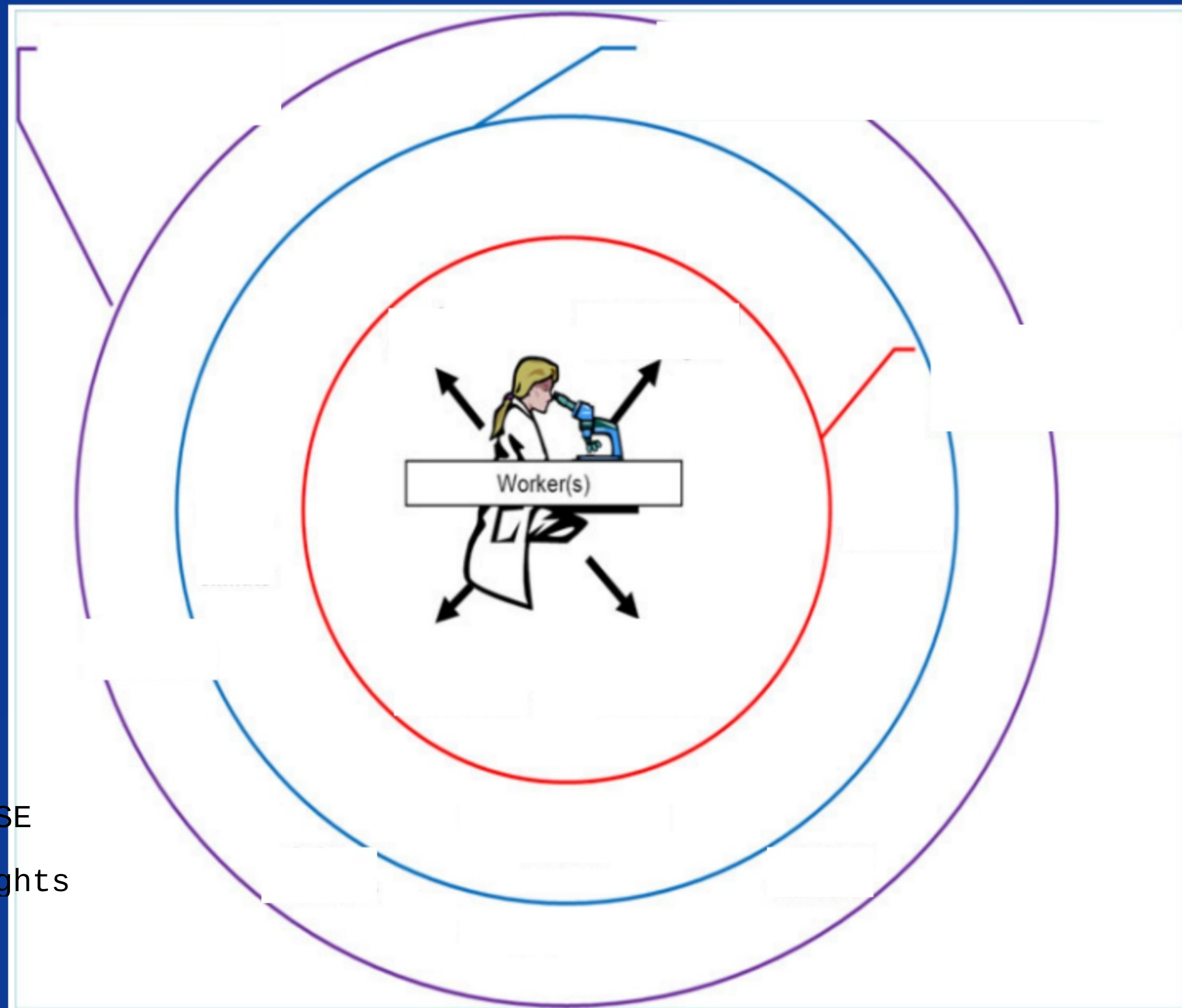

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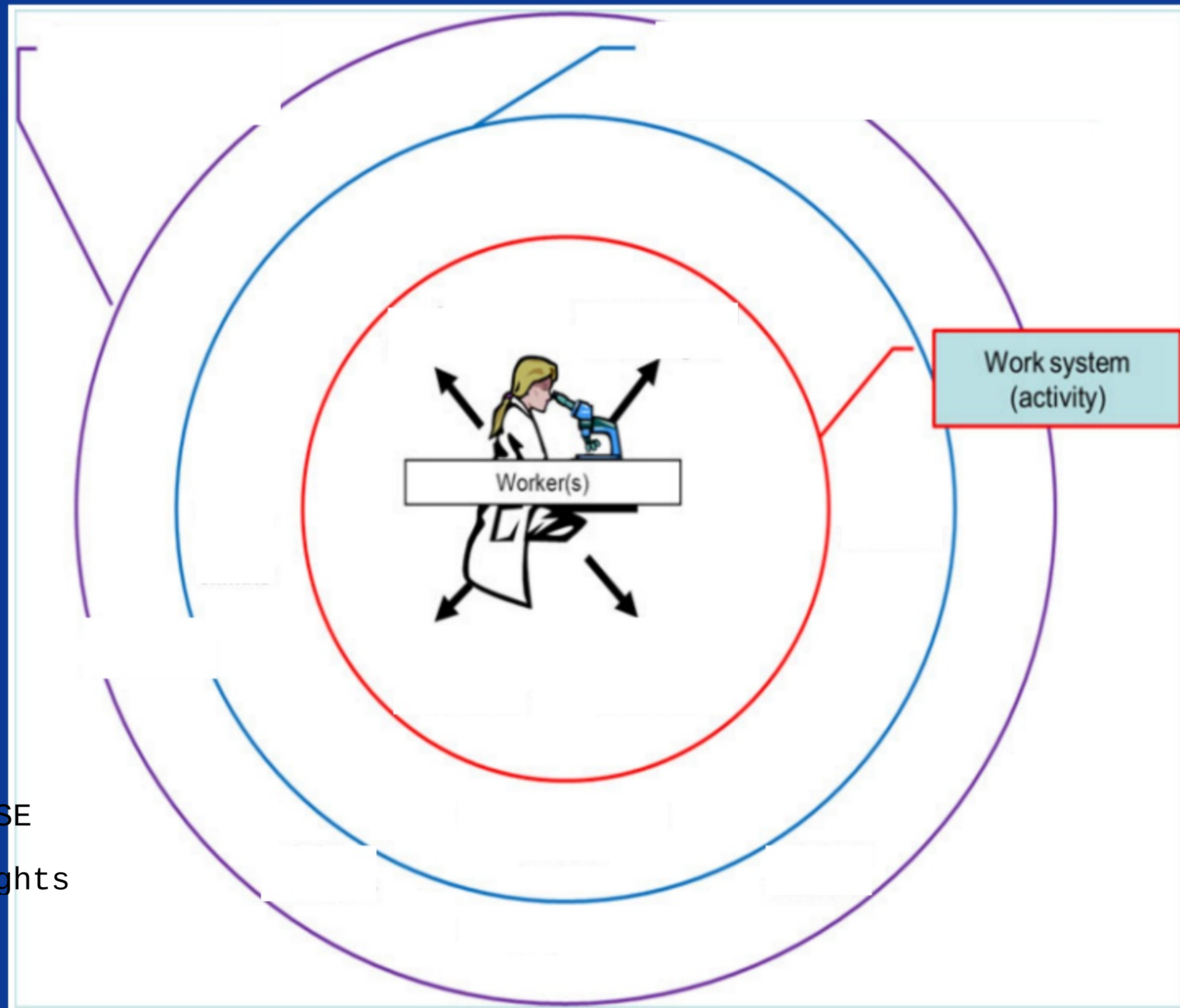

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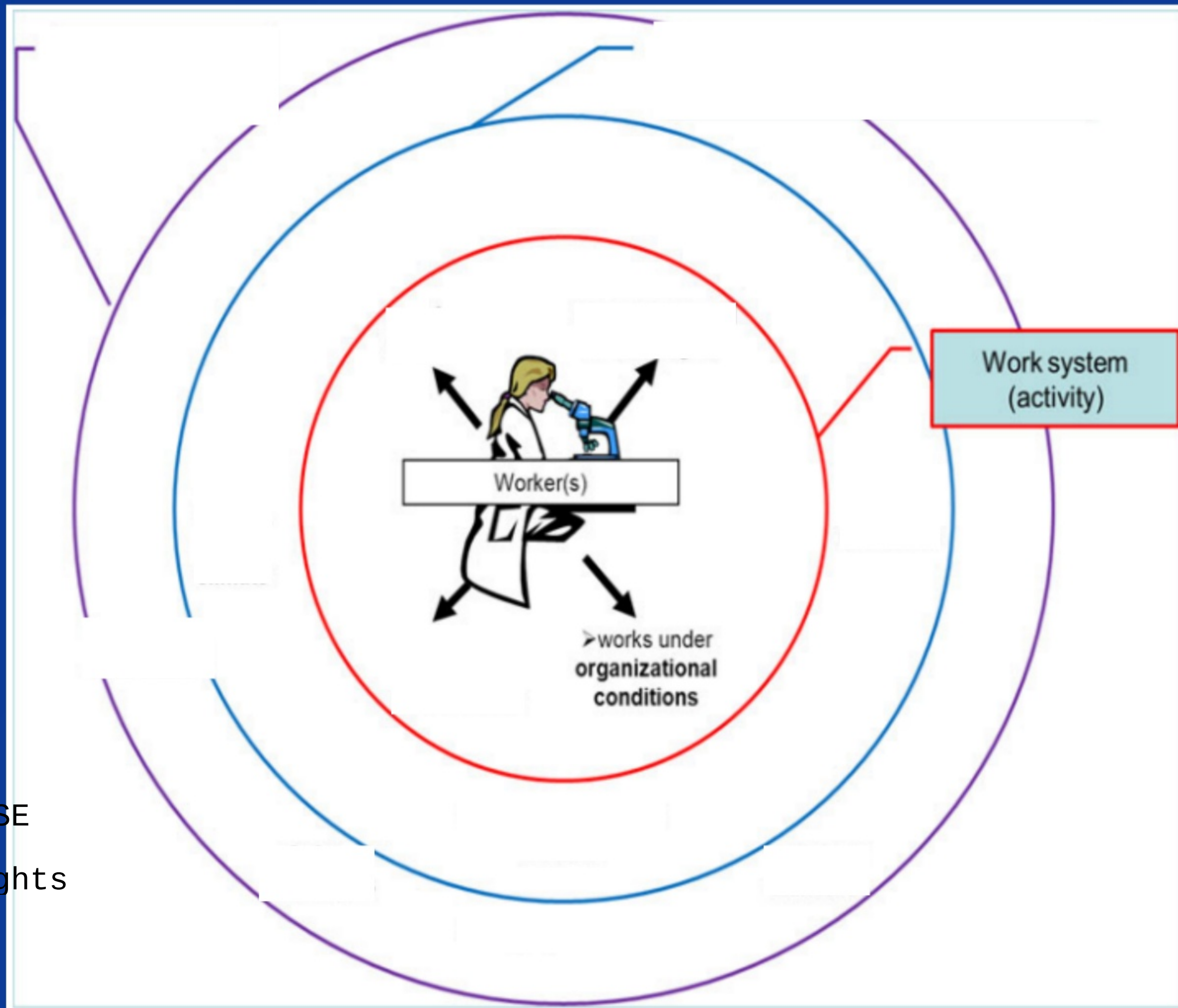

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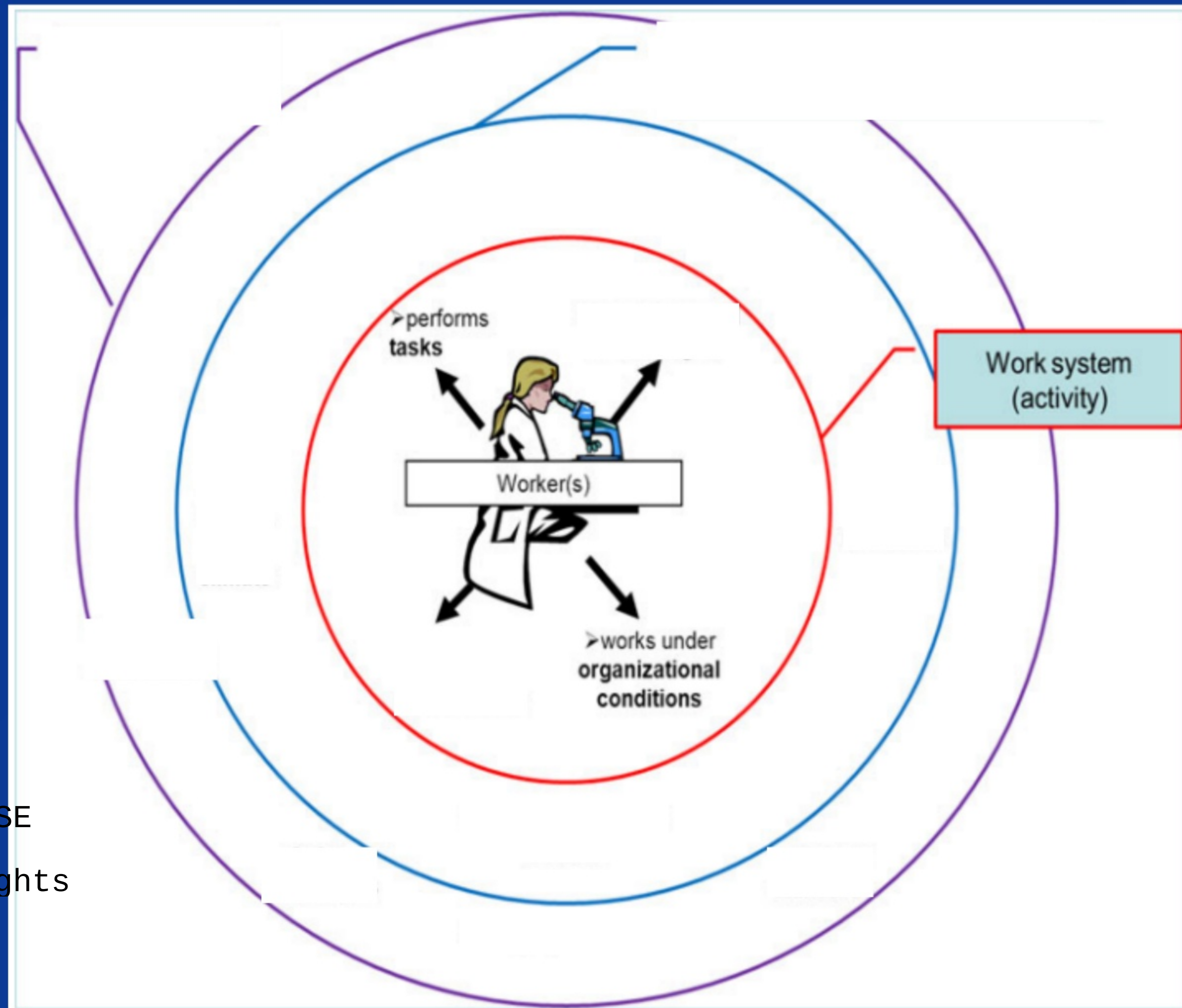

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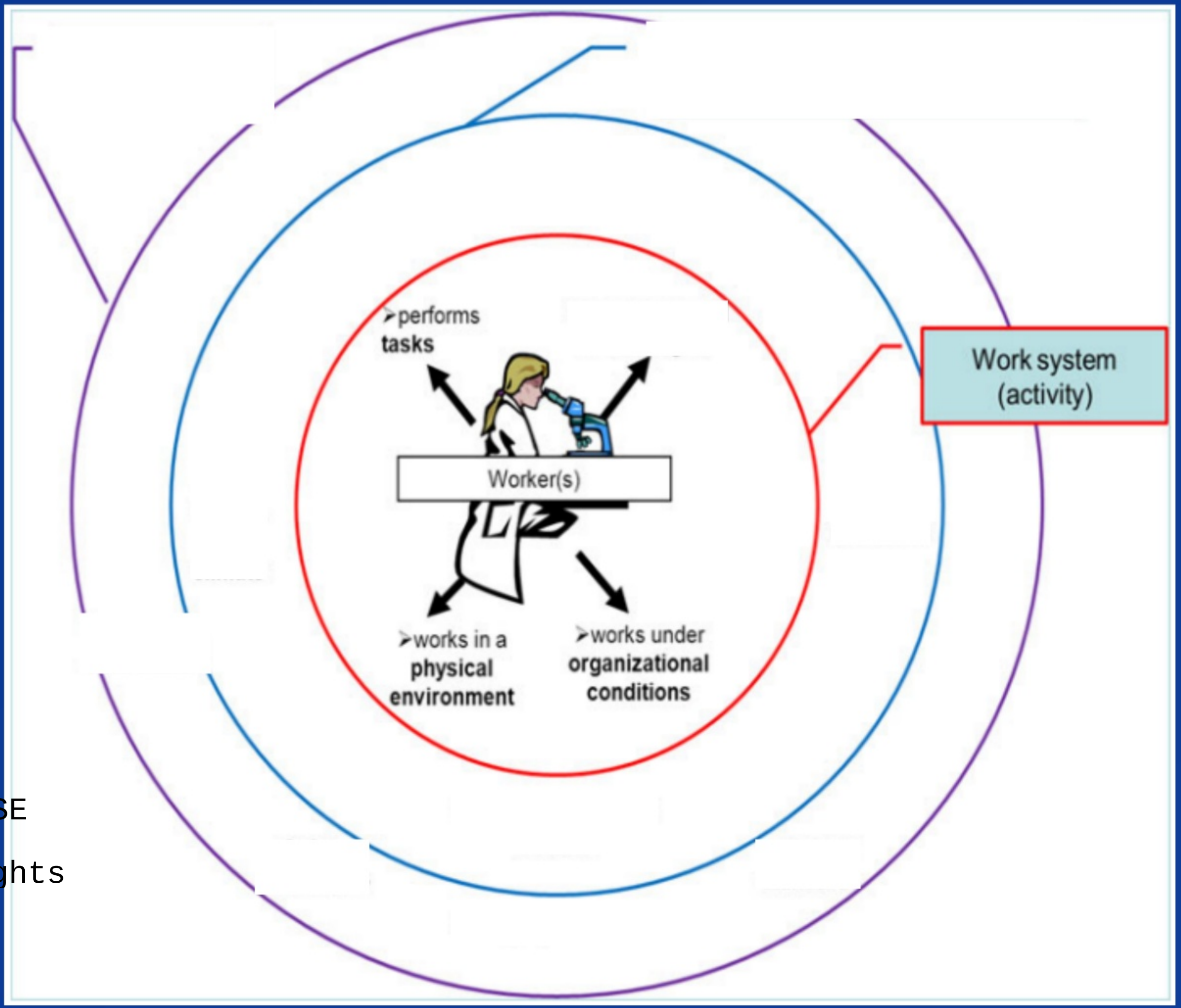

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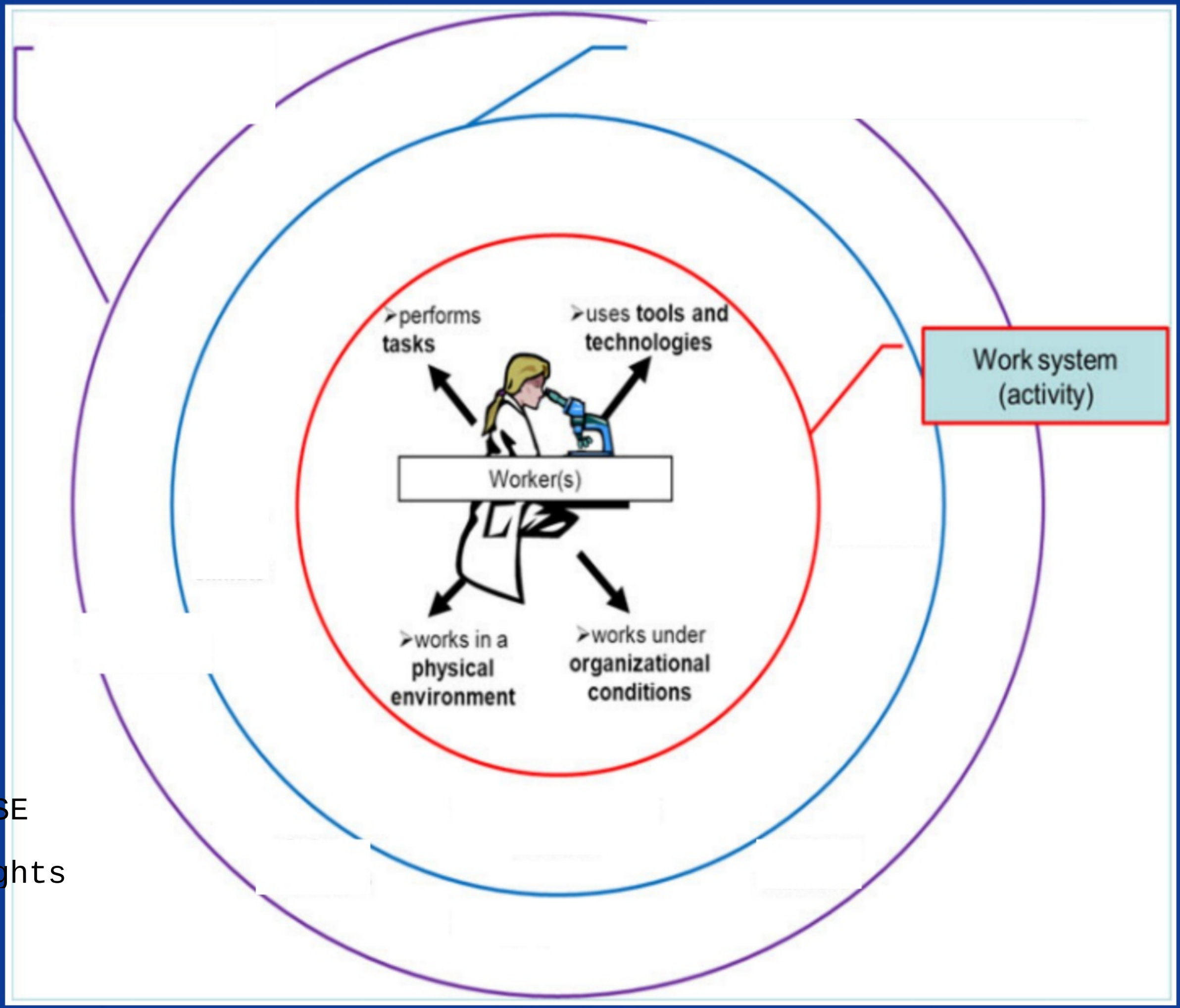

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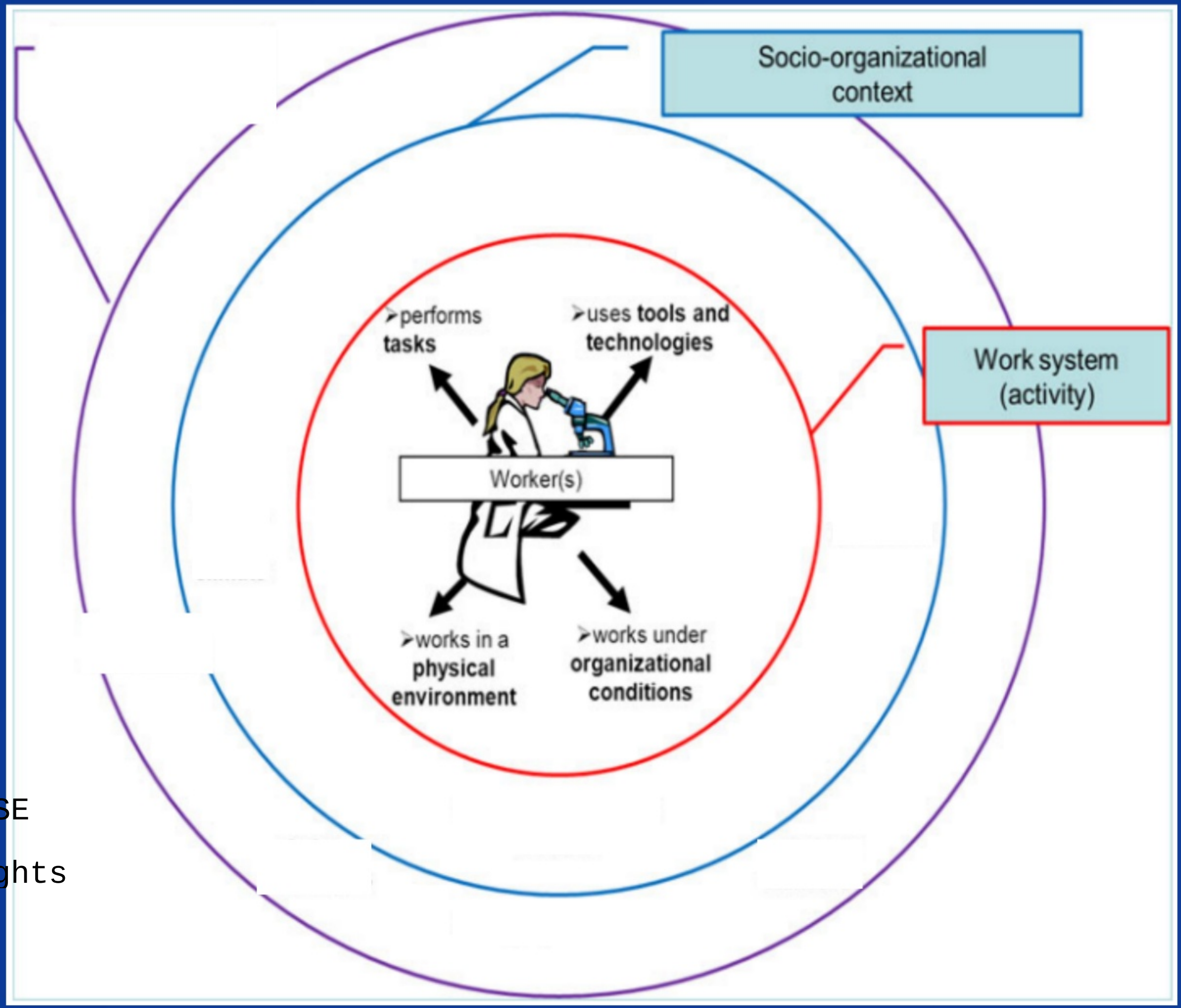

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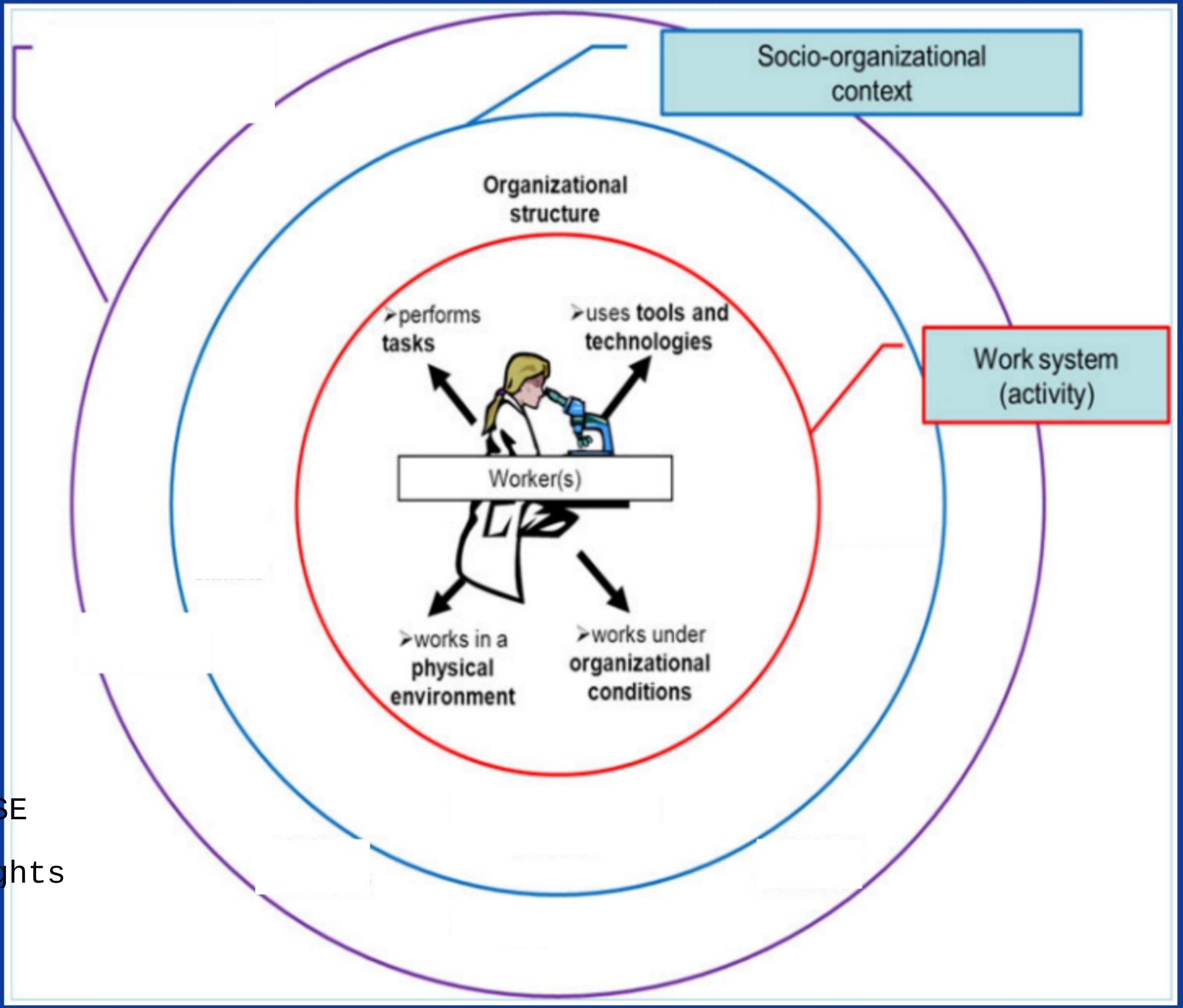

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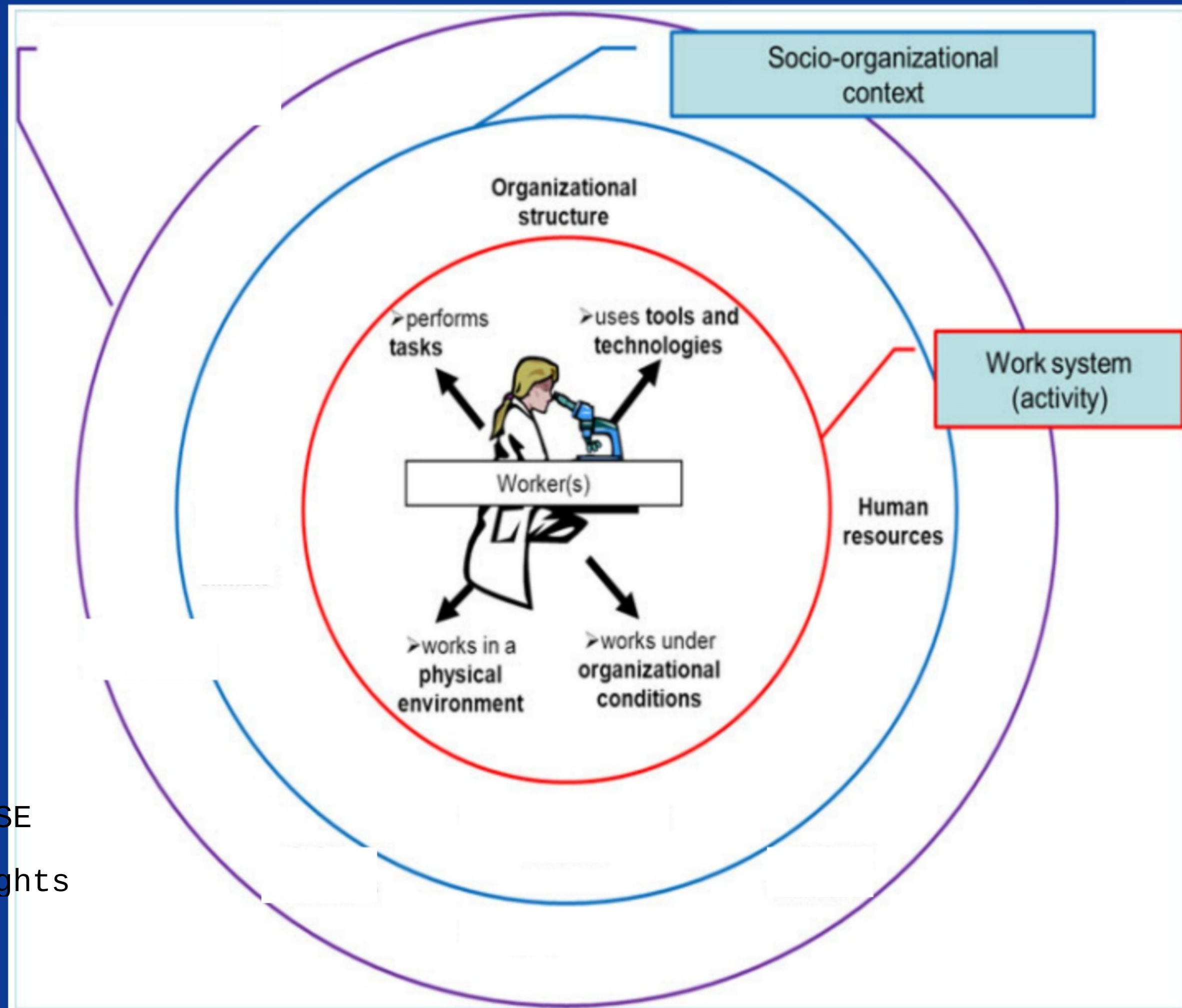

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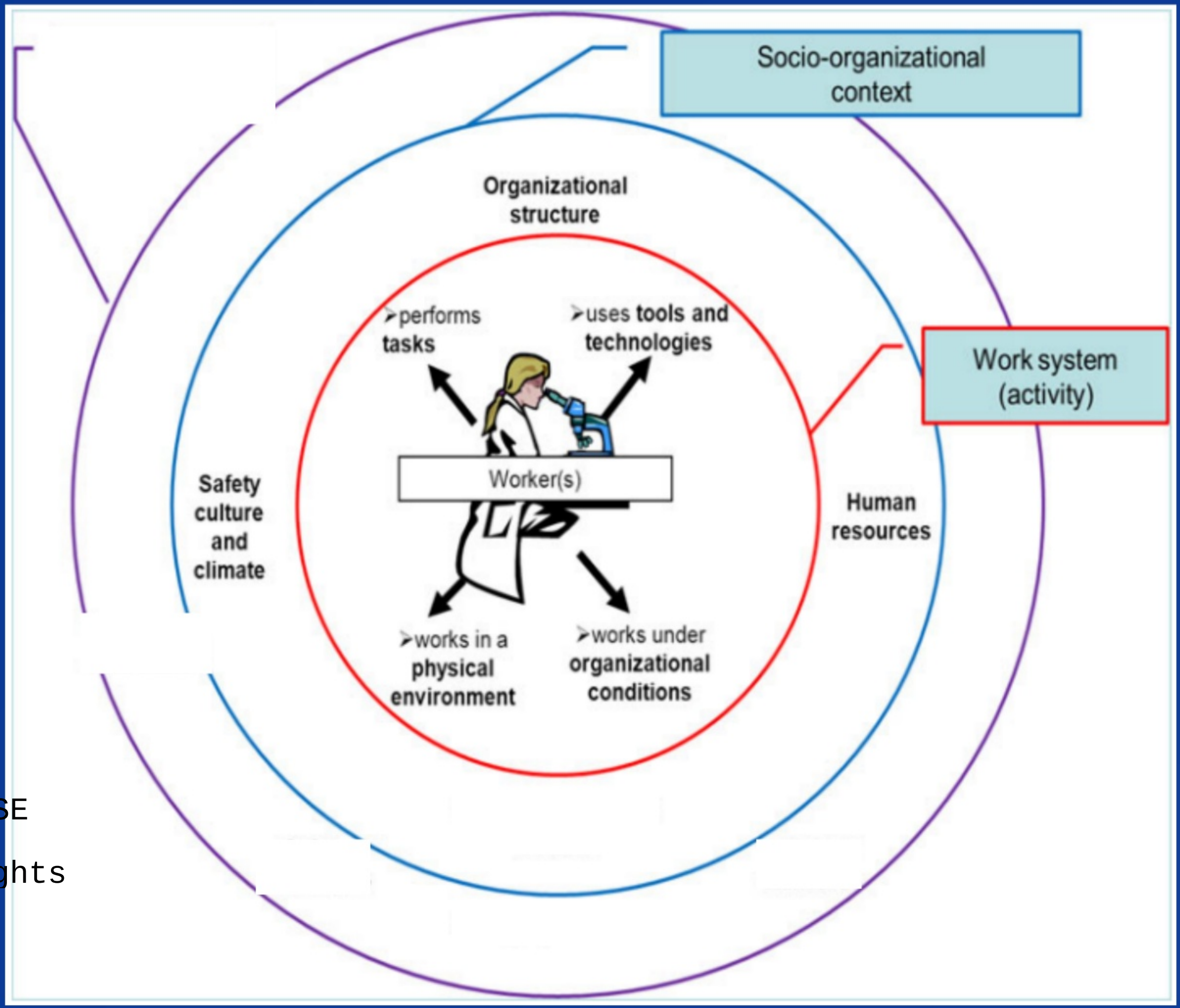

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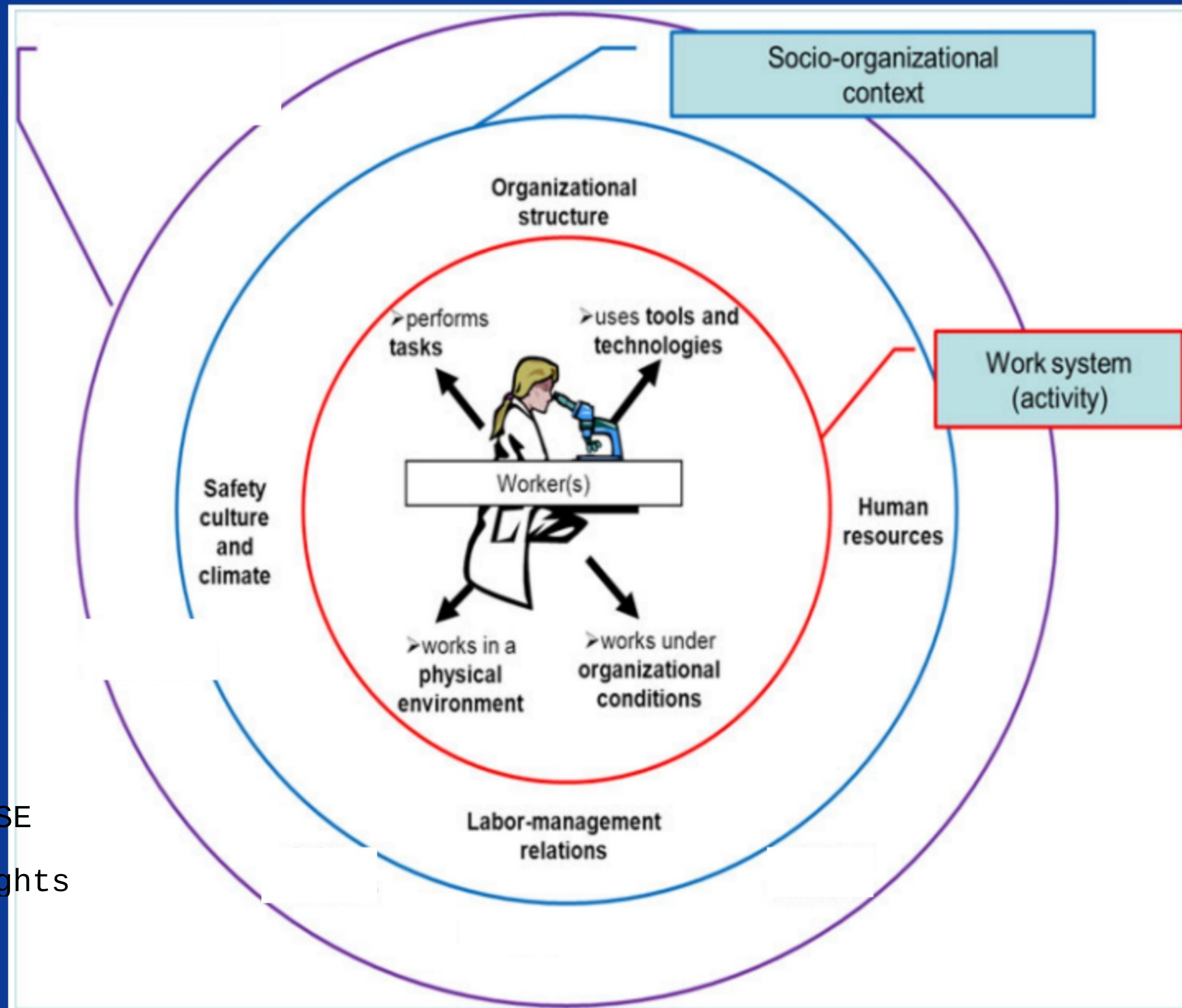

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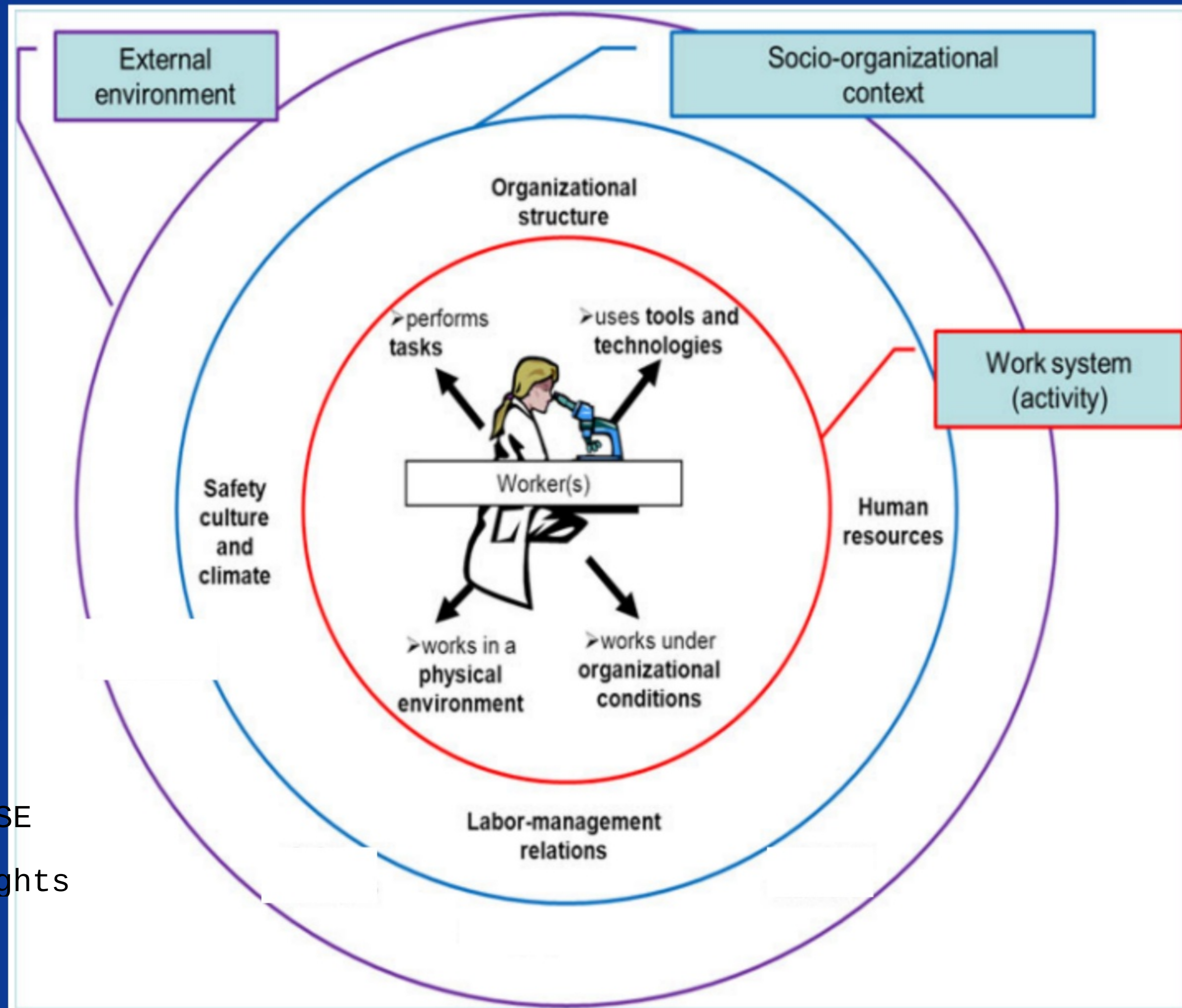

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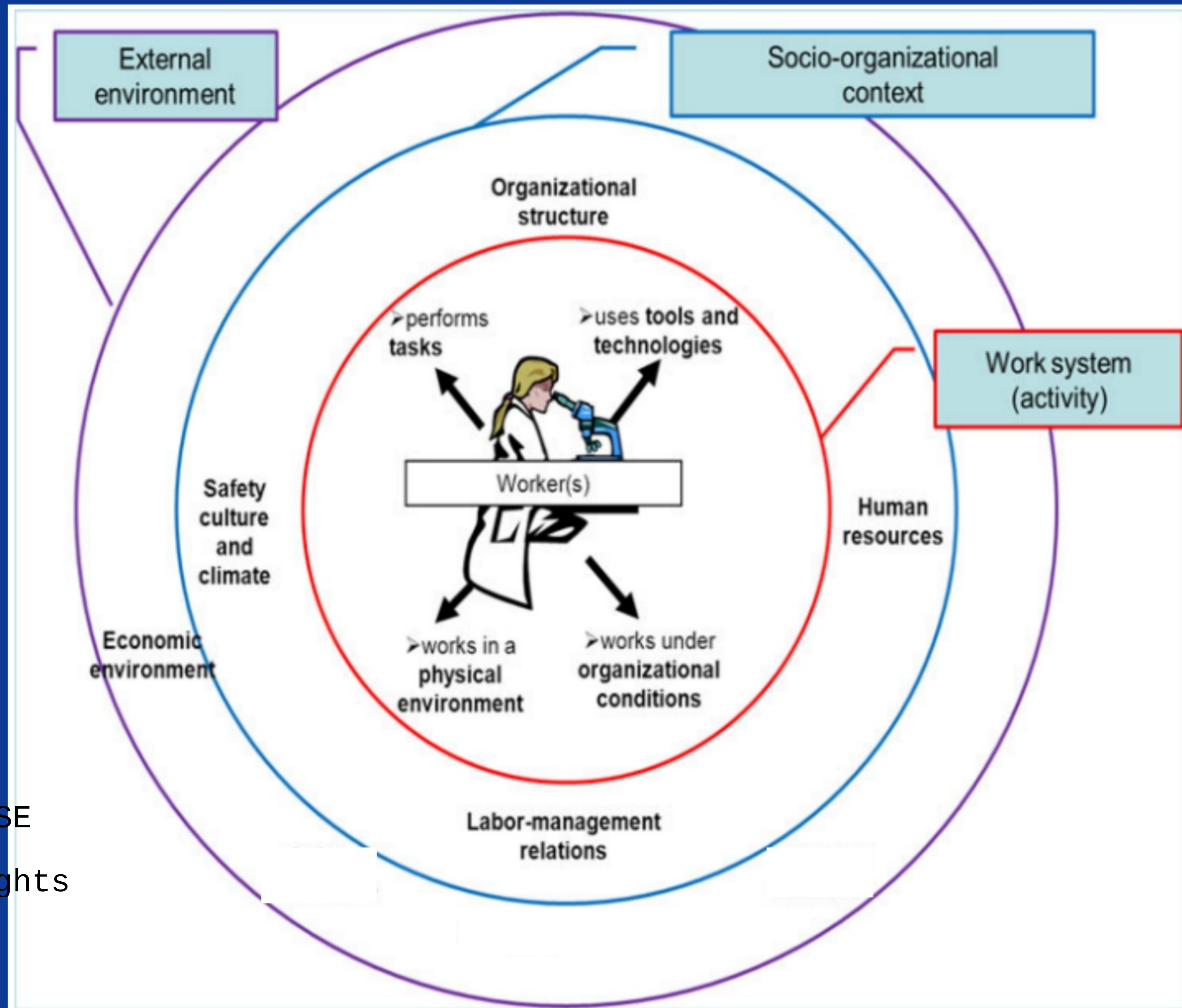

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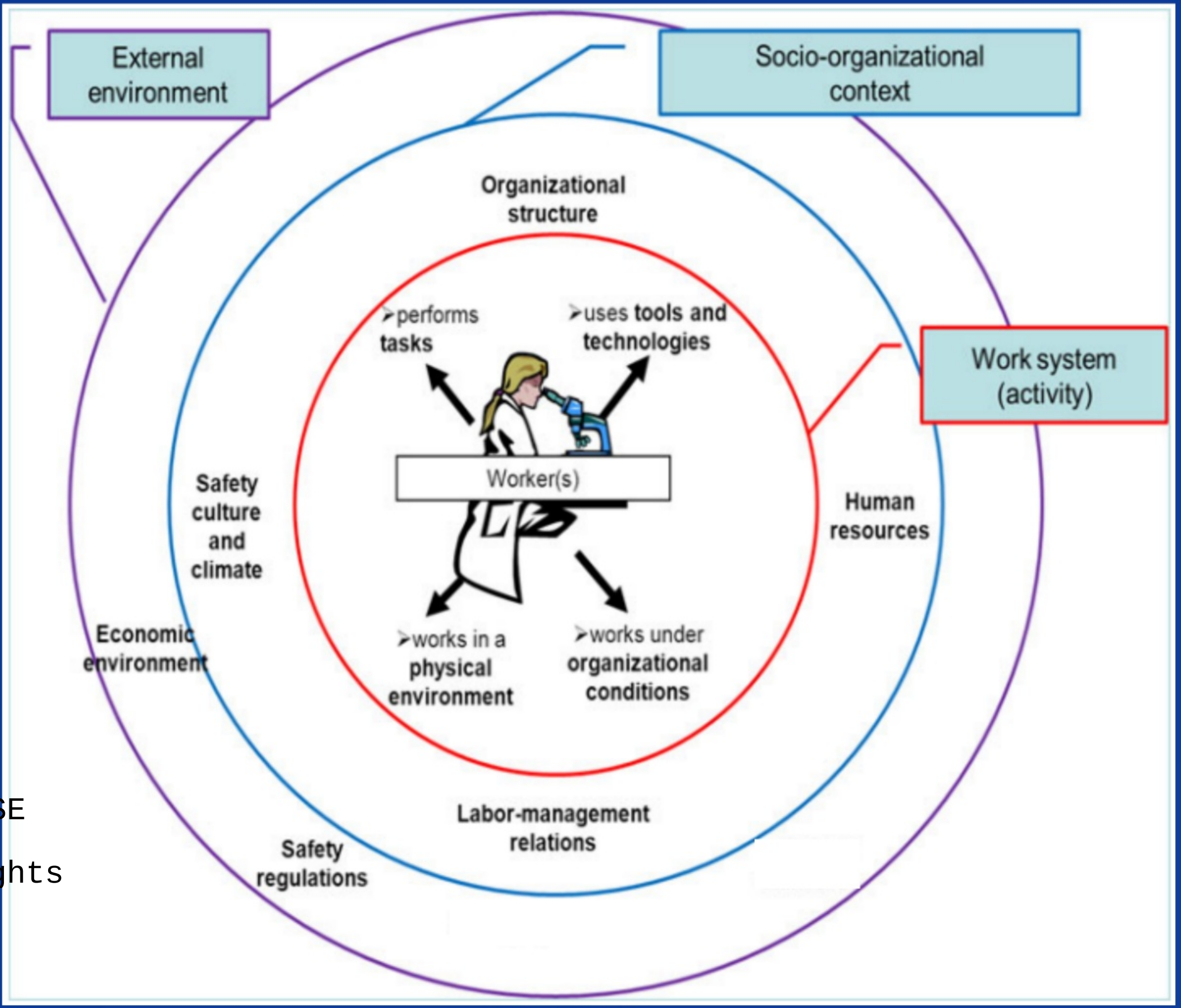

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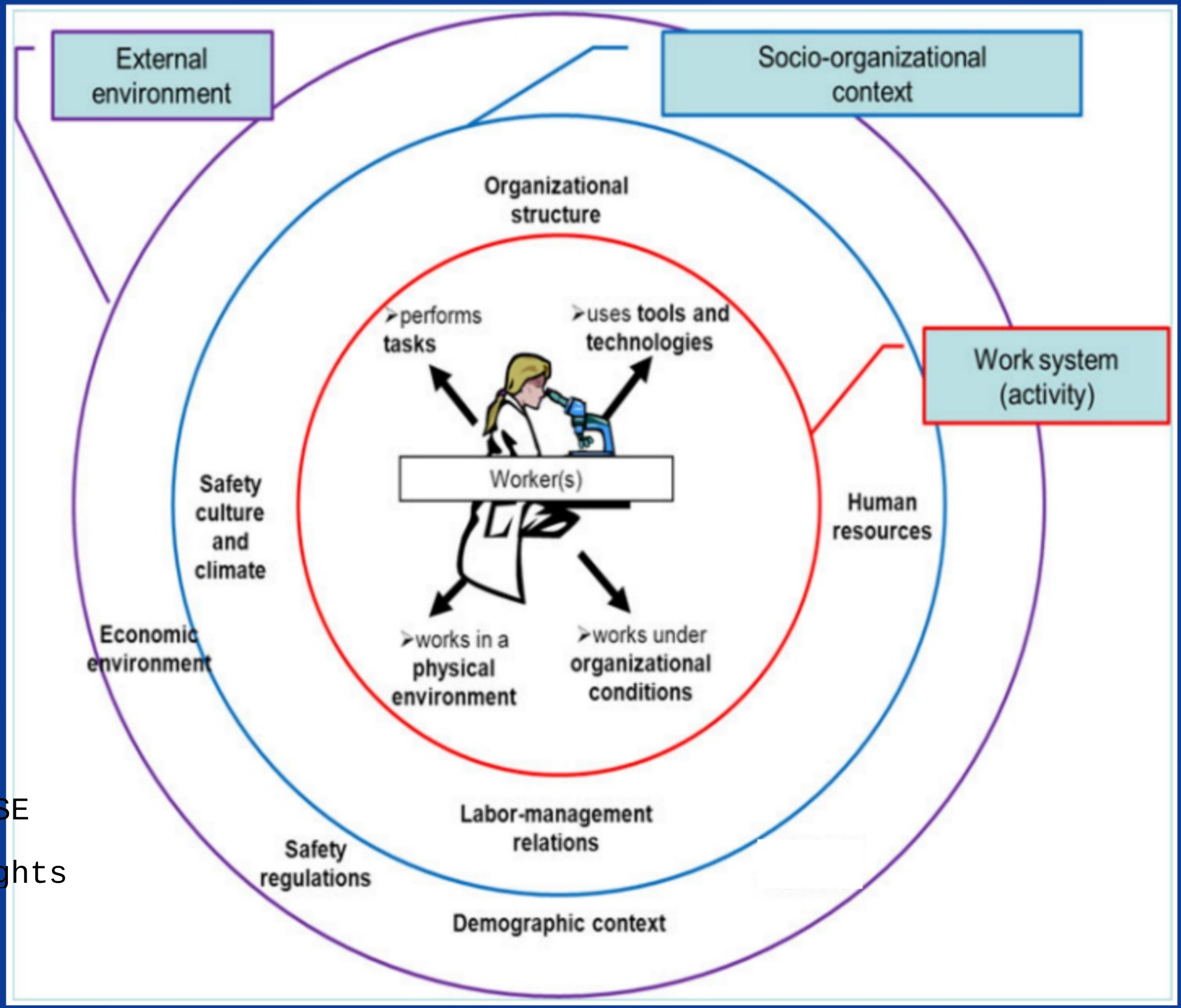

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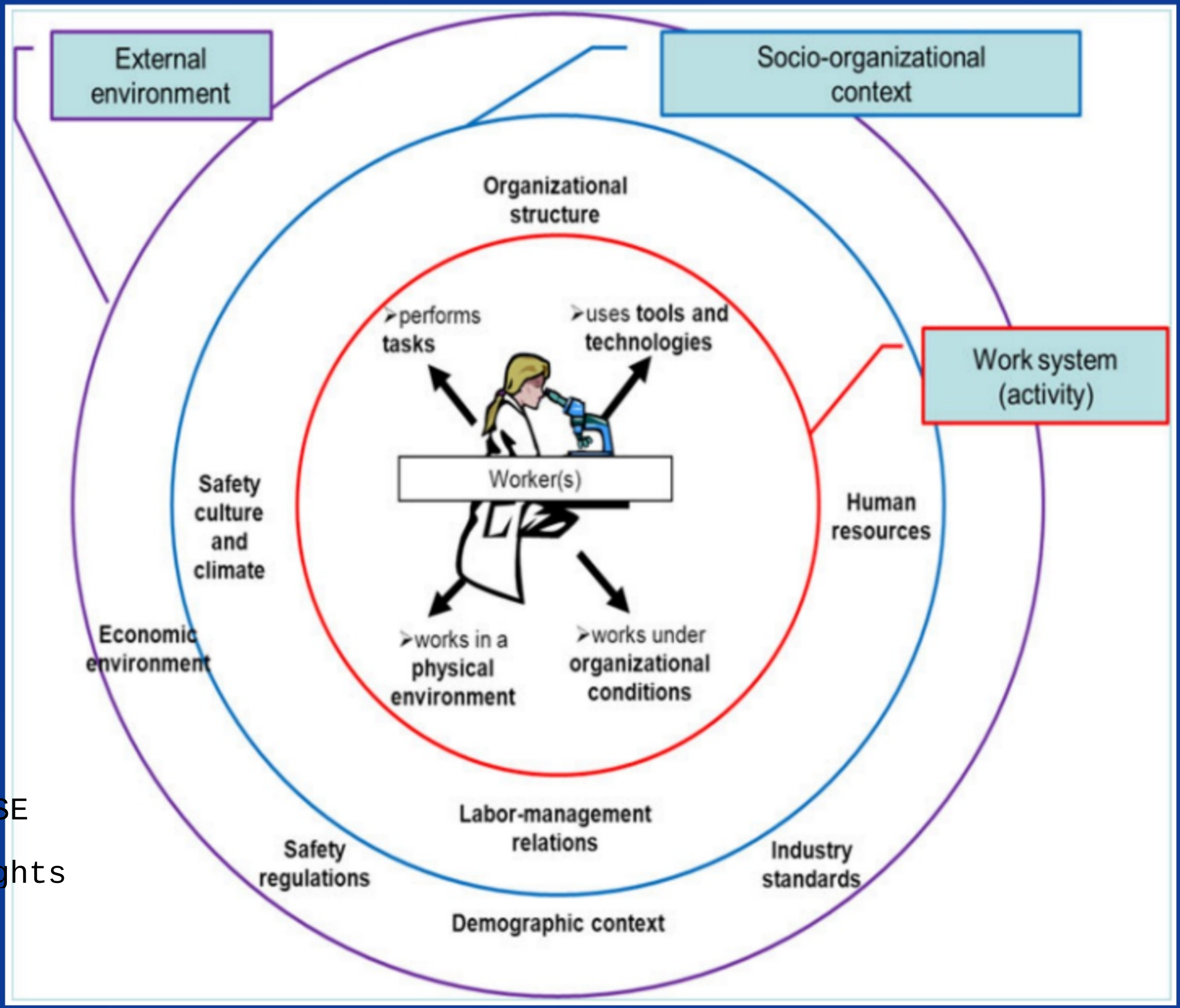


Liveware-Software (L-S)

- Interaction between human operator and non-physical supporting systems in the workplace (Johnston, McDonald & Fuller, 2001 6).
- Involves designing software to match the general characteristics of human users and ensuring that the software (e.g. rules/ procedures) is capable of being implemented with ease (Hawkins & Orlady, 1993 4)

- During training, flight crew members incorporate much of the software (e.g. procedural information) associated with flying and emergency situations into their memory in the form of knowledge and skills.

However, more information is obtained by referring to manuals, checklists, maps and charts. In a physical sense these documents are regarded as hardware however in the information design of these documents adequate attention has to be paid to numerous aspects of the L-S interface (Wiener & Nagel, 1988 10).

Mismatches at the L-S interface may occur through:

- Insufficient/inappropriate procedures
- Misinterpretation of confusing or ambiguous symbology/checklists
- Confusing, misleading or cluttered documents, maps or charts
- Irrational indexing of an operations manual (Hawkins & Orlady, 1993 4)

Liveware-Hardware (L-H)

- Interaction between human operator and machine
- Involves matching the physical features of the aircraft, cockpit or equipment with the general characteristics of human users while considering the task or job to be performed (Hawkins & Orlady, 1993 4). Examples:

- Air conditioning systems to control aircraft cabin temperature
- Sound-proofing to reduce noise
- Pressurisation systems to control cabin air pressure
- Protective systems to combat ozone concentrations

Mismatches at the L-H interface may occur through:

- poorly designed equipment
- inappropriate or missing operational material
- badly located or coded instruments and control devices
- warning systems that fail in alerting, informational or guidance functions in abnormal situations etc (Cacciabue, 2004 1).

Liveware-Environment (L-E)

- Interaction between human operator and internal and external environments (Johnston et al, 2001 6).
- Involves adapting the environment to match human requirements.

Examples:

- Engineering systems to protect crews and passengers from discomfort, damage, stress and distraction caused by the physical environment (Wiener & Nagel, 1988 10).

Examples of mismatches at the L-E interface include:

- Reduced performance and errors resulting from disturbed biological rhythms (jet lag) as a result of long-range flying and irregular work-sleep patterns
- Pilot perceptual errors induced by environmental conditions such as visual illusions during aircraft approach/landing at nighttime
- Flawed operator performance and errors as a result of management failure to properly address issues at the L-E interface including:

- Operator stress due to changes in air transport demand and capacity during times of economic boom and economic recession (Johnston et al, 2001 6).
- Biased crew decision making and operator short-cuts as a consequence of economic pressure brought on by airline competition and cost-cutting measures linked with deregulation (Wiener & Nagel, 1988 10).
- Inadequate or unhealthy organisational environment reflecting a flawed operating philosophy, poor employee morale or negative organisational culture (Hawkins & Orlady, 1993 4).

Liveware-Liveware (L-L)

- Interaction between central human operator and any other person in the aviation system during performance of tasks (International Civil Aviation Organisation, 1993 5).
- Involves interrelationships among individuals within and between groups including maintenance personnel, engineers, designers, ground crew, flight crew, cabin crew, operations personnel, air traffic controllers, passengers, instructors, students, managers and supervisors.

- Human-human/group interactions can positively or negatively influence behaviour and performance including the development and implementation of behavioural norms. Therefore, the L-L interface is largely concerned with:
  - interpersonal relations
  - leadership
  - crew cooperation, coordination and communication

- dynamics of social interactions
- teamwork
- cultural interactions
- personality and attitude interactions (Hawkins & Orlady, 1993 4; Johnston et al, 2001 6).

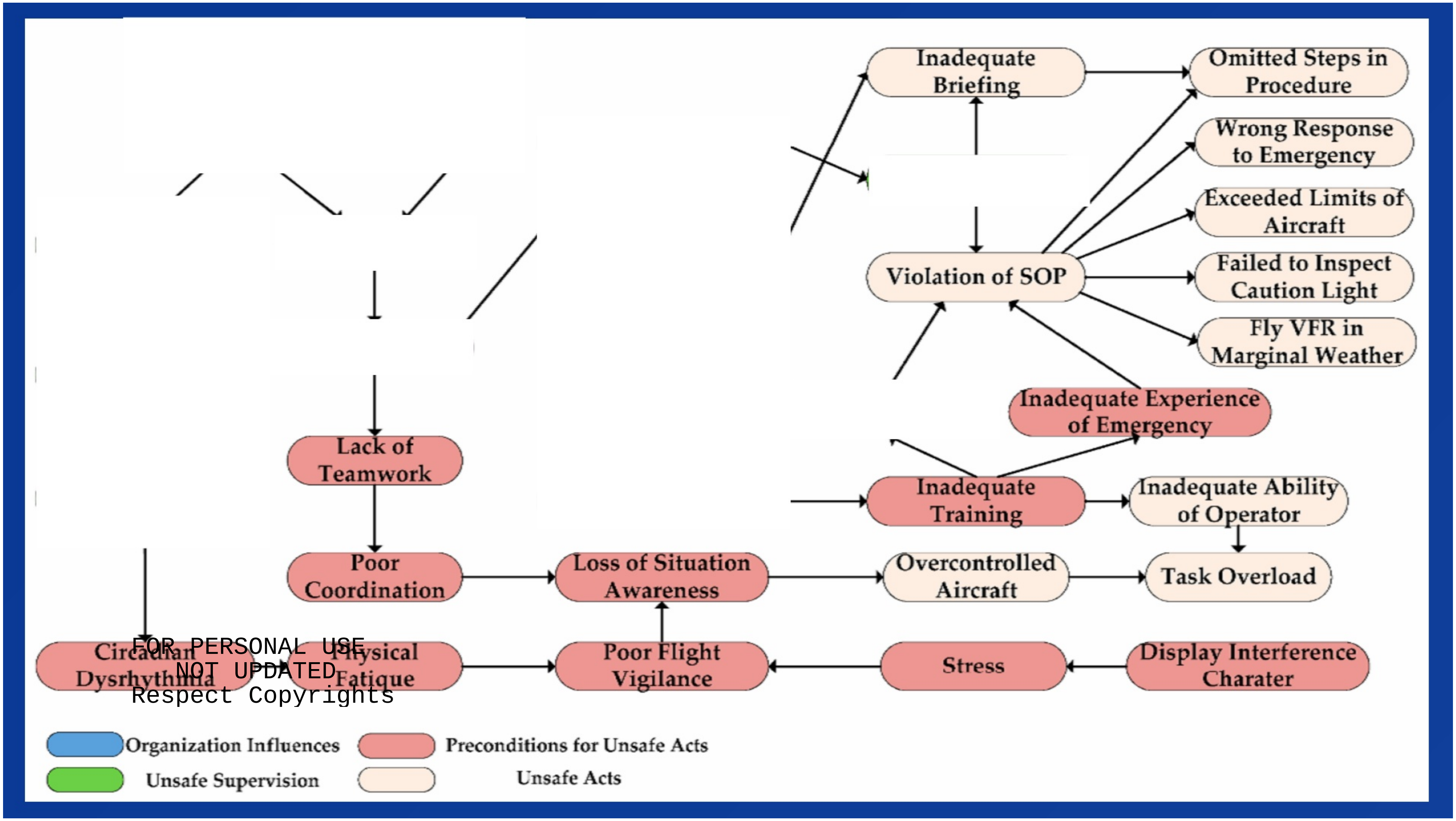
- The importance of the L-L interface and the issues involved have contributed to the development of cockpit/crew resource management (CRM) programmes In an attempt to reduce error at the interface between aviation professionals

Examples of mismatches at the L-L interface include:

- Communication errors due to misleading, ambiguous, inappropriate or poorly constructed communication between individuals. Communication errors have resulted in aviation accidents such as the double Boeing 747 disaster at Tenerife Airport in 1977.

- Reduced performance and error from an imbalanced authority relationship between aircraft captain and first officer (Hawkins & Orlady, 1993 4).

For instance, an autocratic captain and an overly submissive first officer may cause the first officer to fail to speak up when something is wrong, or alternatively the captain may fail to listen.


Inadequate Briefing
Omitted Steps in Procedure
Wrong Response to Emergency
Exceeded Limits of Aircraft
Violation of SOP
Failed to Inspect Caution Light
Fly VFR in Marginal Weather
Inadequate Experience of Emergency
Lack of Teamwork
Inadequate Training
Inadequate Ability of Operator
Poor Coordination
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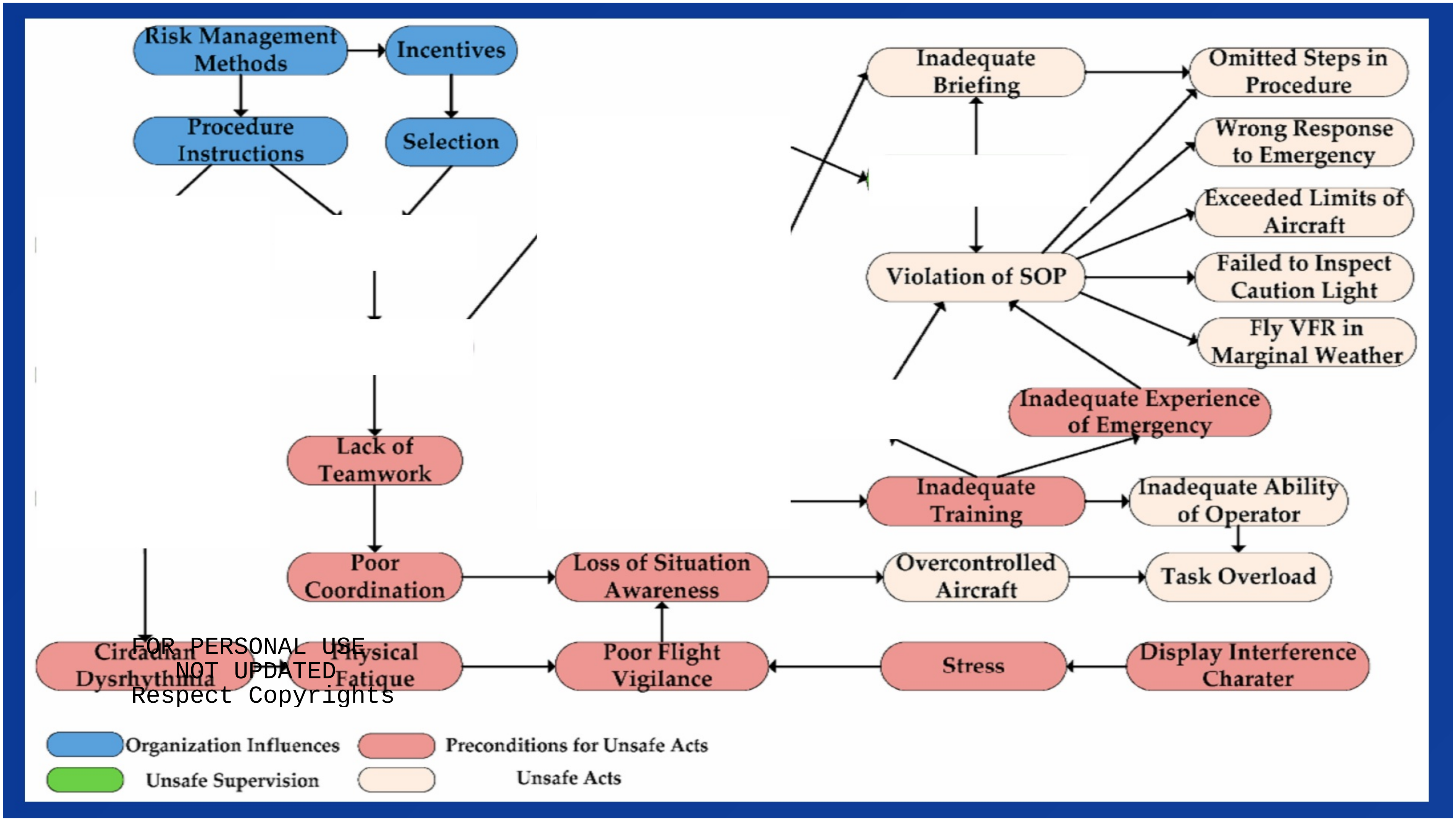
Task Overload
Circadian Dysrhythmia
Physical Fatigue
Poor Flight Vigilance
Stress
Display Interference Charater
Organization Influences
Preconditions for Unsafe Acts
Unsafe Supervision
Unsafe Acts


Risk Management Methods
Incentives
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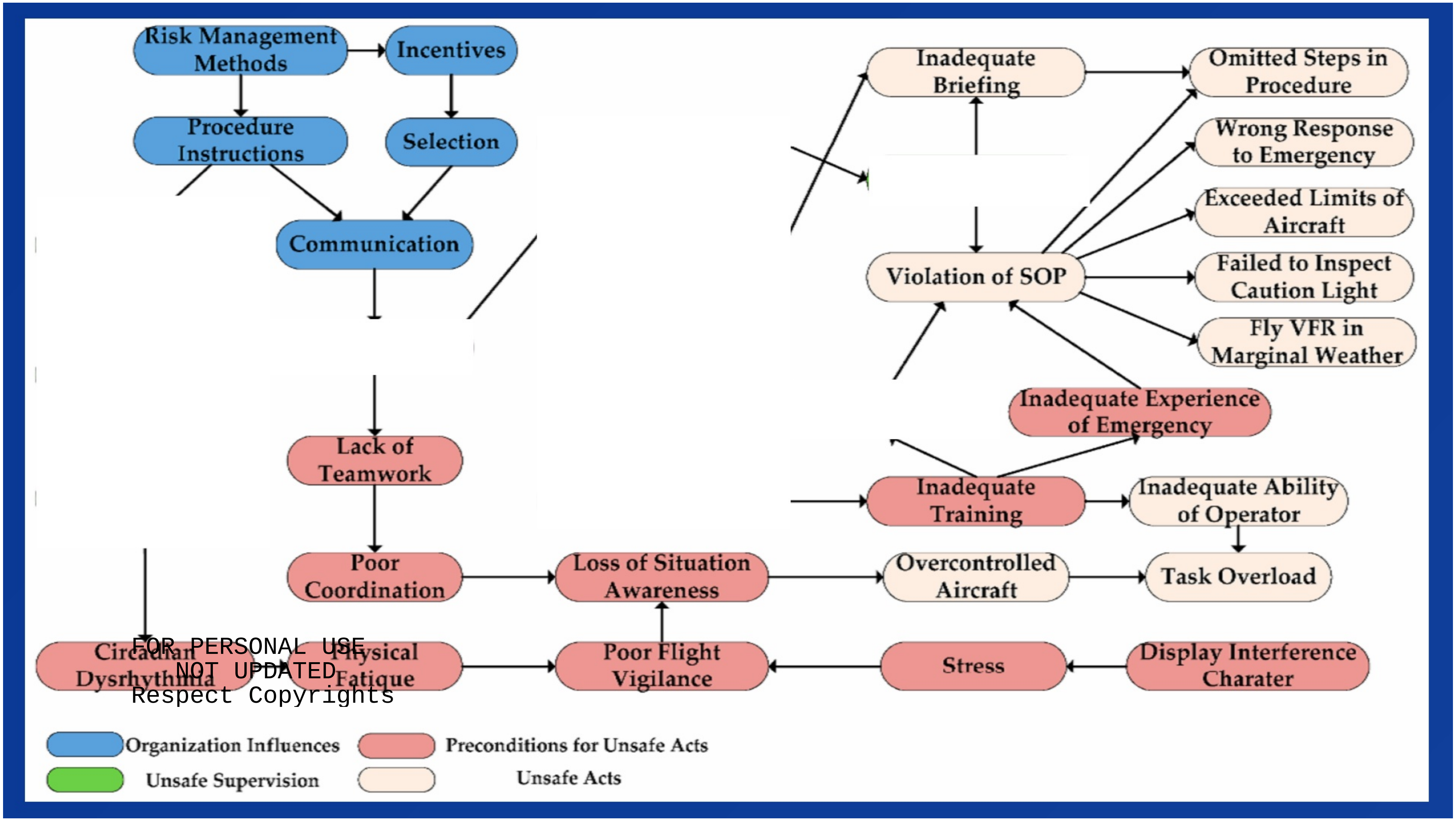
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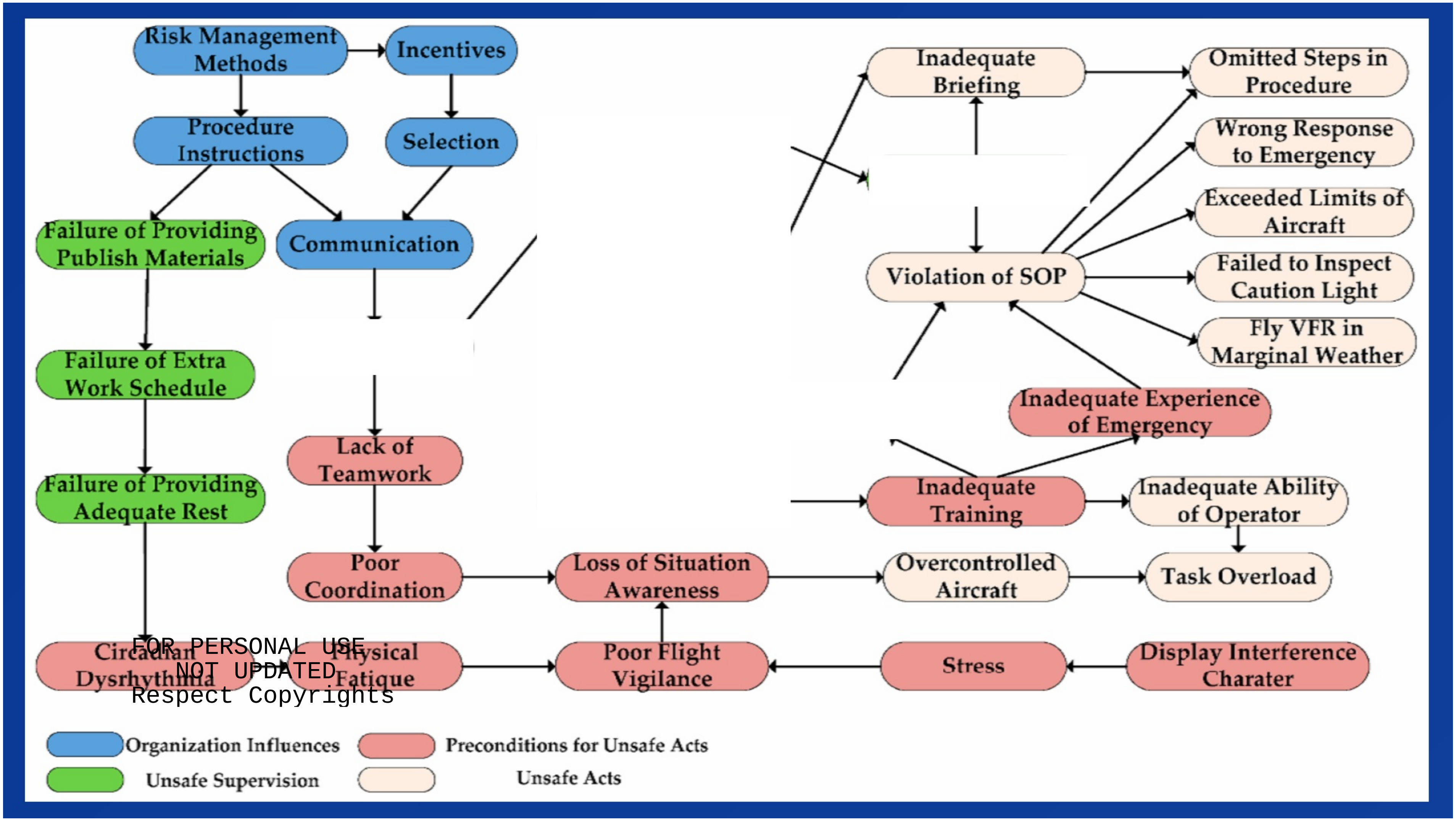
Risk Management Methods
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Selection
Failure of Providing Publish Materials
Communication
Failure of Extra Work Schedule
Lack of Teamwork
Failure of Providing Adequate Rest
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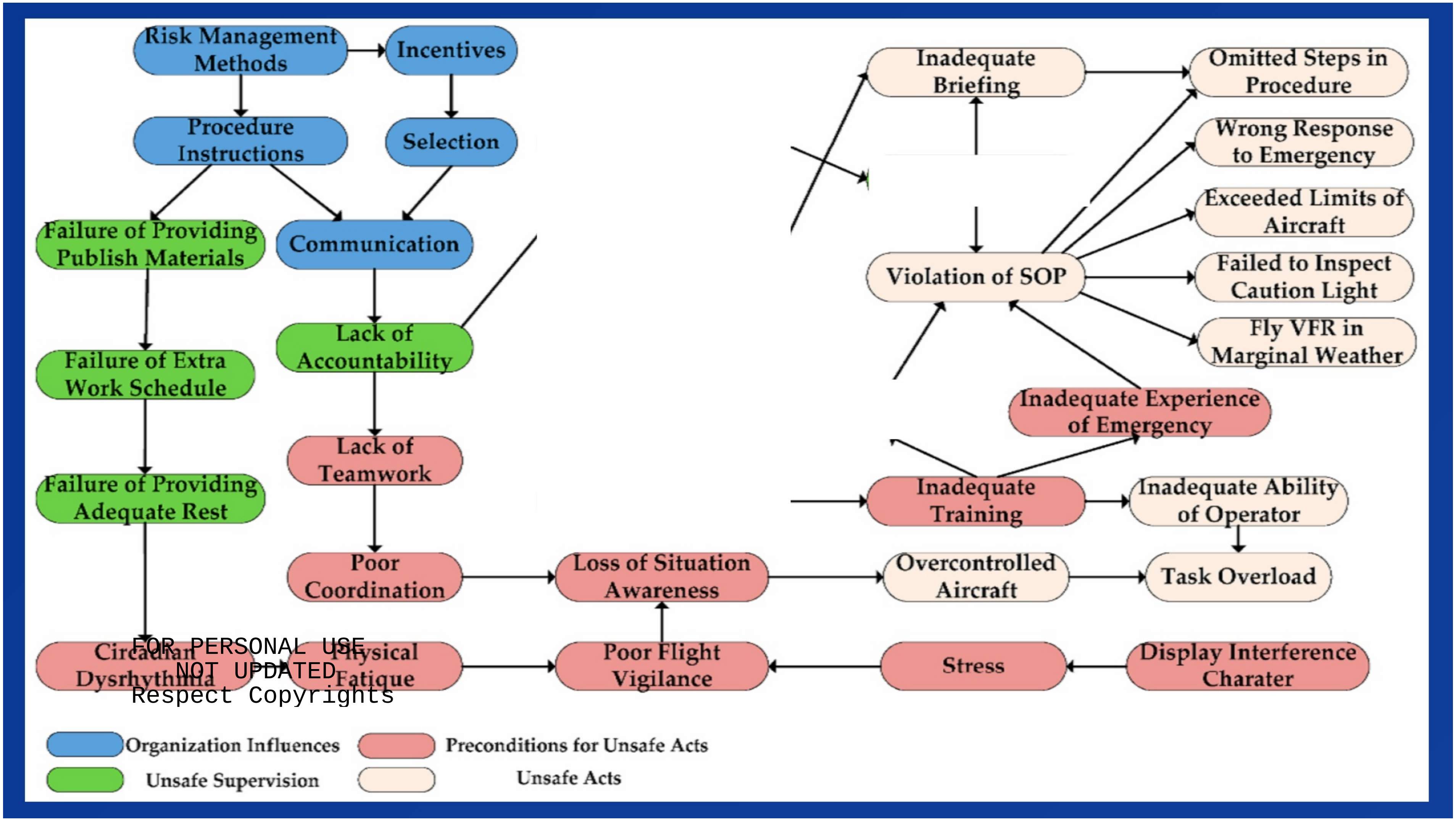

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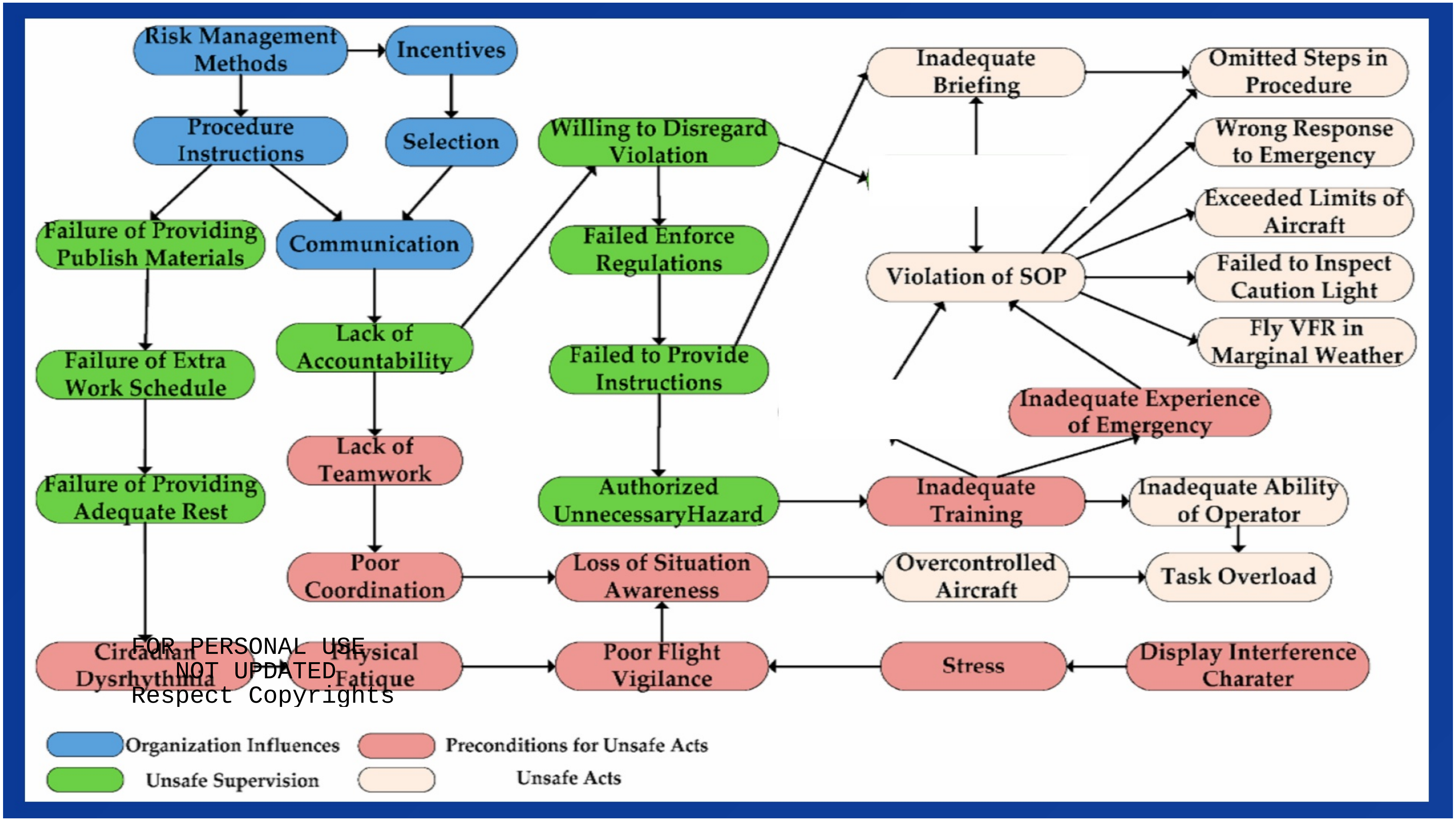
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Lack of Accountability
Failed to Provide Instructions
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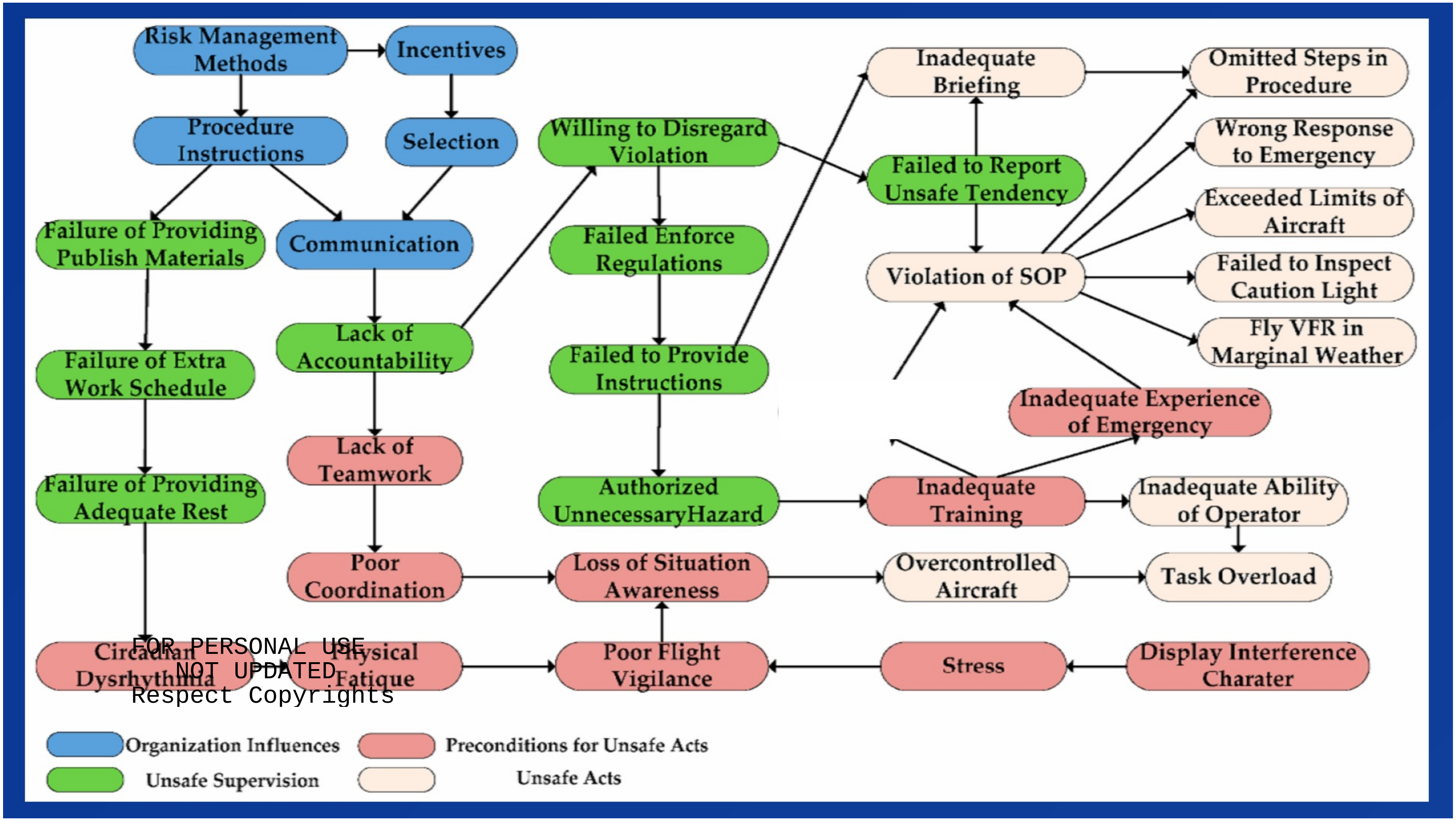

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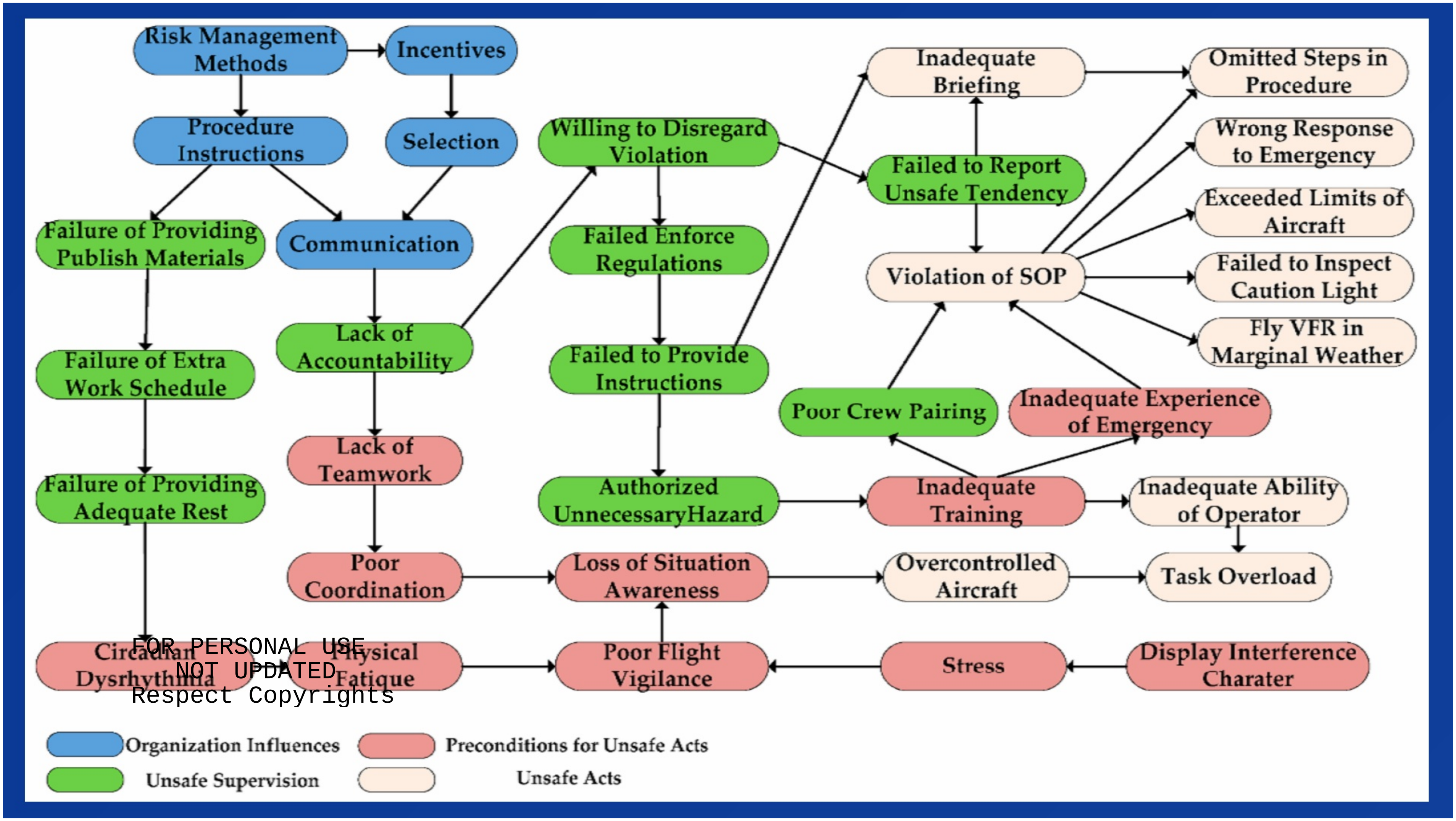
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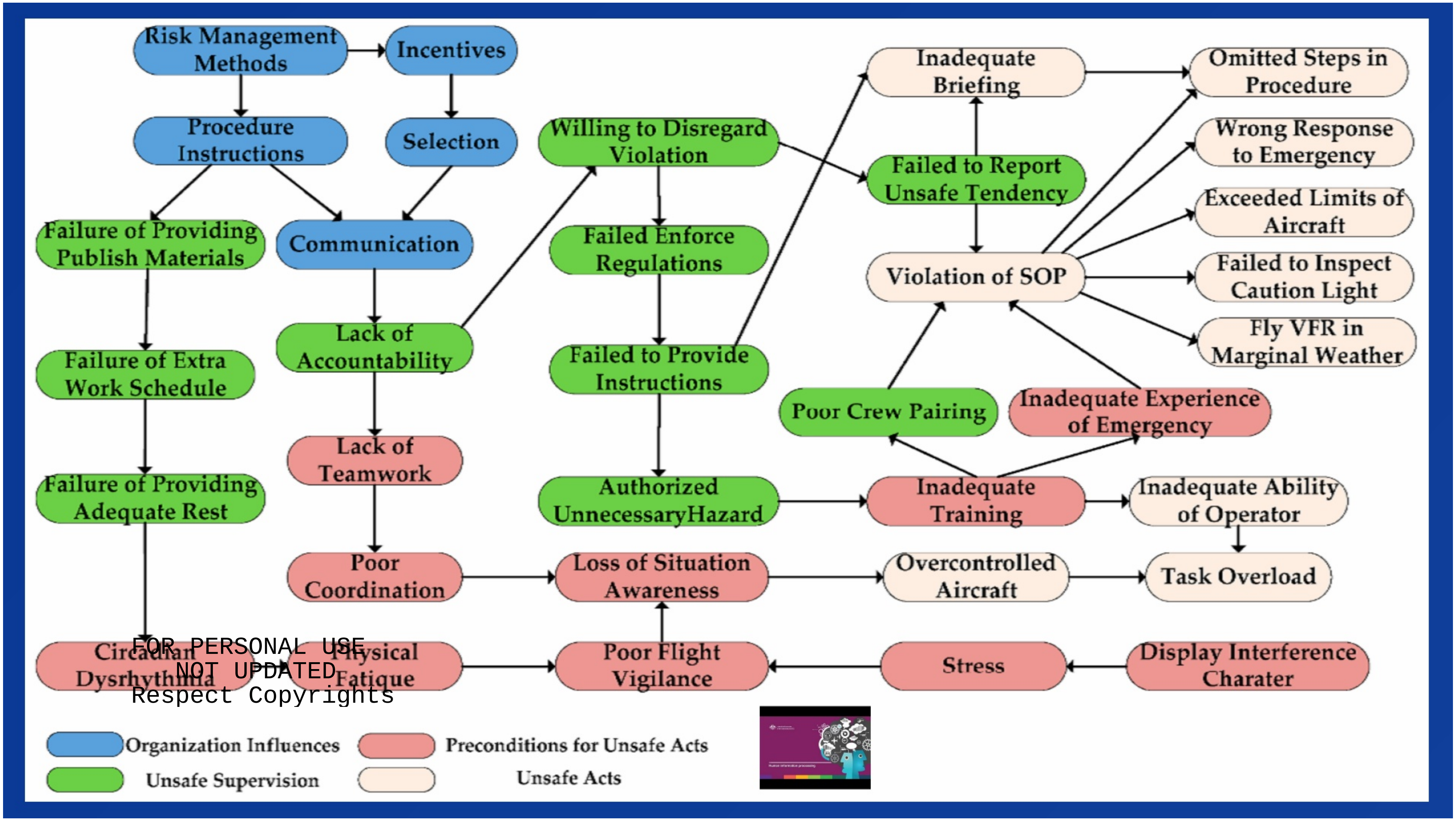
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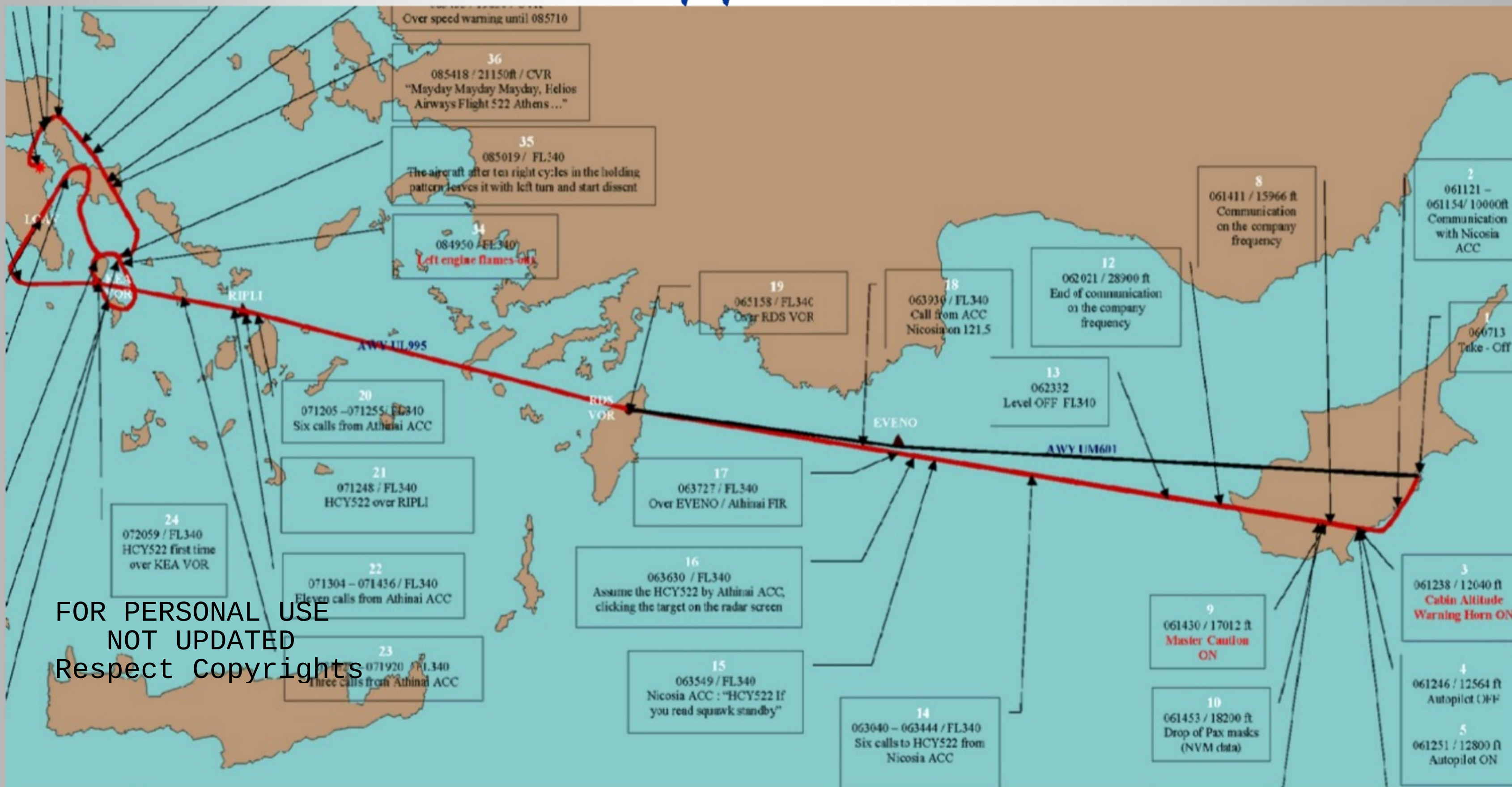
Australian Government
Civil Aviation Safety Authority
Human information processing

Human Factors – Applied



Human Factors – Applied

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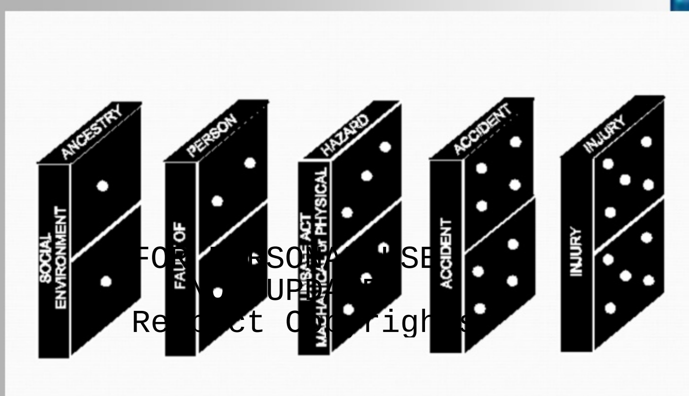

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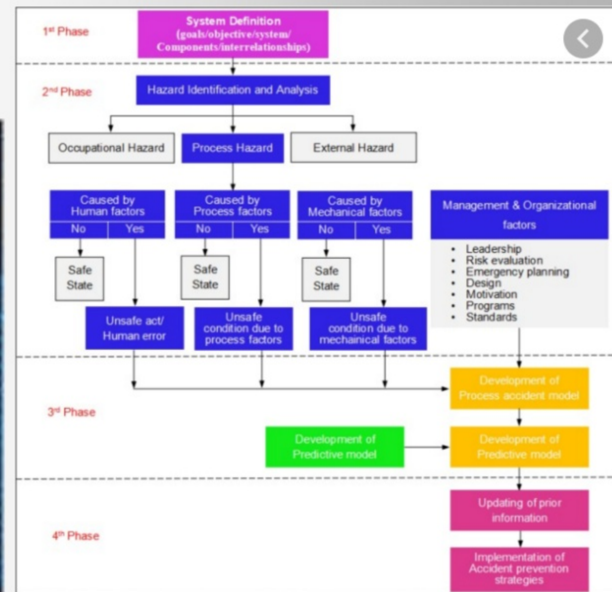

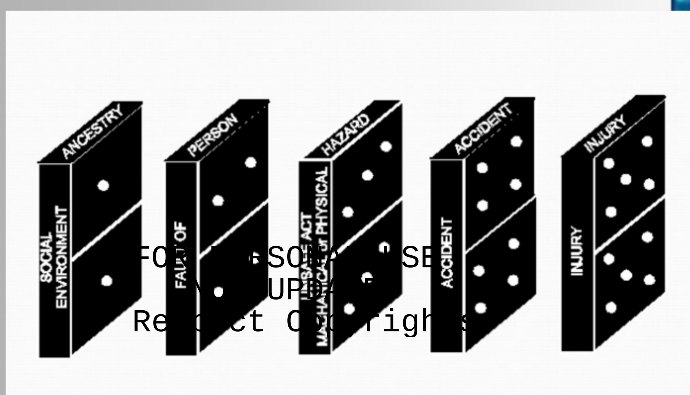

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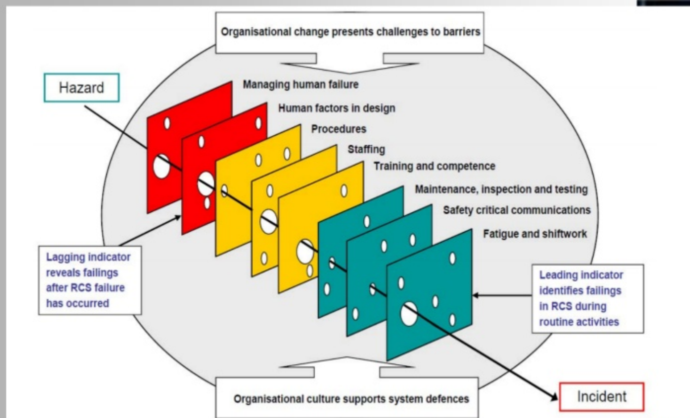
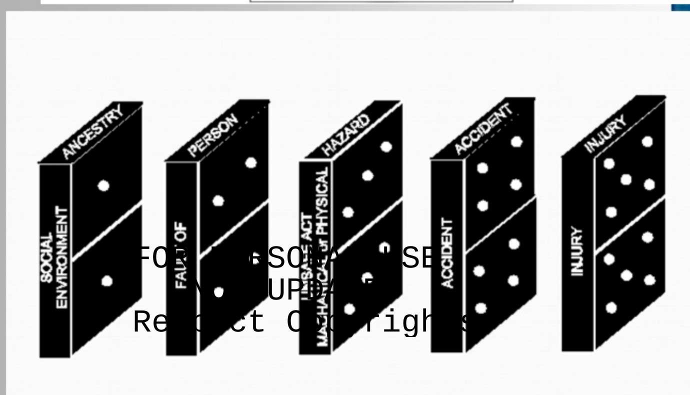
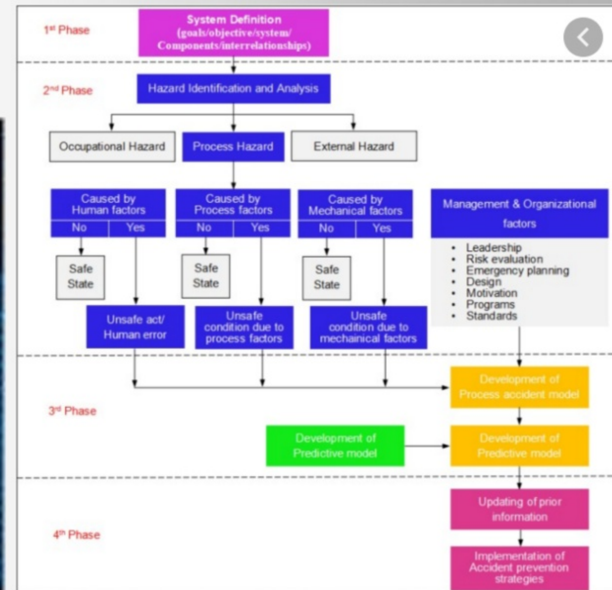
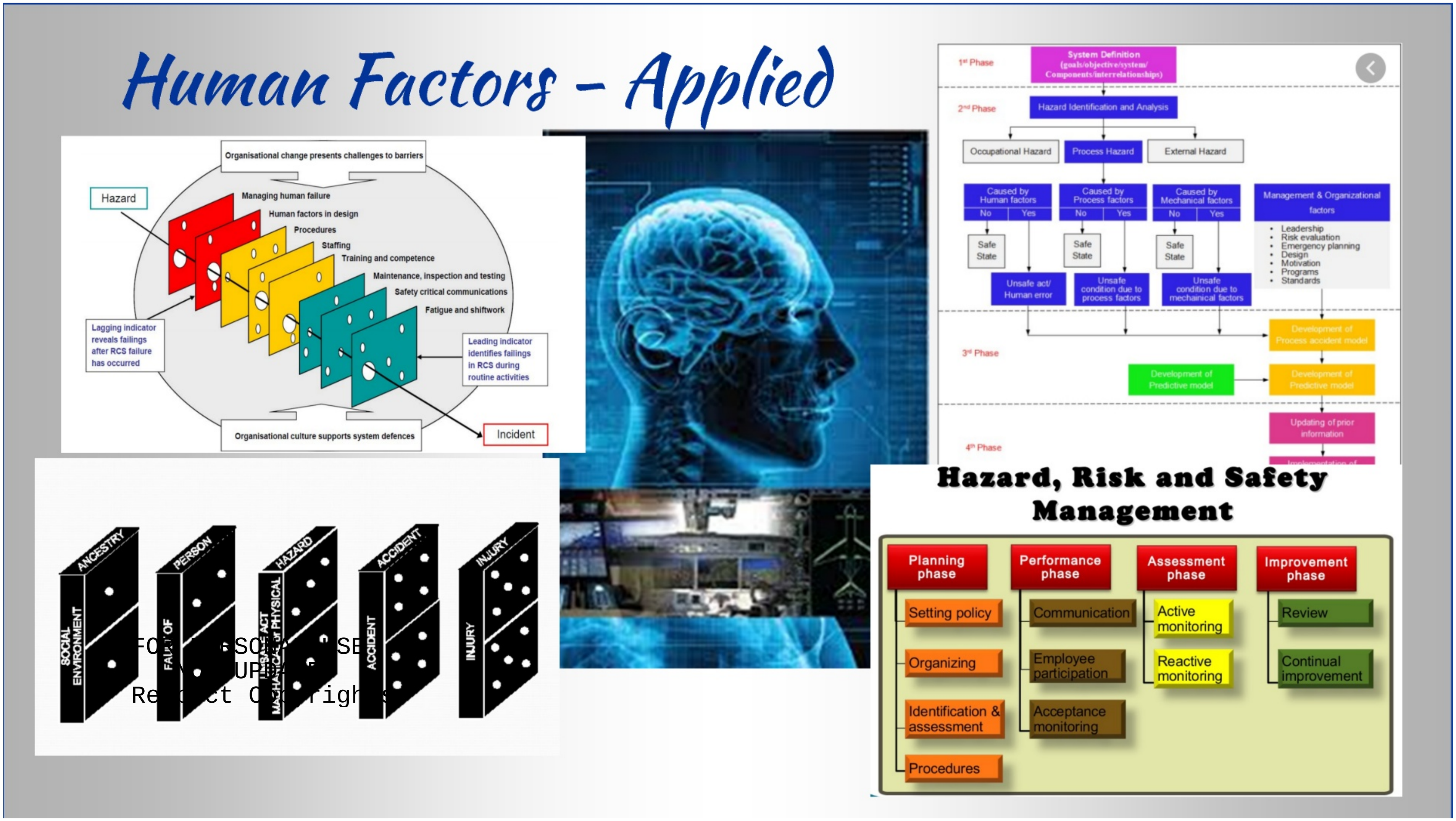







Human Factors – Applied
Organisational change presents challenges to barriers
Hazard
Managing human failure
Human factors in design
Procedures
Staffing
Training and competence
Maintenance, inspection and testing
Safety critical communications
Fatigue and shiftwork
Lagging indicator reveals failings after RCS failure has occurred
Leading indicator identifies failings in RCS during routine activities
Incident
Organisational culture supports system defences
ANCESTRY
SOCIAL ENVIRONMENT
PERSON
HAZARD
UNSAFE ACT MECHANICAL or PHYSICAL
ACCIDENT
INJURY
1st Phase
System Definition (goals/objective/system/ Components/interrelationships)
2nd Phase
Hazard Identification and Analysis
Occupational Hazard
Process Hazard
External Hazard
Caused by Human factors
Caused by Process factors
Caused by Mechanical factors
No
Yes
Safe State
Management & Organizational factors
Leadership
Risk evaluation
Emergency planning
Design
Motivation
Programs
Standards
Unsafe act/ Human error
Unsafe condition due to process factors
Unsafe condition due to mechanical factors
Development of Process accident model
3rd Phase
Development of Predictive model
Development of Predictive model
Updating of prior information
4th Phase
Hazard, Risk and Safety Management
Planning phase
Performance phase
Assessment phase
Improvement phase
Setting policy
Organizing
Identification & assessment
Procedures
Communication
Employee participation
Acceptance monitoring
Active monitoring
Reactive monitoring
Review
Continual improvement

Requirements of Organization, Safety and Human Factors

Human Factors and Safety Topics	Procedures	Inspections, Audits, Workplace Surveys	Training	Organizational Culture
Relevant human factors to worker health, safety, and risk governance	Written, technically correct, maintained and accessible, and easy to understand.	Hazard identification and quantitative or qualitative risk assessment of workers in critical roles	Competence in job function, knowledge of hazard and control measures	Leadership support of compliant workers and workers seeking improvement
Associated health and safety outcomes from performance	Applied, tested, and re-evaluated for valid human performance. Evaluate personnel decision-making needs. Right tools for job and used correctly. Evaluate fitness for duty	Measurement of worker exposure, monitor of work performance, and evaluation of competence. Consider human factors and ergonomic issues. Evaluate proficiency of completing work tasks.	Training applicable to specific hazards and risk, and capability for each worker. Matched skills and aptitude. Know how to use right tools or equipment and report deficiency gap in safety.	Evaluate safety climate and culture Construct of safety policy, program, and operating procedures Provide right tools and equipment for job. Report deficiencies.
Critical Elements	**Procedures reviewed and relevant to current operations/process. Critical tasks identified and analyzed. Work aligns with hiring process**	**Evaluation of mishaps, near-miss events, levels of exposure, and safety controls. Workers capable of completing job tasks/assignments**	**Formal and practical training provided for identified hazards and/or training to use and operate equipment and machinery.**	**Training objectives commensurate with safety hazards/risk. Workers selected based on capability and experience.**
Performance Indicator(s)	Percent (%) of operating procedures based on direct self-assessment of human performance (Leading indicator)	Percent (%) of facility inspections, audits, surveys both planned vs performed annually (Leading indicator)	Number of workers or % of staff provided safety training and determined to be competent (Leading indicator	Health and safety climate measurement and evaluation of psychosocial issues (Leading indicator)

Requirements of Organization, SMS and Human Factors

- **Commitment:** In the face of ever-increasing commercial and economic pressures, does the organization have the will to make SMS tools work effectively?
- **Cognizance:** Does the organization understand the financial and social impact of safety relative to the involvement of human and organizational factors?
- **Competence:** Neither of the other two drivers is sufficient without the necessary practical skills. Does the organization's SMS possess the right tools, and are they properly understood and utilized appropriately by leadership and the workforce?

Predictive analysis and solutions can be applied to properly manage human factors issue related to safety management and risk.

Requirements of Organization, SMS and Human Factors

	Commitment	Cognizance	Competence
Principles	Safety management is an integral part of the business process. Past events are carefully reviewed; novel scenarios are imagined. Top management is actively engaged in safety-related issues.	No final victories in the safety war. Human fallibility and natural hazards will never be eliminated, only moderated. Organization understands: person, engineering and system models of safety management It expects its workforce to make errors and trains them to detect and recover. 'Upstream' systemic factors are easier to manage than fleeting psychological states like inattention or	Organization recognizes that the effective management of safety. It involves the regular sampling of a variety of organizational parameters (scheduling, planning, resource allocation, procedures, defenses, training, communication, production conflicts, and the like), identify which of these 'vital signs' is most in need of attention, and carrying out remedial
Policy	Company policy to remind all levels of leadership that safety is everyone's responsibility. Resolve short-term production and protection issues safely. Policies should be in place to encourage safety messengers.	Organization should publically recognize critical dependence of effective SMS upon the trust of the workforce. A safe culture is the product of a reporting culture that, in turn, can only arise from a just culture. Use crisis emergency and recovery planning to test business.	Policies relating to near-miss and incident reporting should make clear the company's stance. Disciplinary policies should be predicated on distinction between acceptable/unacceptable behavior. Key determinant is not so much the act — error or violation—as the nature of the embedded behavior.

Requirements of Organization, SMS and Human Factors

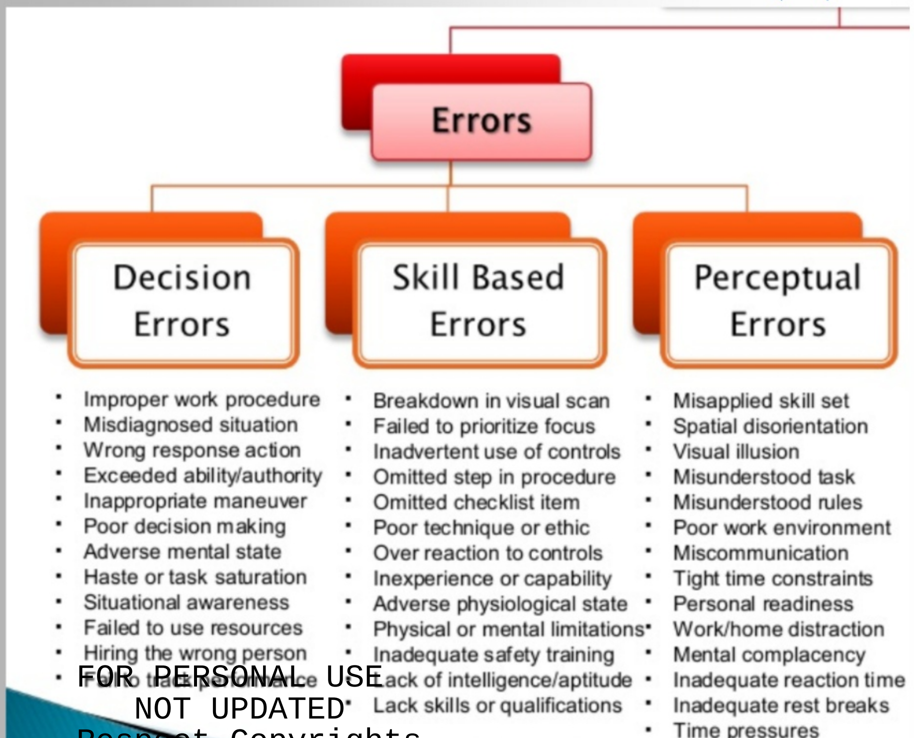
	Commitment	Cognizance	Competence
Procedures	Organization should establish written operating procedures for each work task based on hazard identification using a job safety analysis and risk assessment. Controls should be identified to include engineering, administrative, and finally the use of personal protective equipment suited for the individual work	Procedures, i.e., maintenance, should not only explain how the job be done, but also identify the likely error-prone steps in the task. Training in the recognition/recovery of errors should support appropriate procedures. Inform by data on recurrent error traps derived from safety information reporting systems. Procedures should be well written in cooperation with those actually experienced doing the job.	Procedures should be appropriate, accessible, intelligible and workable. Write procedures with the understanding that people hardly ever read and do at the same time. Such a balance is very important in relation to intrinsically error-provoking activities like repairs and maintenance activities.
Practice	Routine audits, inspections, and surveys along with interviews of the workforce are needed to understand what gets done and how it gets done. Errors and omissions can be detected and corrections made before a crisis develops.	The 'safety health' of the organization should be continuously monitored using both reactive outcome data and proactive process measures. The former help to identify recurrent error traps, while the latter focus attention upon current systemic weaknesses. Use rapid, useful and intelligible feedback channels to communicate the lessons learned and the actions needed.	Visible top-level involvement in safety practices. Management should not only walk the talk, but also talk the walk. Each level of management should understand the hazards and risks associated with the work and the need to have established policy, programs, and operating procedures to the work.

Human Factors – Applied

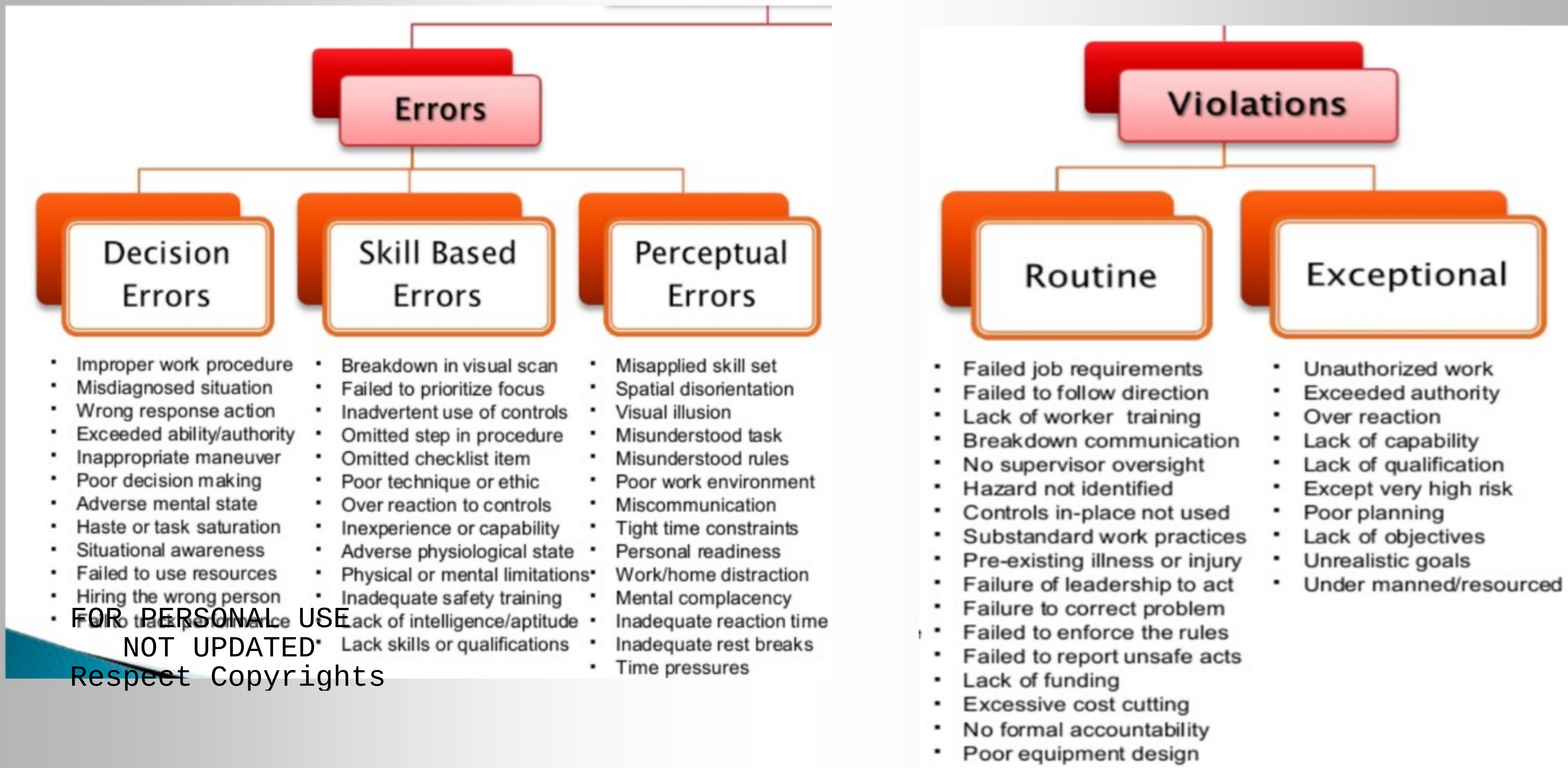
Human Factors – Applied

Human Factors - Applied

Human Factors – Applied



Human Factors – Applied



Requirements of Organization, SMS and Human Factors

Most Common Issues...

- Organizational change
- Staffing levels/workload
- Training and competence
- Operating procedures
- Managing human failure
- Correct hard/soft skills
- Fatigue and shift change
- Organizational culture
- Human factors in design
- Communications/interfaces
- Integration of human factors into risk
- Assessment and investigations

Requirements of Organization, SMS and Human Factors

Some of the human factor issues and conditions reflecting a weak safety culture include:

- Poor risk perception and accident threat recognition
- Lack of leadership commitment to safeguards
- Inadequate management oversight and control
- Inadequate or unclear risk-decision criteria
- Too difficult to report safety concerns and at-risk decisions/behaviors
- Policy and incentives reward excess risk taking
- Culture does not support desired attitudes/behavior
- Unhealthy attitudes about safety, risk tolerance, and performance expectations
- Inadequate performance standards or poor training
- Schedule and production dominance over safety

Requirements of Organization, SMS and Human Factors

Some key components of human factors that contribute to improved safety performance and might help to prevent human error accidents and organizational failures are:

• Clear specification of personnel qualification standards and required knowledge and skill competencies for both workers and supervisors.

• Scenario – based simulation training for individuals and teams for normal and emergency operations.

- Improved collection, analysis, and display of safety critical well test data, and other operational data, with better human - interface technology, improved operational procedures, and continuous technical training.

Requirements of Organization, SMS and Human Factors

Cont'd

• Identifying critical human factors hazards and risk mitigation procedures for inclusion in the overall SMS.

• Safety training for line supervisors to include human performance and, communication and risk decision-making limitations, and Organizational – Culture Management principles.

• Creating a clear channel for open reporting of safety concerns and feedback from front line workers to management (without fear of reprisal).

• Conducting periodic assessments of a Safety Climate and Culture principles - to include valid metrics, benchmarking, and desired norms.

Requirements of Organization, SMS and Human Factors

Each area involving human performance factors is briefly summarized below:
Individual Worker – considerations include, but are not limited to:

- personnel qualifications,
- training, and experience requirements;
- equipment design and system complexity;
- worker task complexity,
- workspace design and working conditions;
- workload and fatigue;
- local supervision.

Requirements of Organization, SMS and Human Factors

Each area involving human performance factors is briefly summarized below:

Crew/Team – considerations include, but are not limited to:

- crew composition (mixed skill set, and national origin – language and culture);
- work leader's use of authority, supervisory style and oversight permissions;
- on the job communications and prescribed communication protocols;
- Task coordination required; and
- crew training in teamwork or crew resource training.

Requirements of Organization, SMS and Human Factors

Each area involving human performance factors is briefly summarized below:

Organization – includes leadership style and commitment to safe operations versus production goals;

- adequacy of resources (time and materials);
- working conditions; and
- organizational and
- workplace cultures.

HFACS applied to Helios 5B-DBY Accident

Capt Gabe with thanks and
Courtesy of: Dr Ph. Christophides Dr G.Athanasiou

Human Factors

- The causal factor in 80% of all mishaps
- Identified as the single greatest mishap hazard.
- Mishaps are rarely attributed to a single cause or a single individual. They are the end result of many conditions, both active and latent.

Human Factors:
Active and Latent conditions

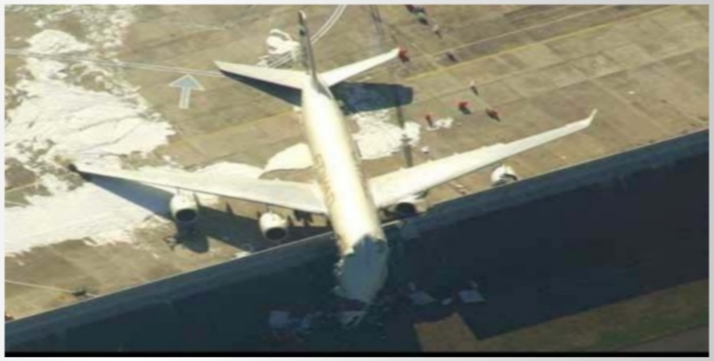
- **Active failures** are the last actions/inactions that are believed to cause the mishap (*direct causes*). Referred to as “error”.

- **Latent failures** are the conditions that *pre-exist* that may influence the sequence of events in a mishap. May remain undetected for some time before they manifest into an event.

Human factors

- The aim of an event investigation is

- to identify these failures,
- understand why it happened,
- prevent it from happening again.



Human Factors: *Domino Theory*

- "Domino" theory:

  mishap is the end result of a series of errors.

Human Factors: *Swiss Cheese Model*

Describes different levels at which failures and conditions may occur.

First level:

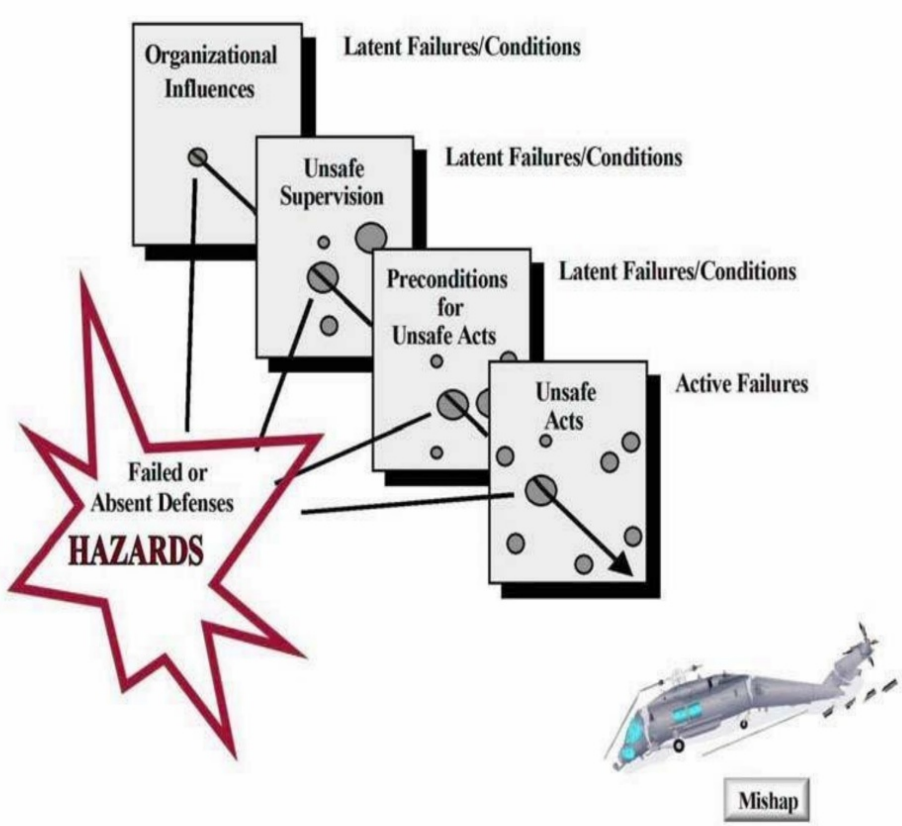
•Unsafe acts of the operator (actions/inactions) leading to the event.

•Active failures / direct causes

Other levels:

• Latent causes

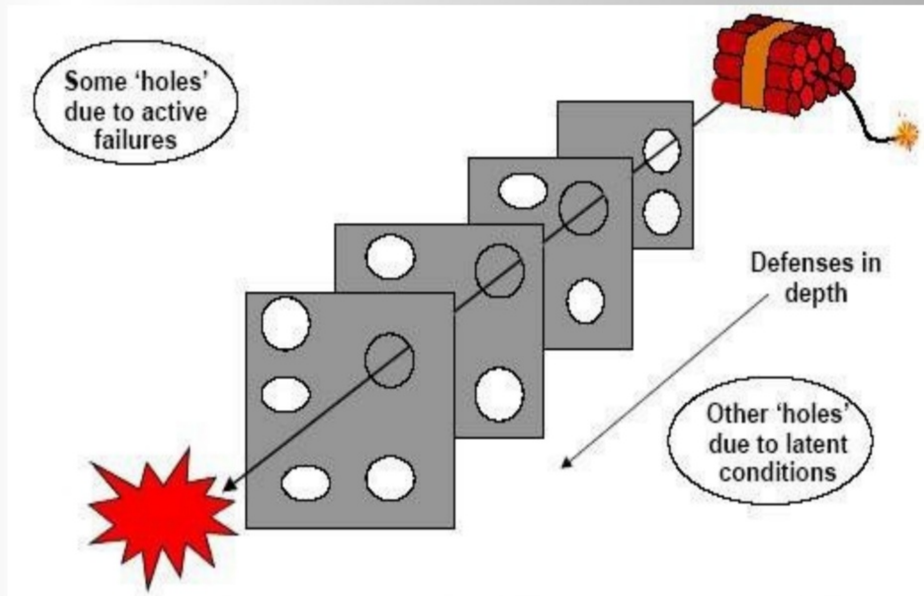
•Should be examined for a more thorough investigation of the mishap.

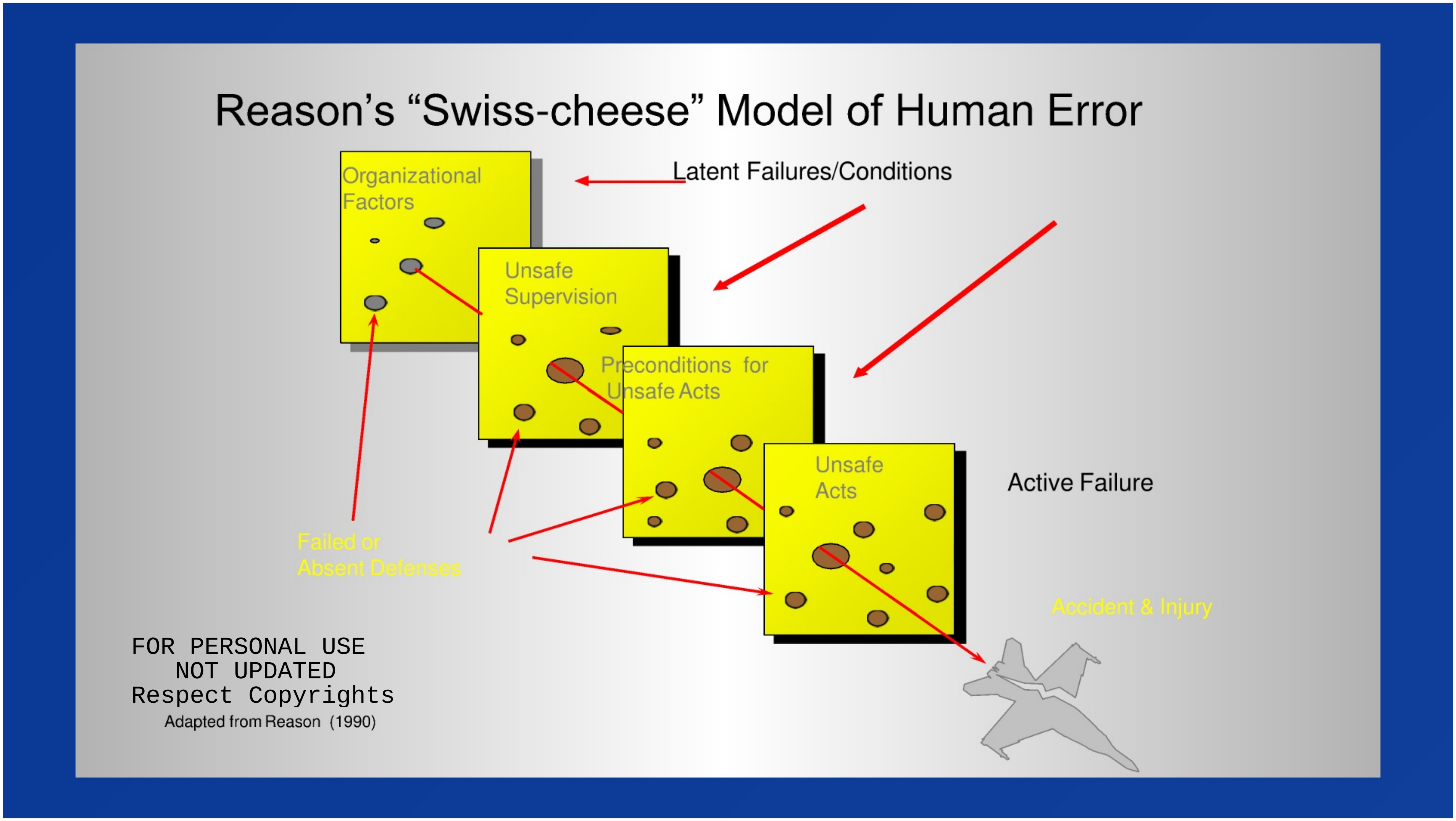


Human Factors: *Swiss Cheese Model*

Even if each mishap is unique, most mishaps have very similar causes! Same "holes" in the cheese!

When the "holes" of every "slice" line up, the system provides a trajectory for an accident to occur




Reason's "Swiss-cheese" Model of Human Error
Latent Failures/Conditions
Organizational Factors
Unsafe Supervision
Preconditions for Unsafe Acts
Unsafe Acts
Active Failure
Failed or Absent Defenses
Accident & Injury
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Respect Copyrights
Adapted from Reason (1990)

Human Factor Analysis and Classification System (HFACS)

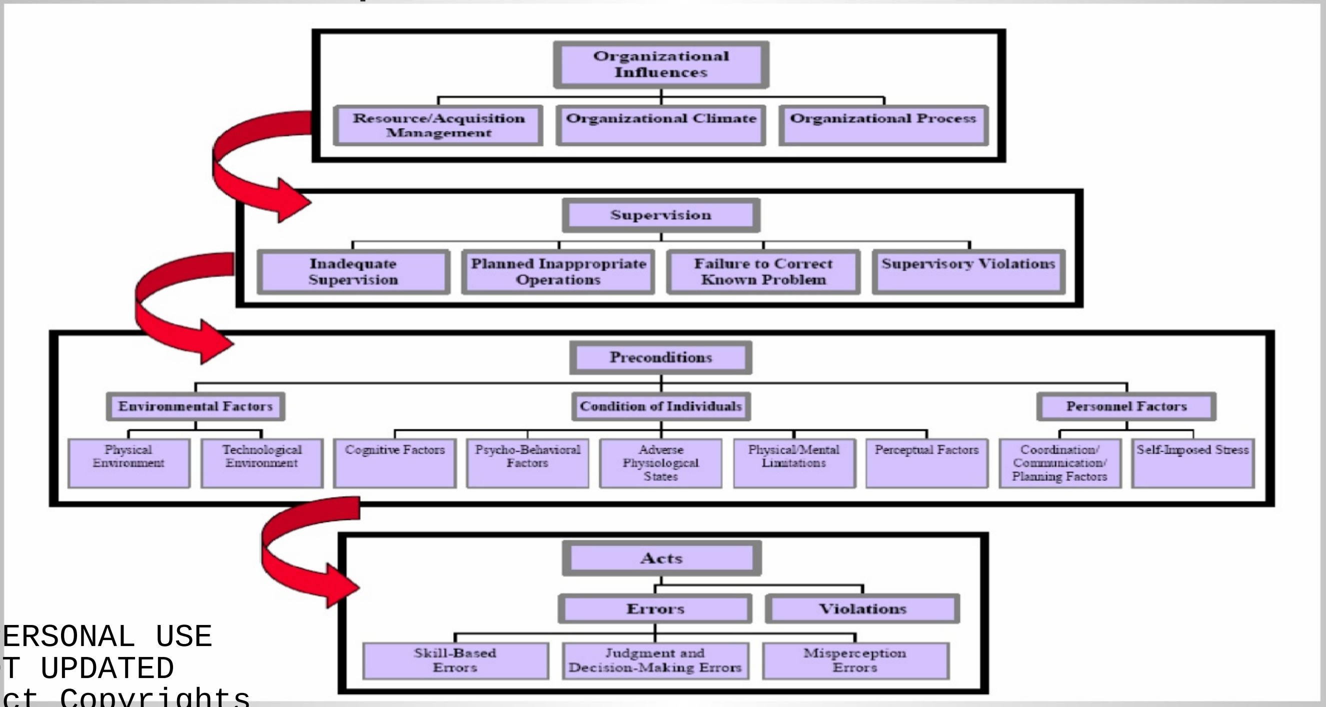
- A new model/taxonomy of Human factors.
- Aim to reduce the number of mishaps and accidents in organizations, incl. aviation.
- Can be used as a primary or secondary tool to investigate ***active*** and ***latent*** failures in an event/mishap.

Human Factor Analysis and Classification System (HFACS)

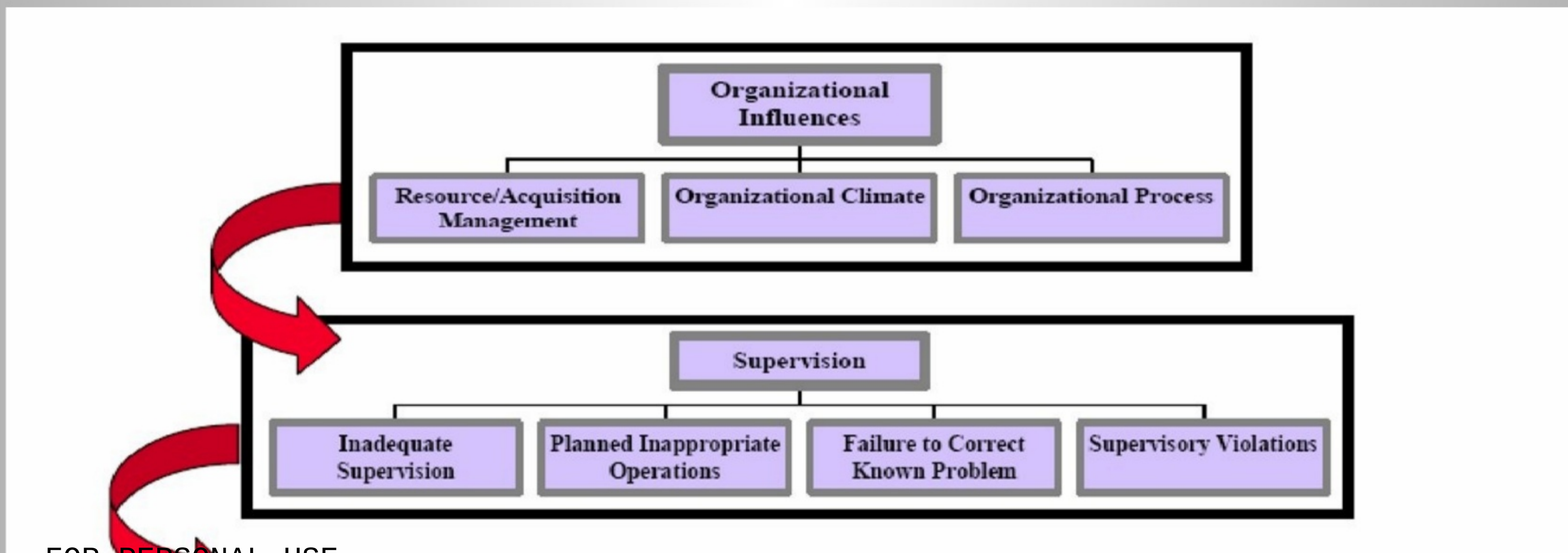
- Brings together Human Factors, Operations, Human Systems, Engineering Issues:
  Man, Machine, Medium, Mission, Management.

- It describes four main tiers of failures/conditions:
  - Acts
  - Preconditions
  - Supervision
  - Organizational Influences

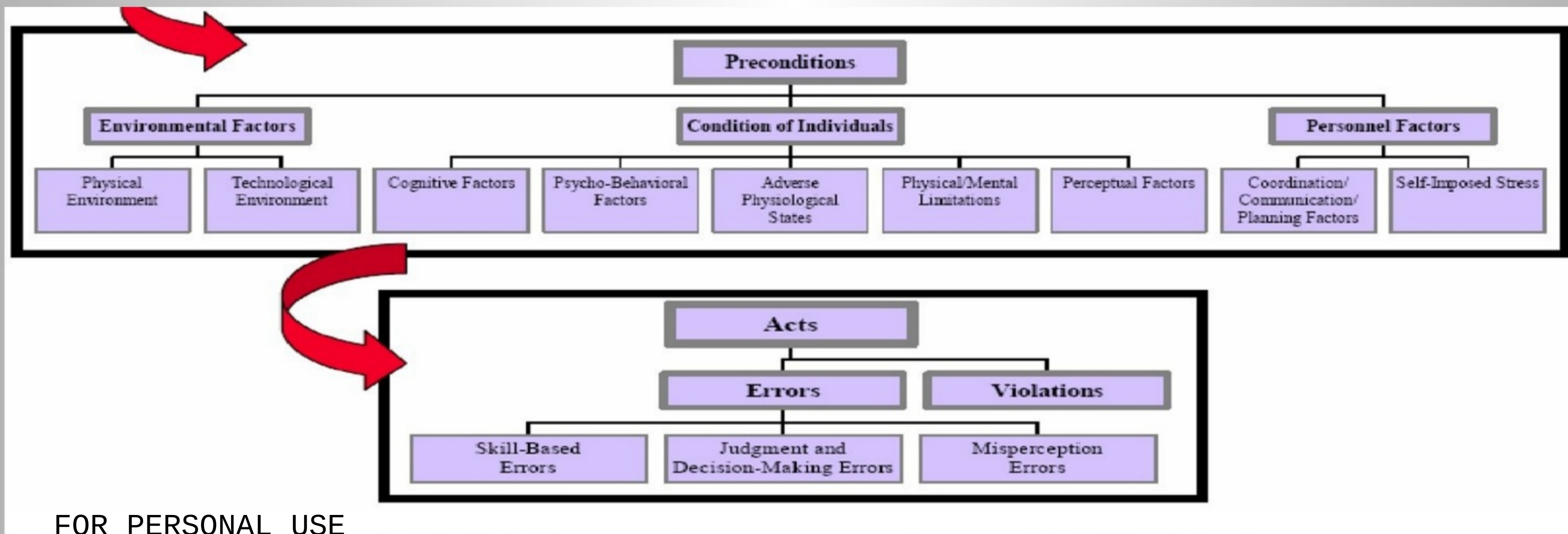
- HFACS Model picture



- HFACS Model picture



- HFACS Model picture

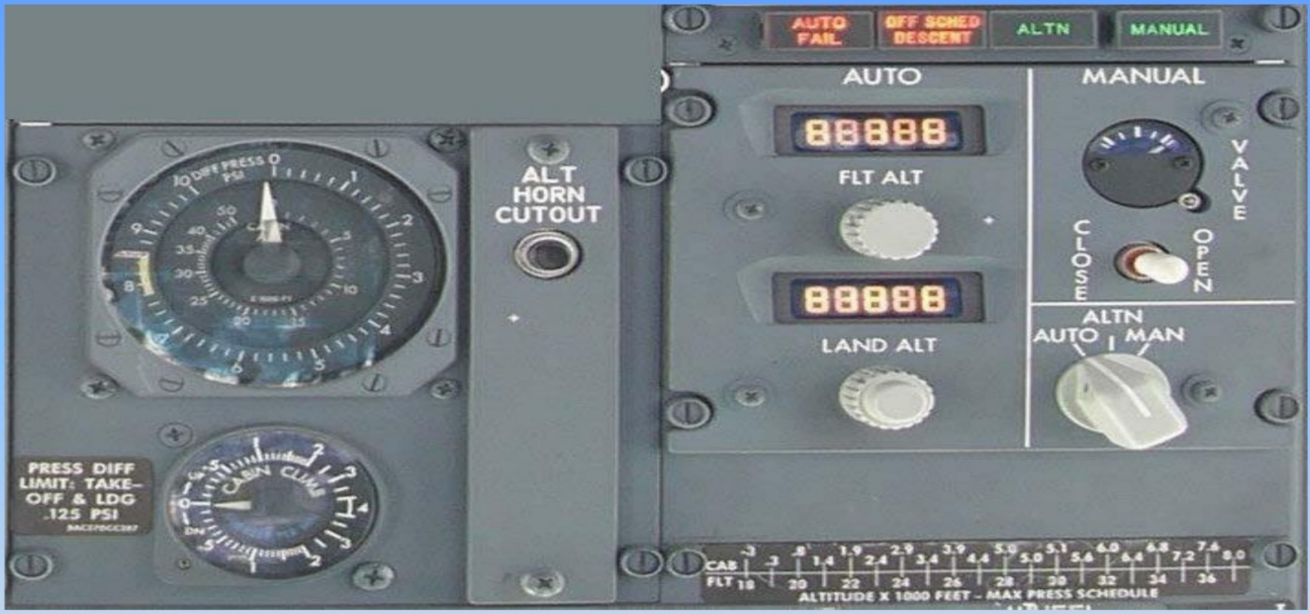


Human Factor Analysis and Classification System (HFACS)

- Focuses on the system instead of the individual (more holistic approach)
- Not just individual failures
- Failures in systems that humans design, build, operate and maintain
- Organized in a systemic format / code system for easier identification

Sequence of events

- B737-300 arrived LCA from LHR 04:25
- After concerns of crew, inspection of aft service door and cabin pressurization check by ground engineer.

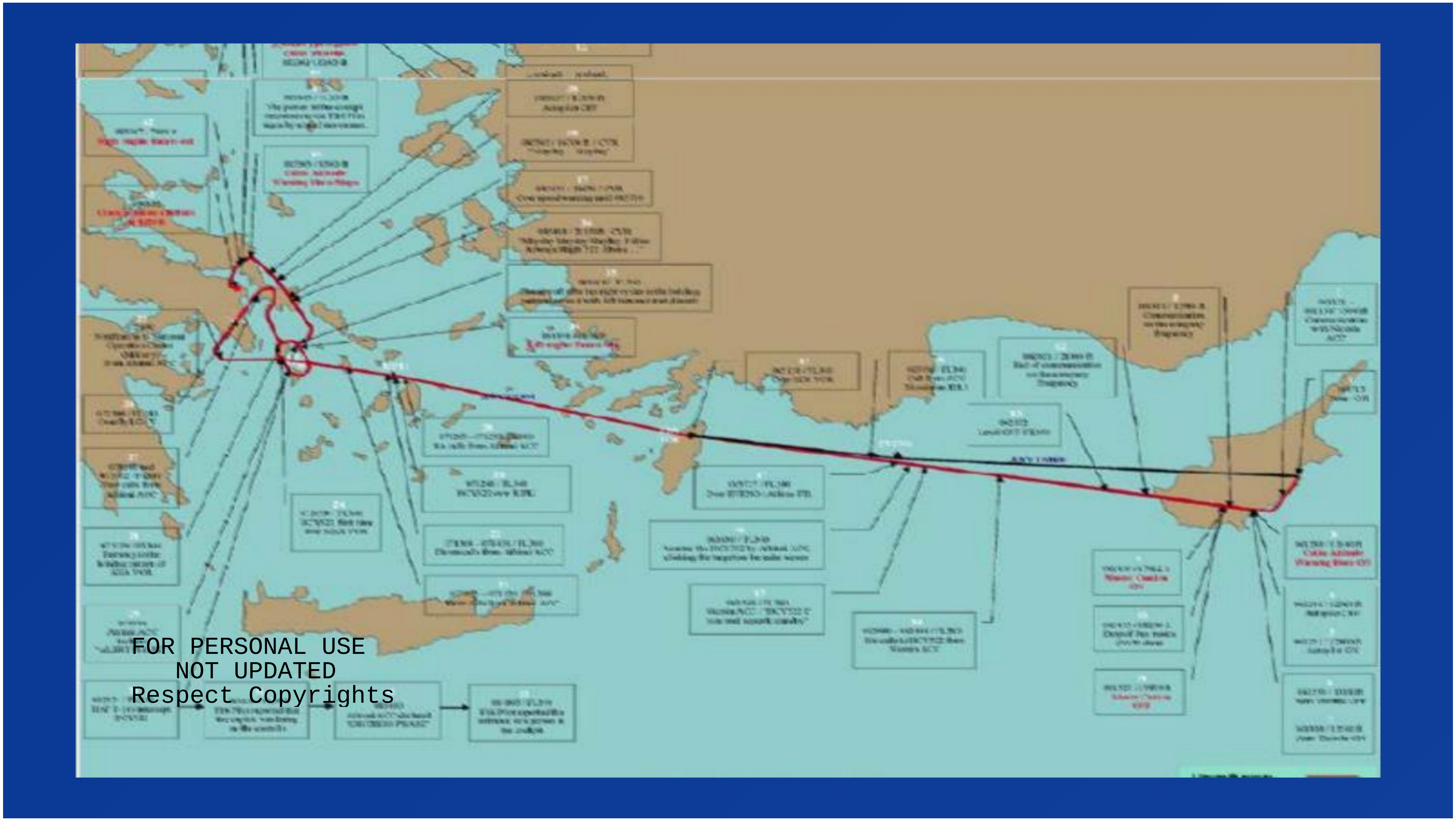


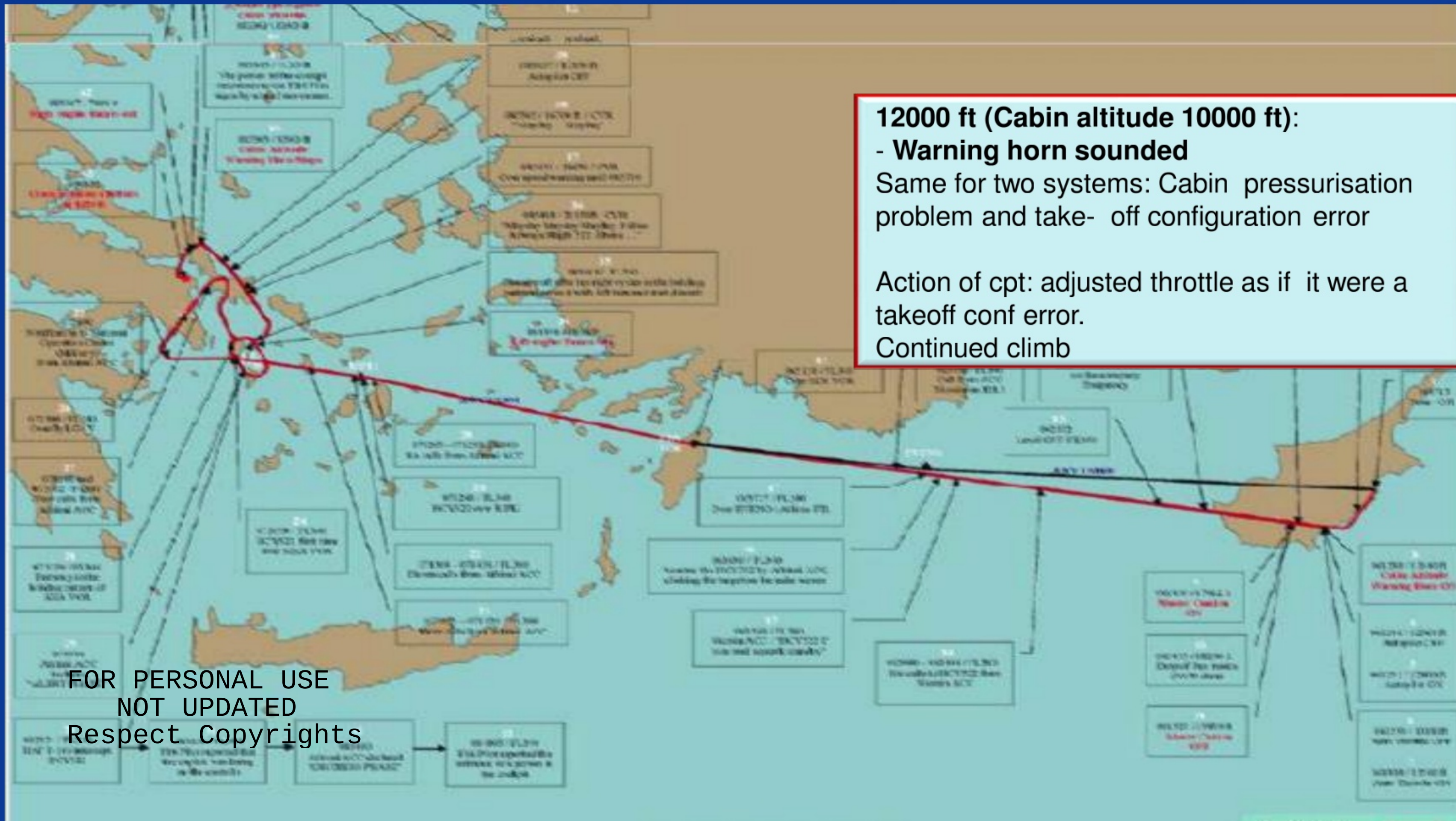
- DCPCS: Digital cabin pressure control system
- AUTO / ALTN / MAN

- Ground pressurization check requires the DCPS to be in the MAN position.
- Nil defects
- Aircraft released for next flight
- Remained in MAN position


• Scheduled flight HCY522 LCA-ATH-PRG 09:00h
• German Captain, Cypriot FO, 4 cabin crew, 115 passengers

Departure from RNW 22 LCA 09:07am Cleared for FL340, direct to RDS VOR

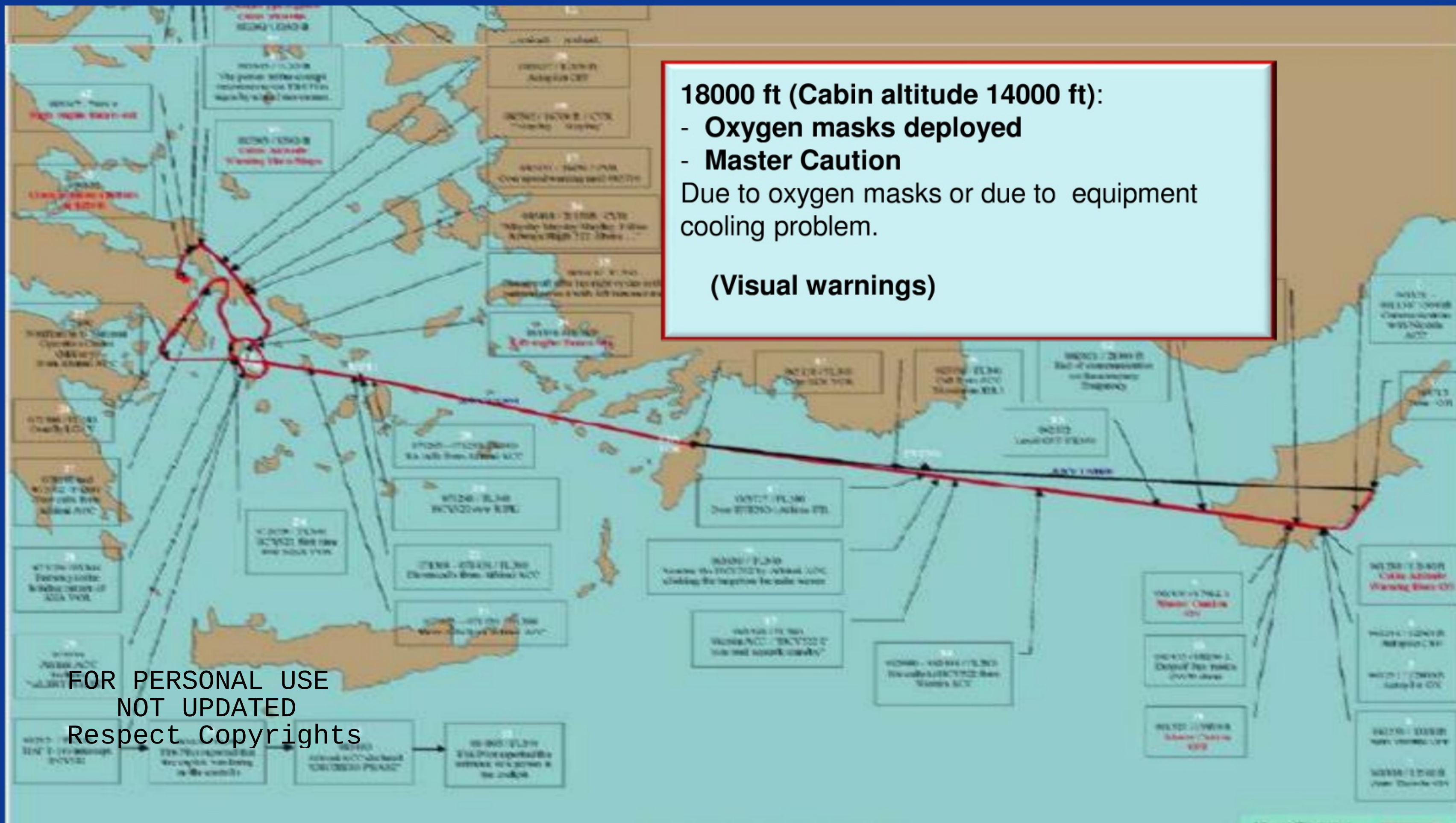


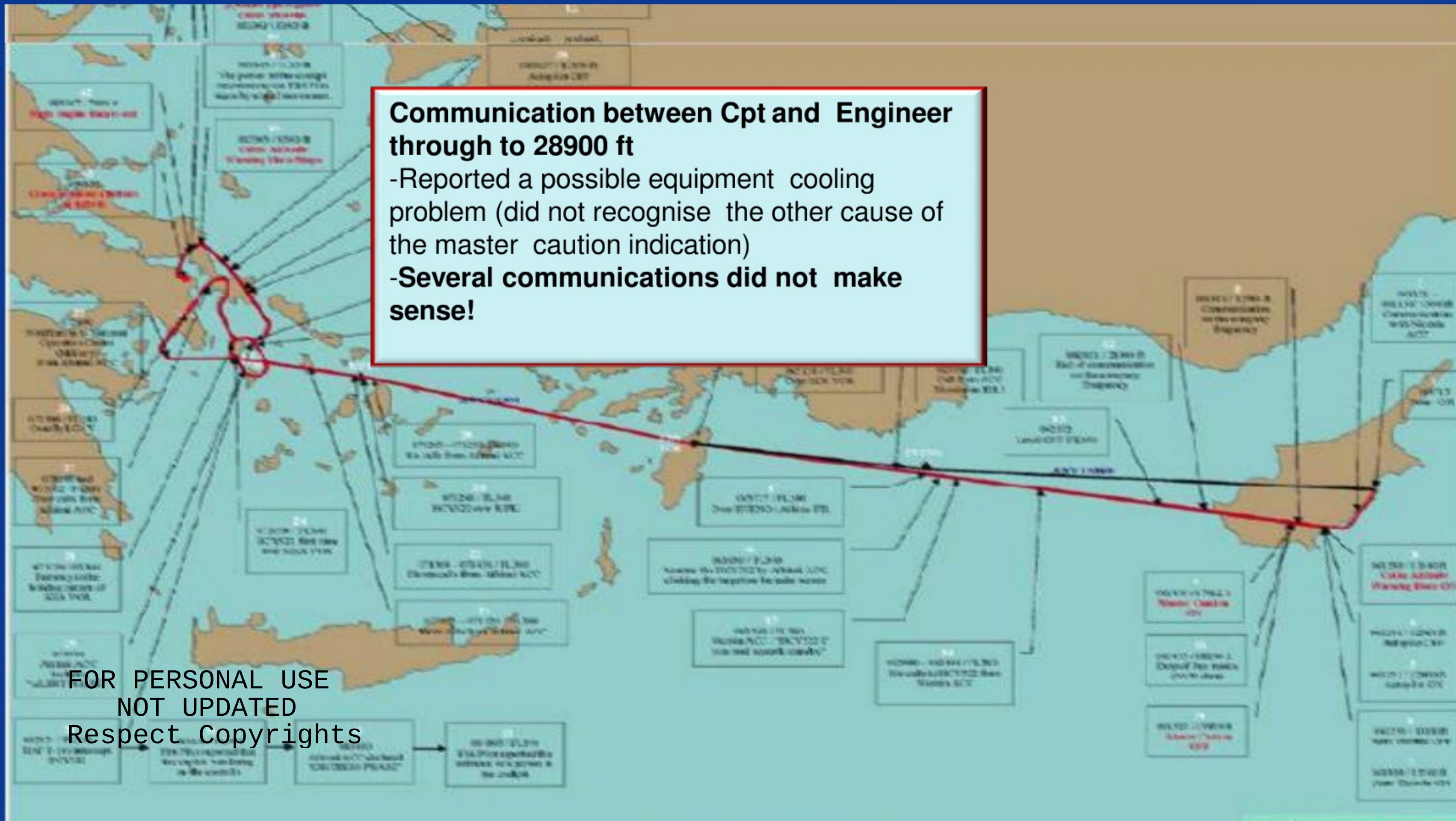


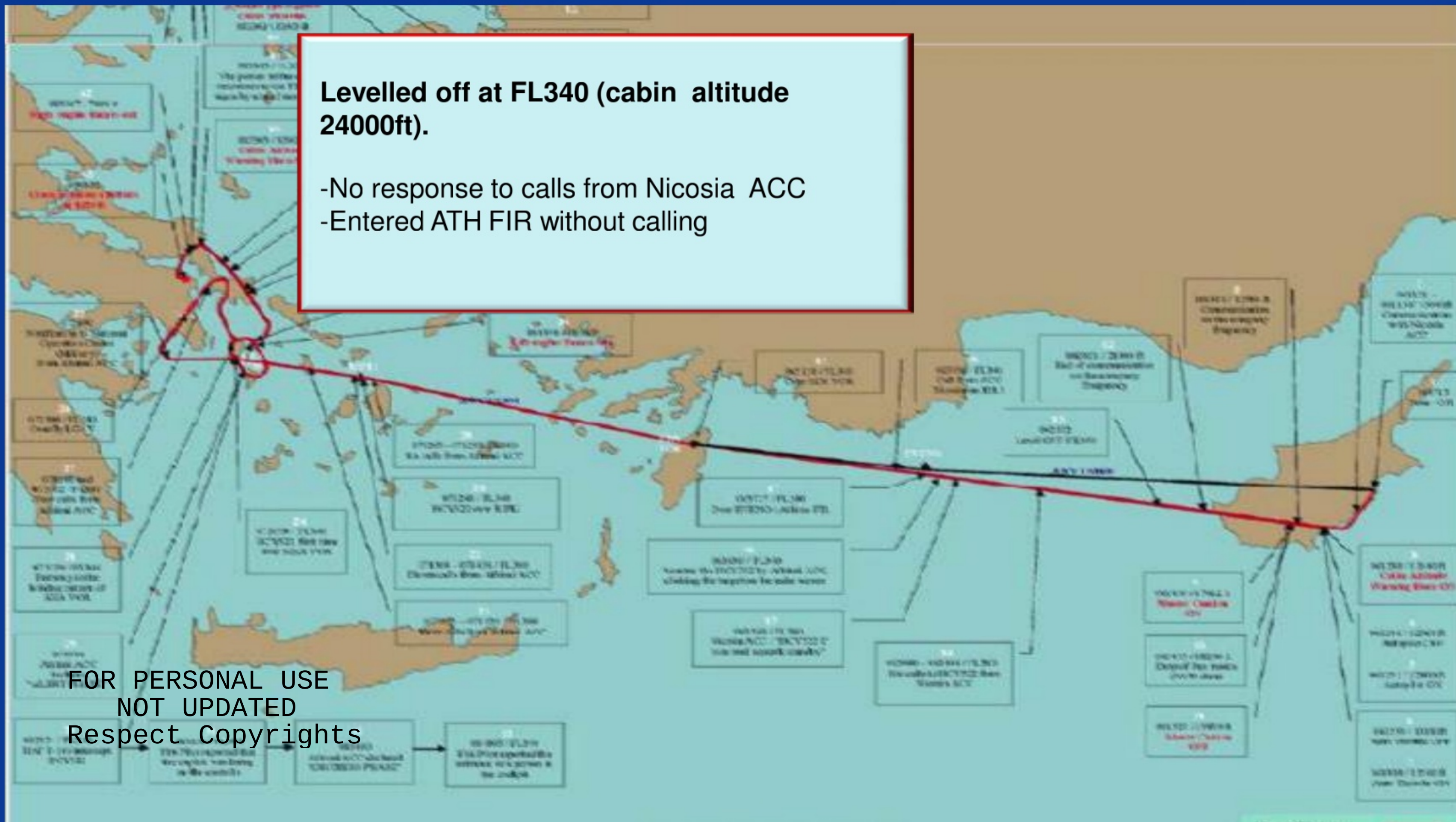
12000 ft (Cabin altitude 10000 ft):
- **Warning horn sounded**

Same for two systems: Cabin pressurisation problem and take- off configuration error

Action of cpt: adjusted throttle as if it were a takeoff conf error.
Continued climb

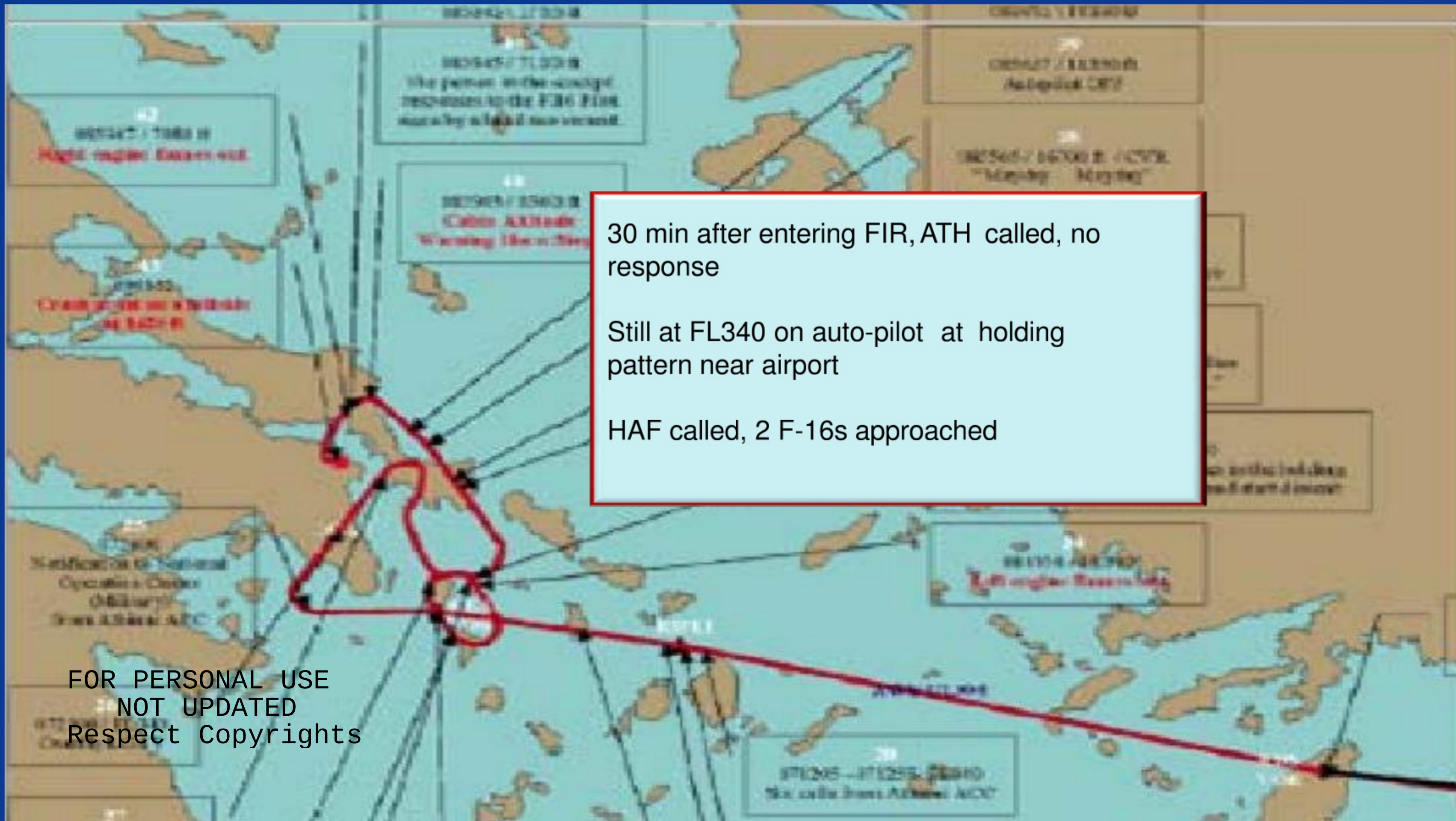

18000 ft (Cabin altitude 14000 ft):
- Oxygen masks deployed
- Master Caution
Due to oxygen masks or due to equipment cooling problem.
(Visual warnings)


Communication between Cpt and Engineer through to 28900 ft
-Reported a possible equipment cooling problem (did not recognise the other cause of the master caution indication)
-Several communications did not make sense!



Levelled off at FL340 (cabin altitude 24000ft).

-No response to calls from Nicosia ACC
-Entered ATH FIR without calling



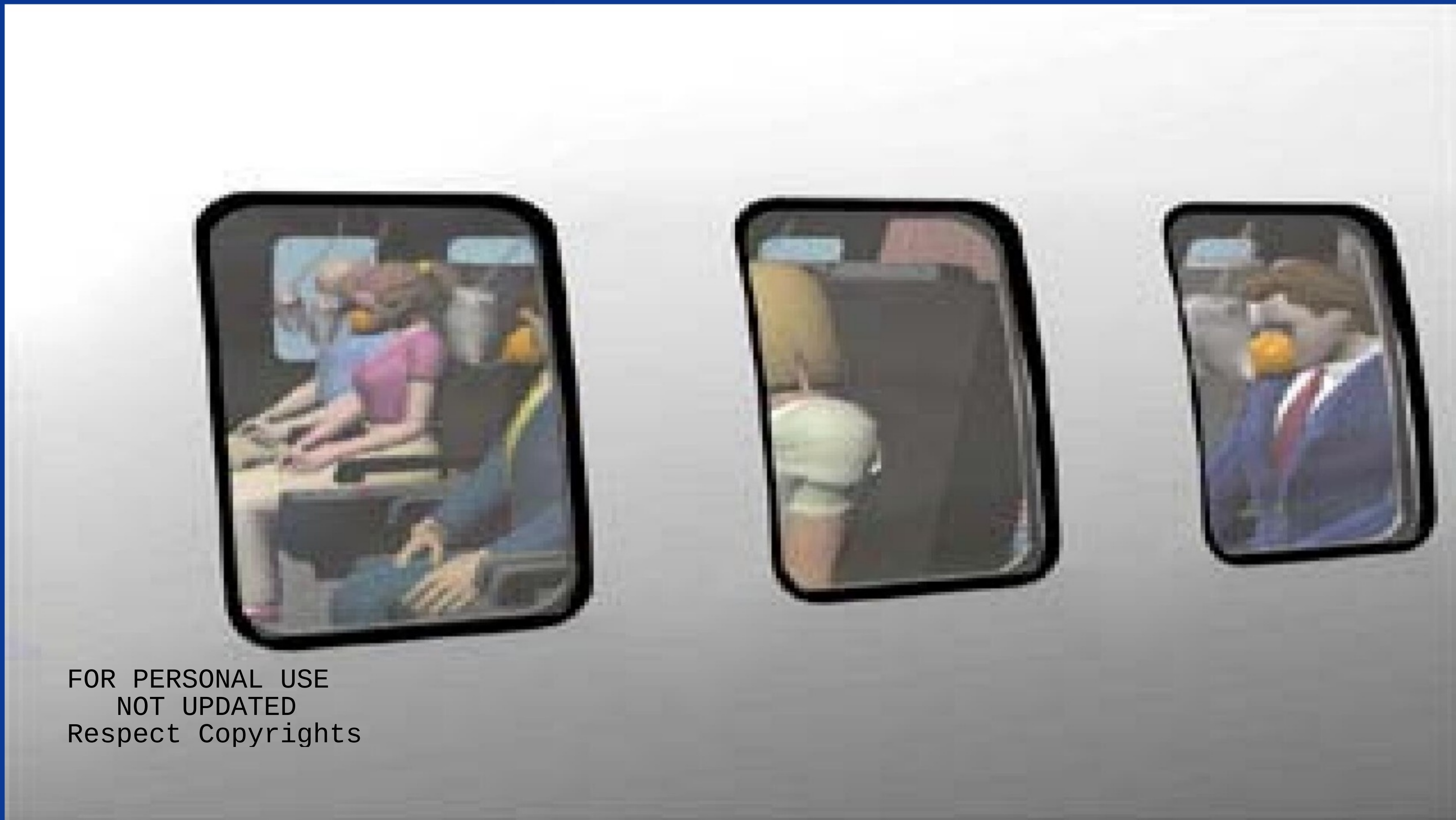
30 min after entering FIR, ATH called, no response

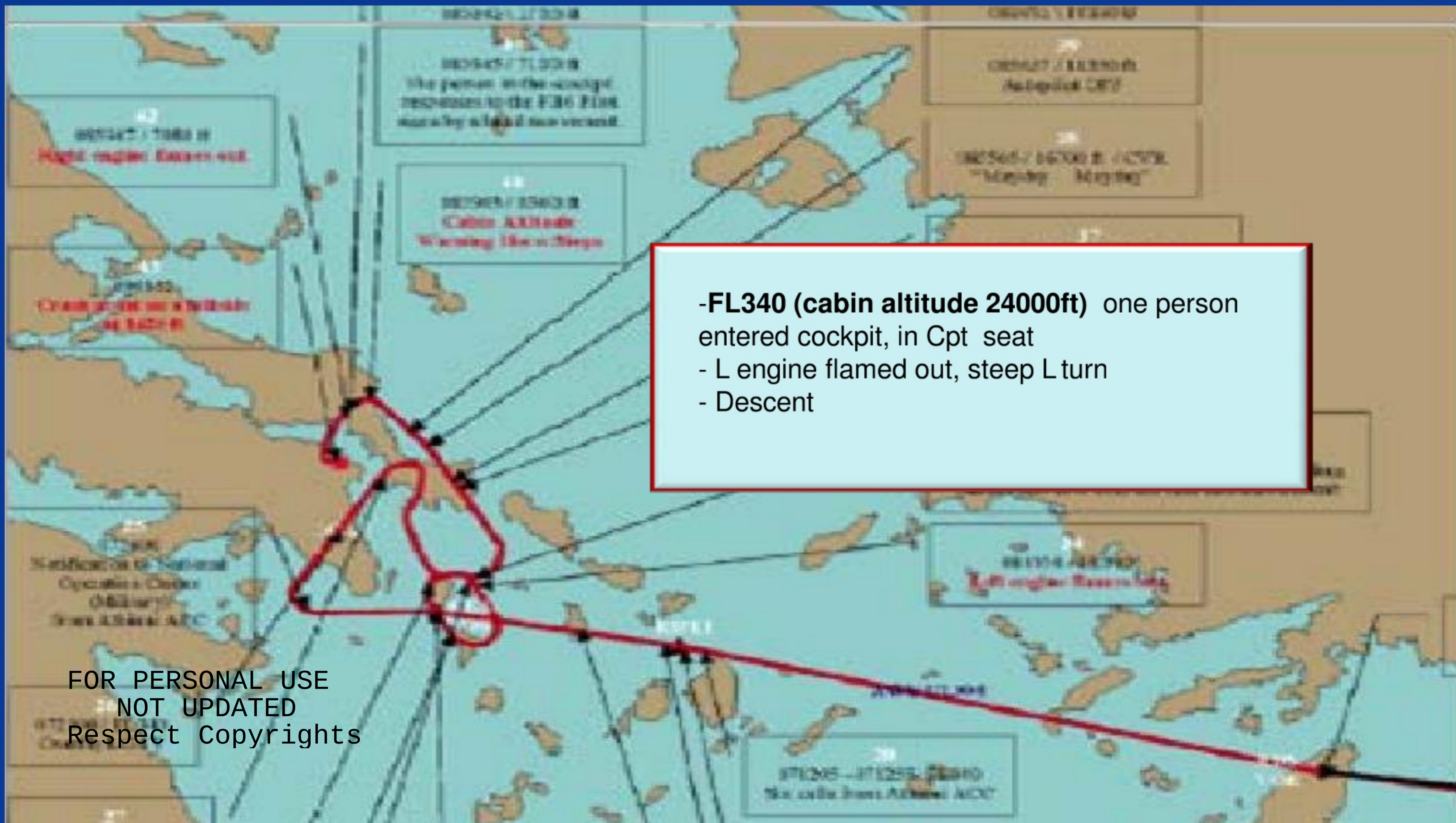
Still at FL340 on auto-pilot at holding pattern near airport

HAF called, 2 F-16s approached


HELIOS
HELIOS
HELIOS
HELIOS

- Cpt seat empty
- FO slumped over controls without Oxygen mask
- Cabin motionless
- Passenger oxygen masks deployed
- Some passengers wearing masks

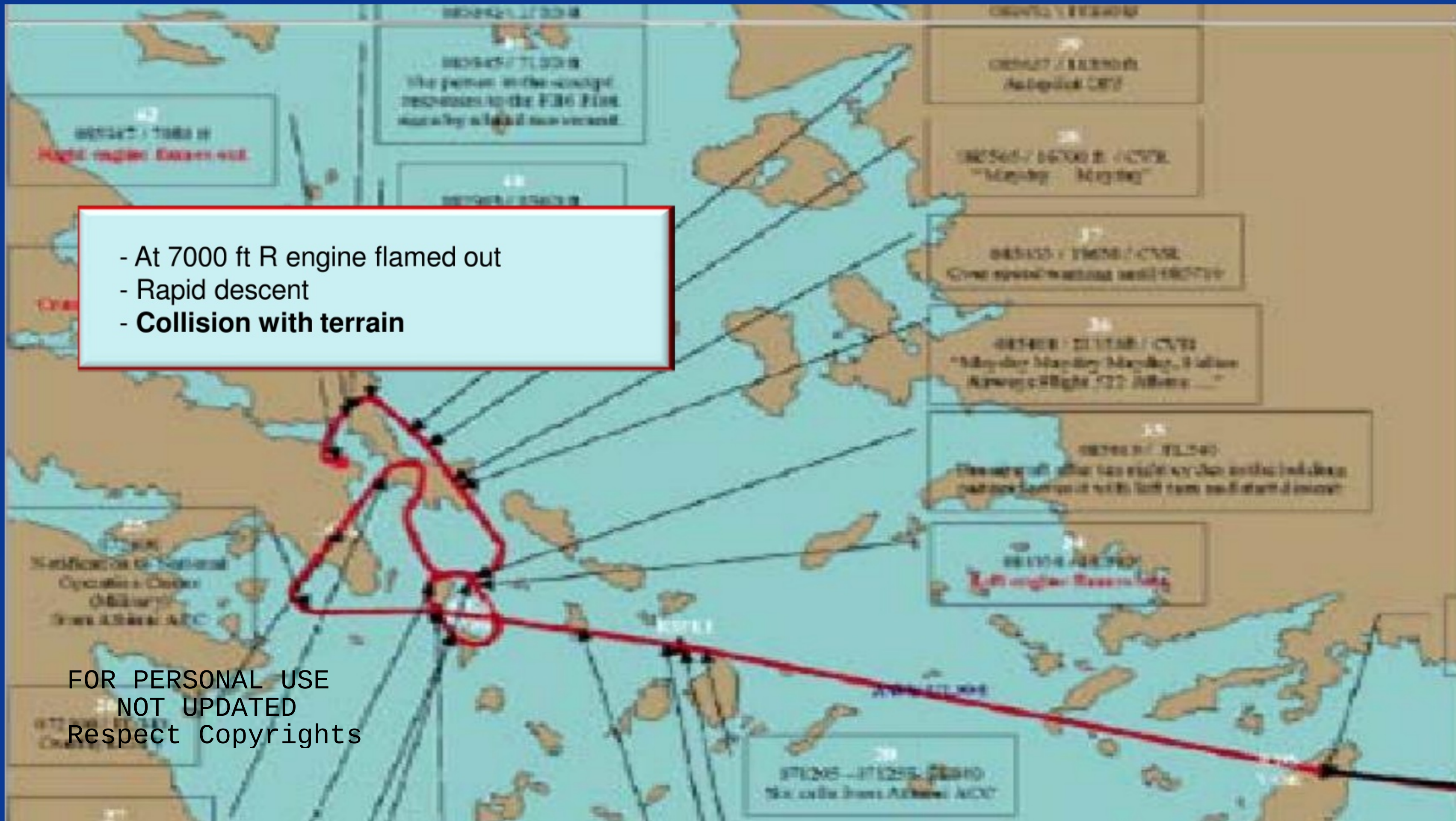


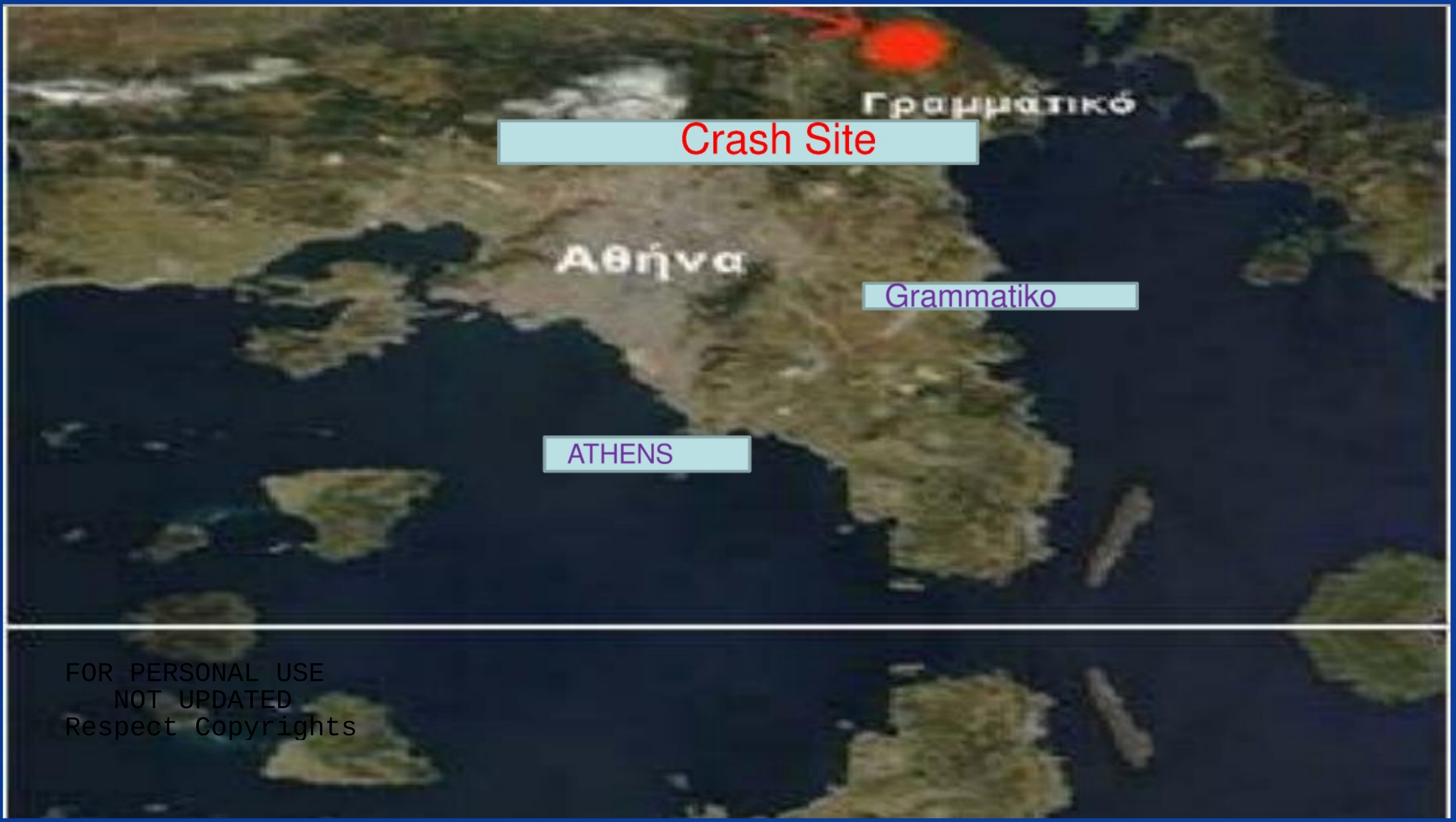


-**FL340 (cabin altitude 24000ft)** one person entered cockpit, in Cpt seat
- L engine flamed out, steep L turn
- Descent

A very weak voice was recorded on CVR:

"MAYDAY, MAYDAY, MAYDAY, Helios Airways Flight 522 Athens…"


- At 7000 ft R engine flamed out
- Rapid descent
- **Collision with terrain**


Γραμματικό
Crash Site
Αθήνα
Grammatiko
ATHENS

HELLENIC REPUBLIC
MINISTRY OF TRANSPORT & COMMUNICATIONS

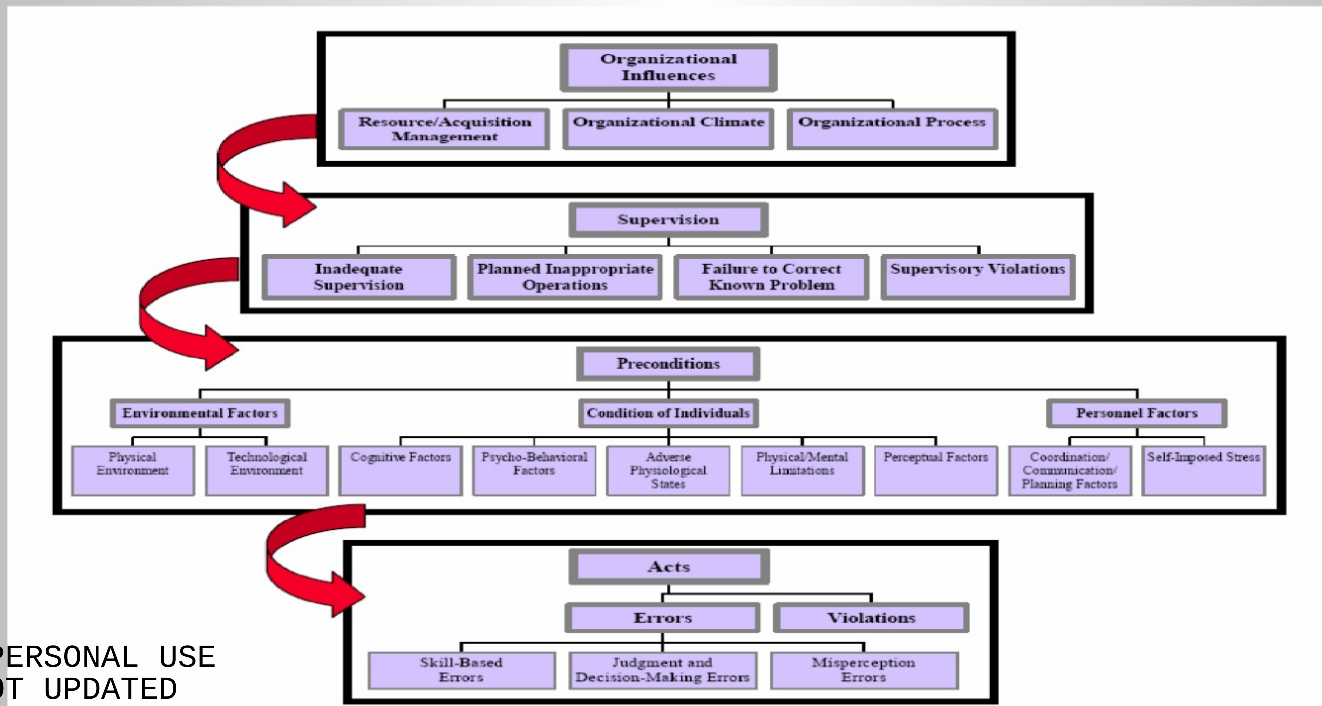
AIR ACCIDENT INVESTIGATION
& AVIATION SAFETY BOARD
(AAIASB)

AAIASB

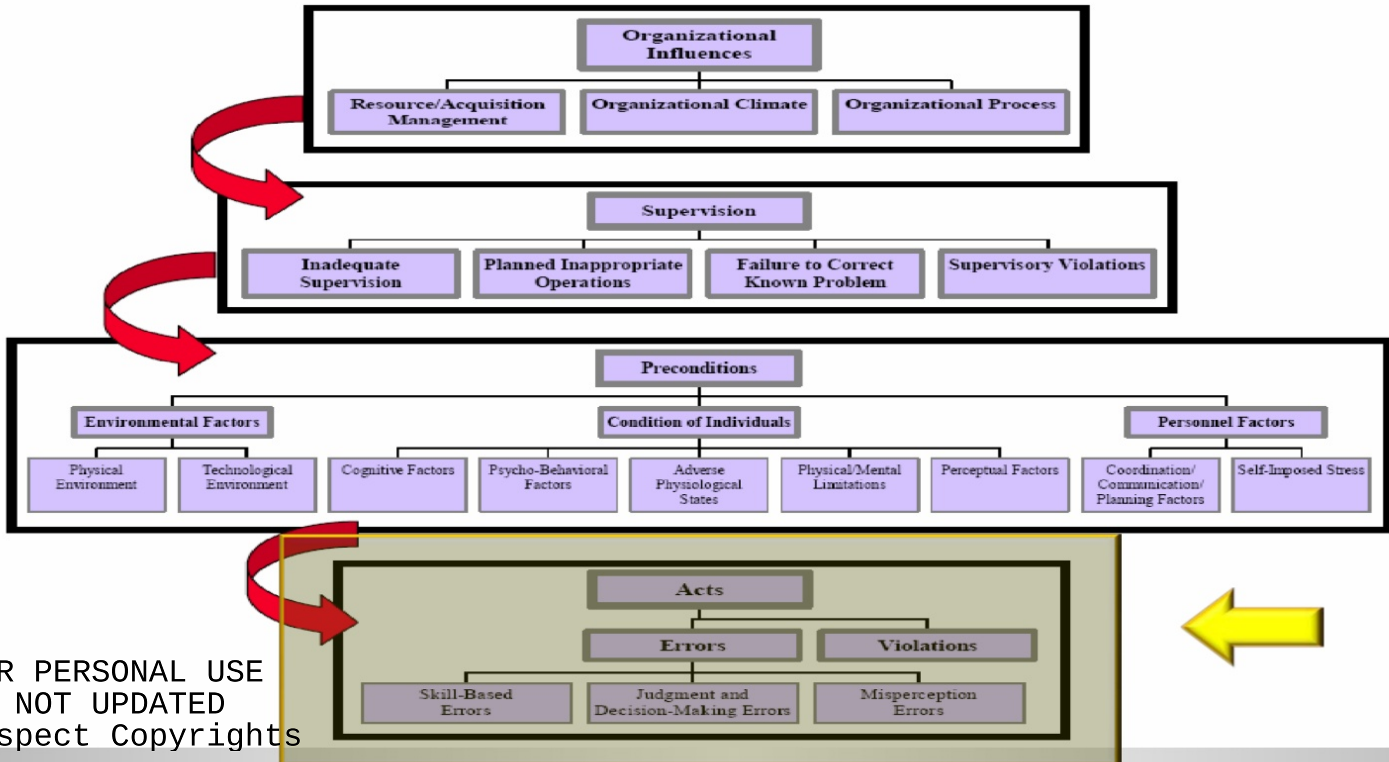
AIRCRAFT ACCIDENT REPORT

HELIOS AIRWAYS FLIGHT HCY522
BOEING 737-31S
AT GRAMMATIKO, HELLAS
ON 14 AUGUST 2005

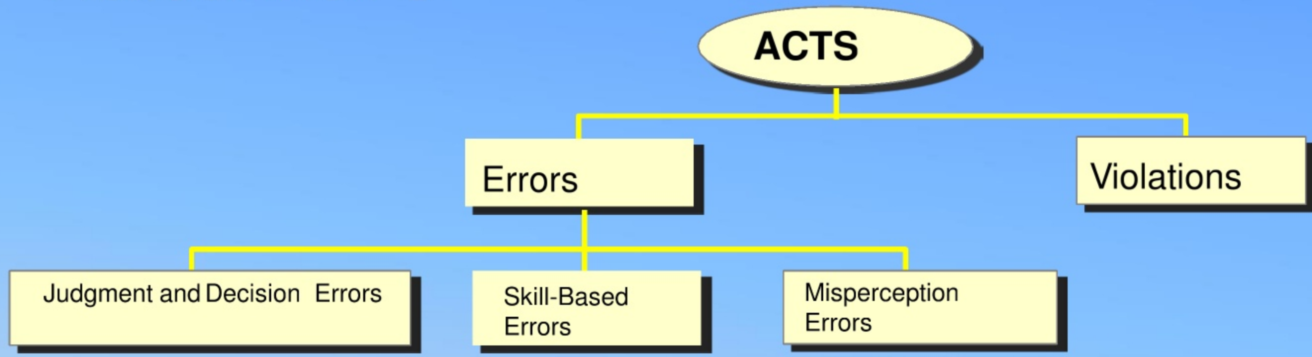
- HFACS Model picture



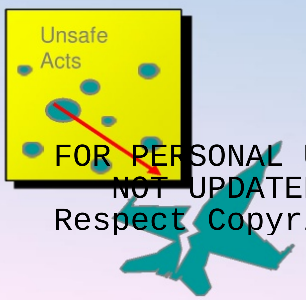
• HFACS Model picture

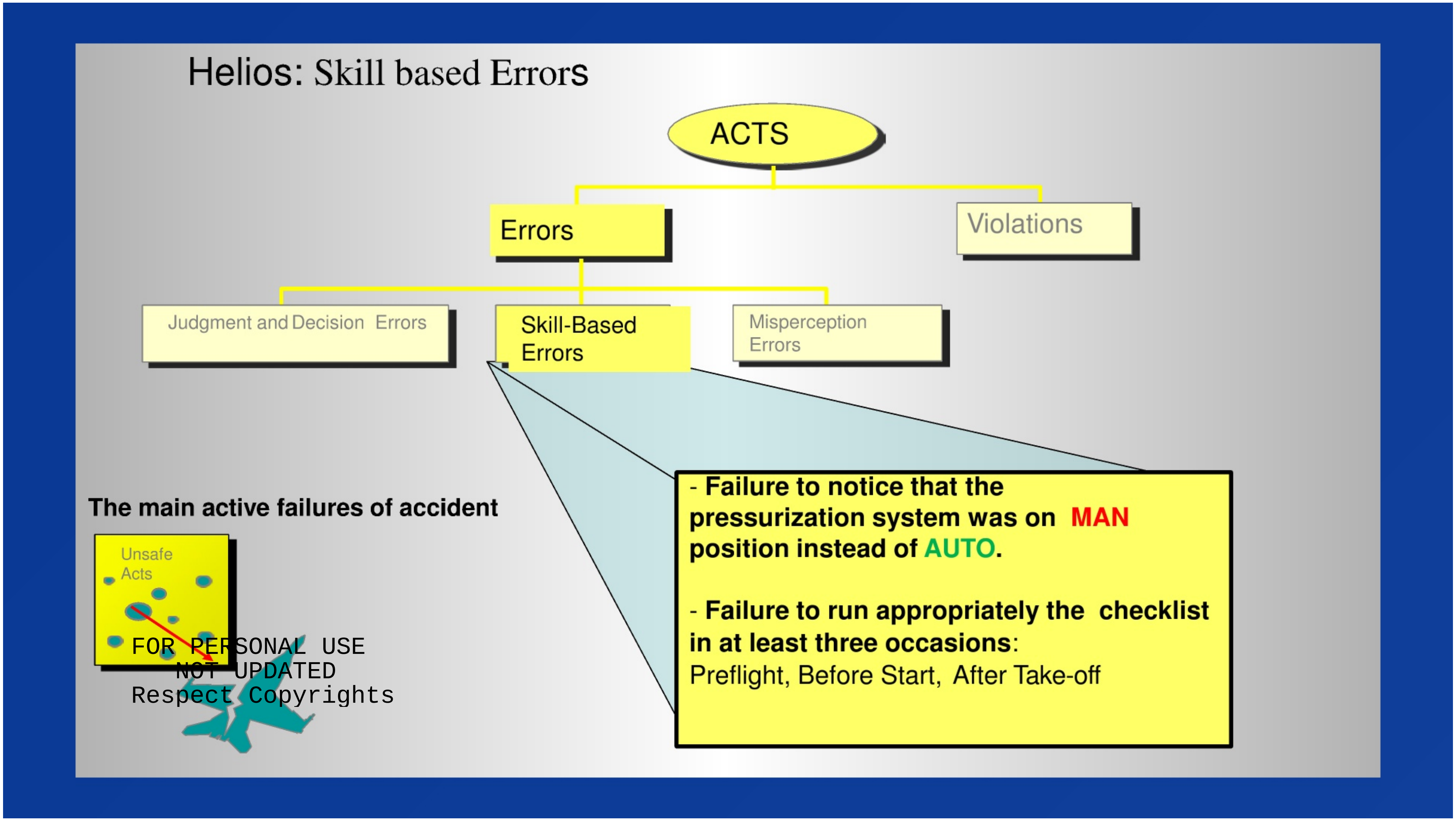


Helios: ACTS

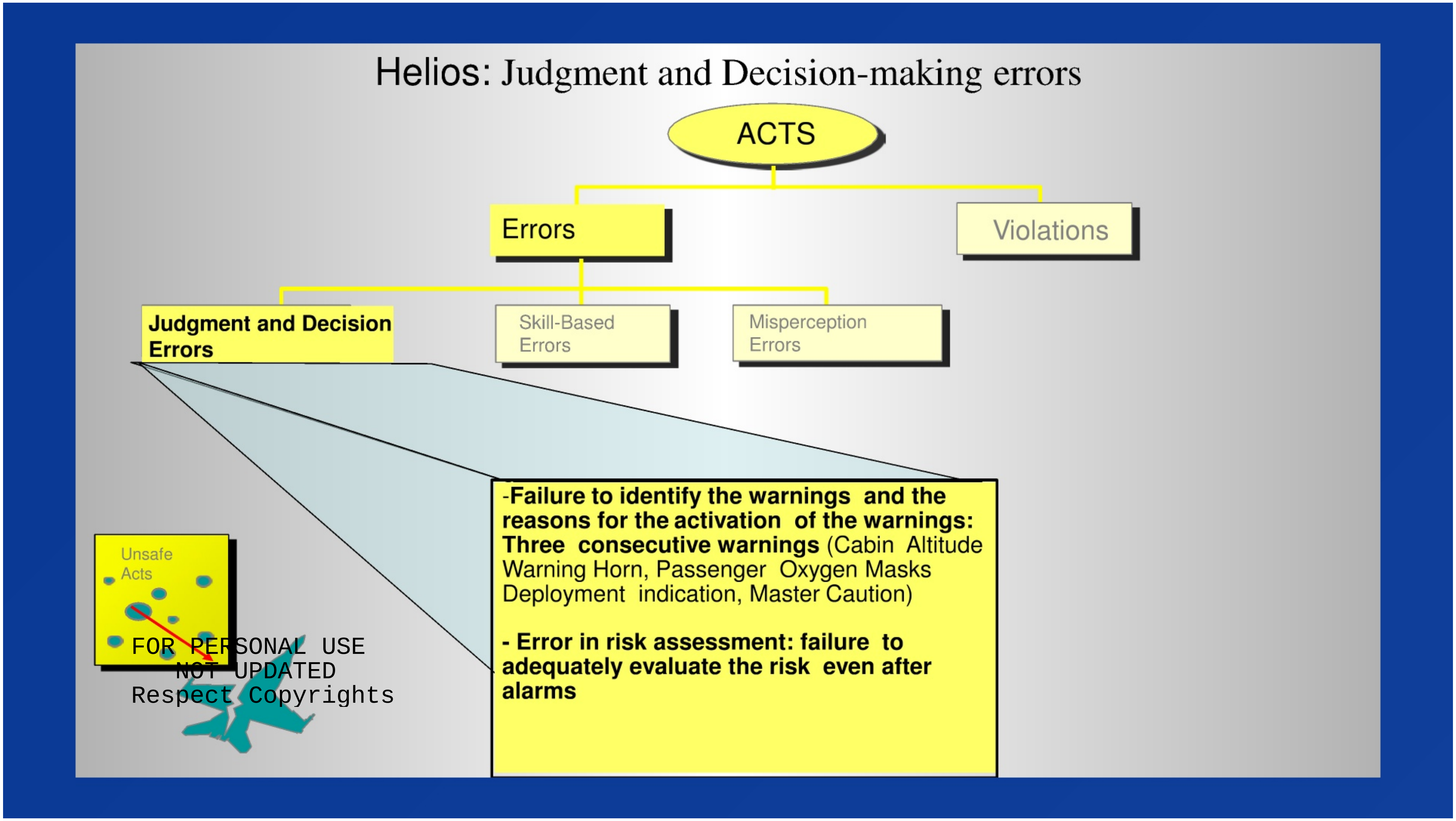


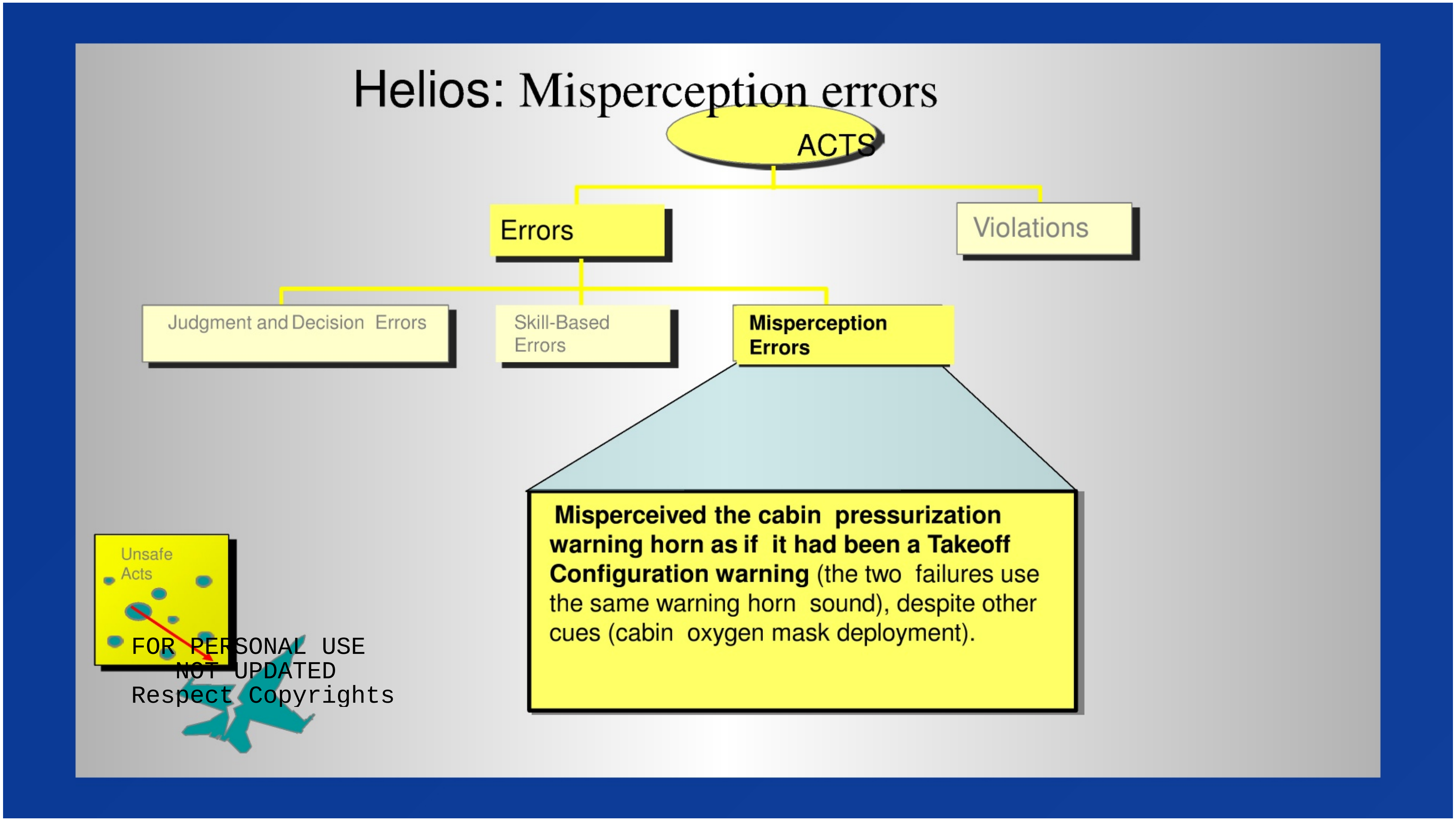
- Active failures / Direct Factors most closely tied to a mishap.
- Errors: Unintended factors as a result of skilled- based, judgment or decision making errors and misperception
- Violations: deliberate actions in a mishap that lead to unsafe situation



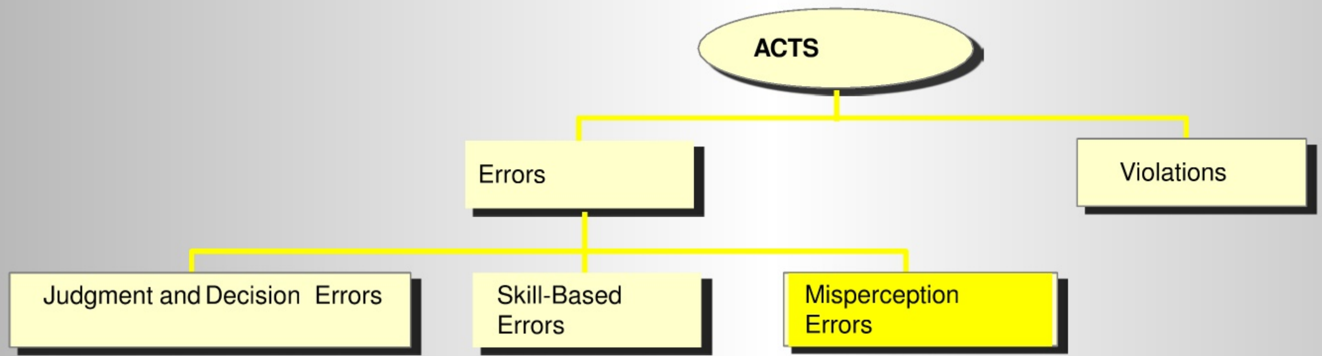

Helios: Skill based Errors
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
The main active failures of accident
Unsafe Acts
- Failure to notice that the pressurization system was on MAN position instead of AUTO.
- Failure to run appropriately the checklist in at least three occasions:
Preflight, Before Start, After Take-off


AUTO
MANUAL
FLT ALT
VALVE
CLOSE
OPEN
ALTN
AUTO
MAN
LAND ALT

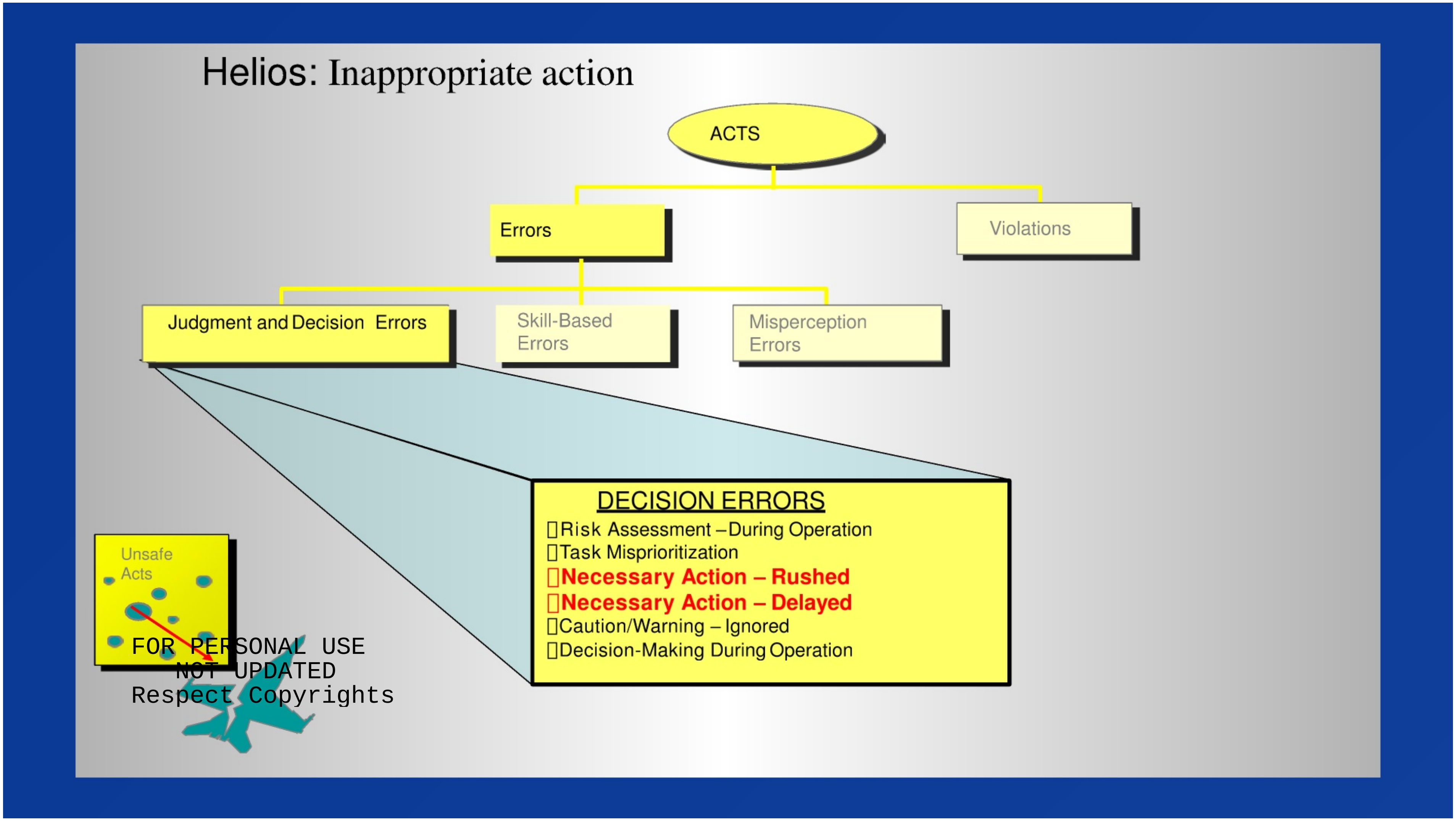

Helios: Judgment and Decision-making errors
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
-Failure to identify the warnings and the reasons for the activation of the warnings: Three consecutive warnings (Cabin Altitude Warning Horn, Passenger Oxygen Masks Deployment indication, Master Caution)
- Error in risk assessment: failure to adequately evaluate the risk even after alarms
Unsafe Acts

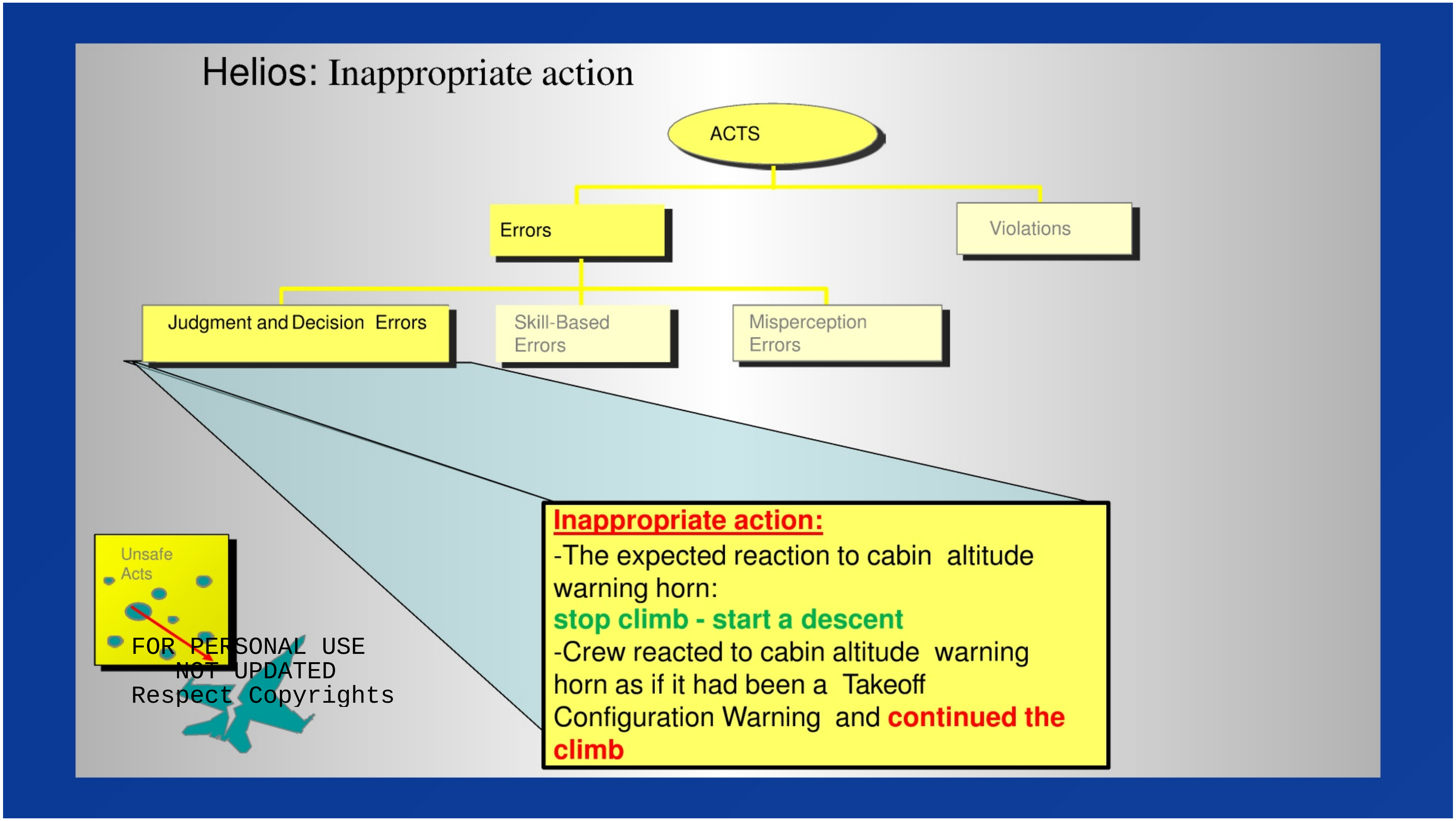

Helios: Misperception errors
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
Misperceived the cabin pressurization warning horn as if it had been a Takeoff Configuration warning (the two failures use the same warning horn sound), despite other cues (cabin oxygen mask deployment).
Unsafe Acts

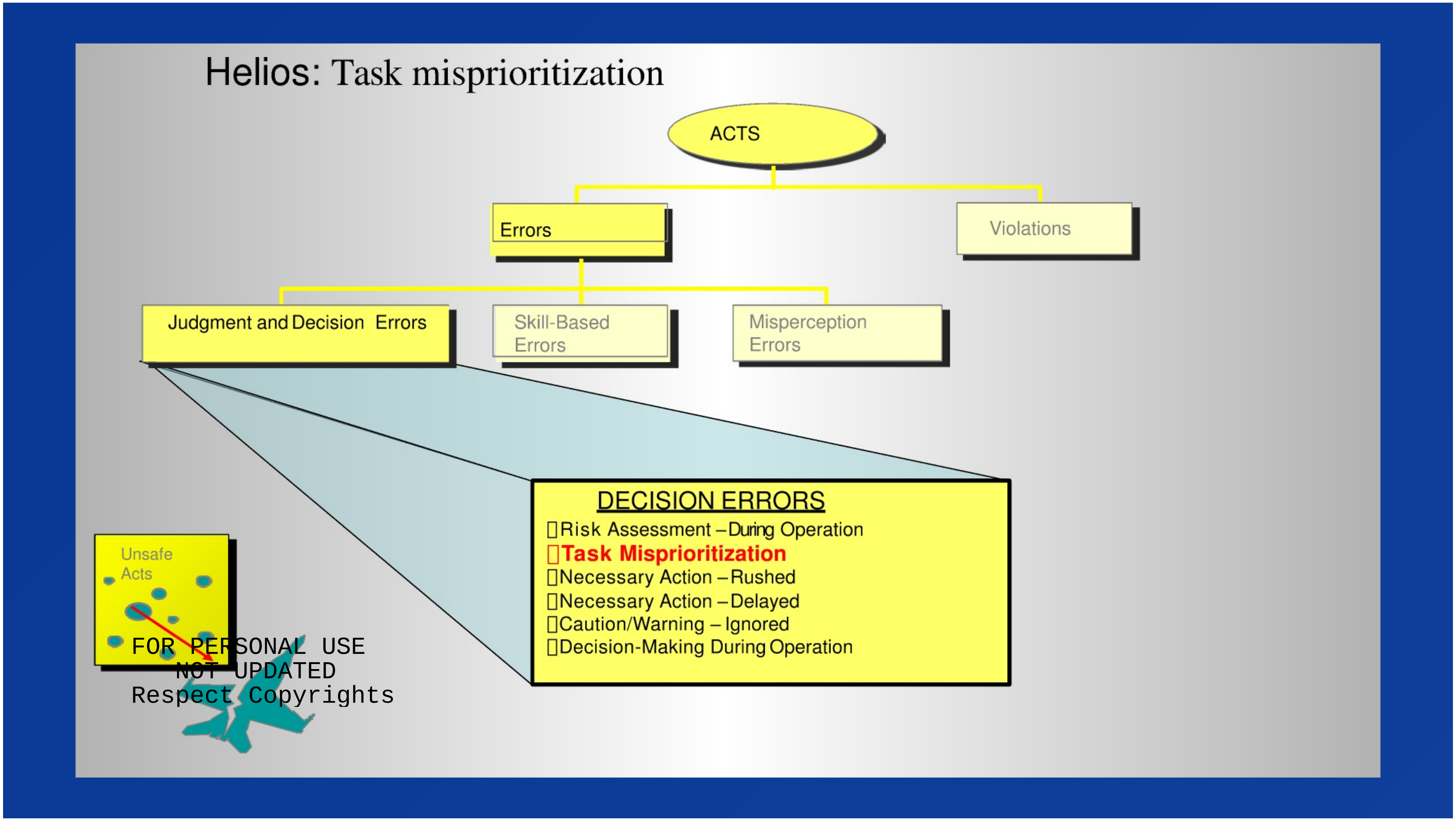
Helios: Misperception errors



- Recommendation to FAA to differentiate the warning horn between the two systems.
- *Why two experienced pilots misperceived these cues?*


Helios: Inappropriate action
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
DECISION ERRORS
Risk Assessment – During Operation
Task Misprioritization
Necessary Action – Rushed
Necessary Action – Delayed
Caution/Warning – Ignored
Decision-Making During Operation
Unsafe Acts


Helios: Inappropriate action
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
Unsafe Acts
Inappropriate action:
-The expected reaction to cabin altitude warning horn:
stop climb - start a descent
-Crew reacted to cabin altitude warning horn as if it had been a Takeoff Configuration Warning and continued the climb


Helios: Task misprioritization
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
DECISION ERRORS
Risk Assessment – During Operation
Task Misprioritization
Necessary Action – Rushed
Necessary Action – Delayed
Caution/Warning – Ignored
Decision-Making During Operation
Unsafe Acts
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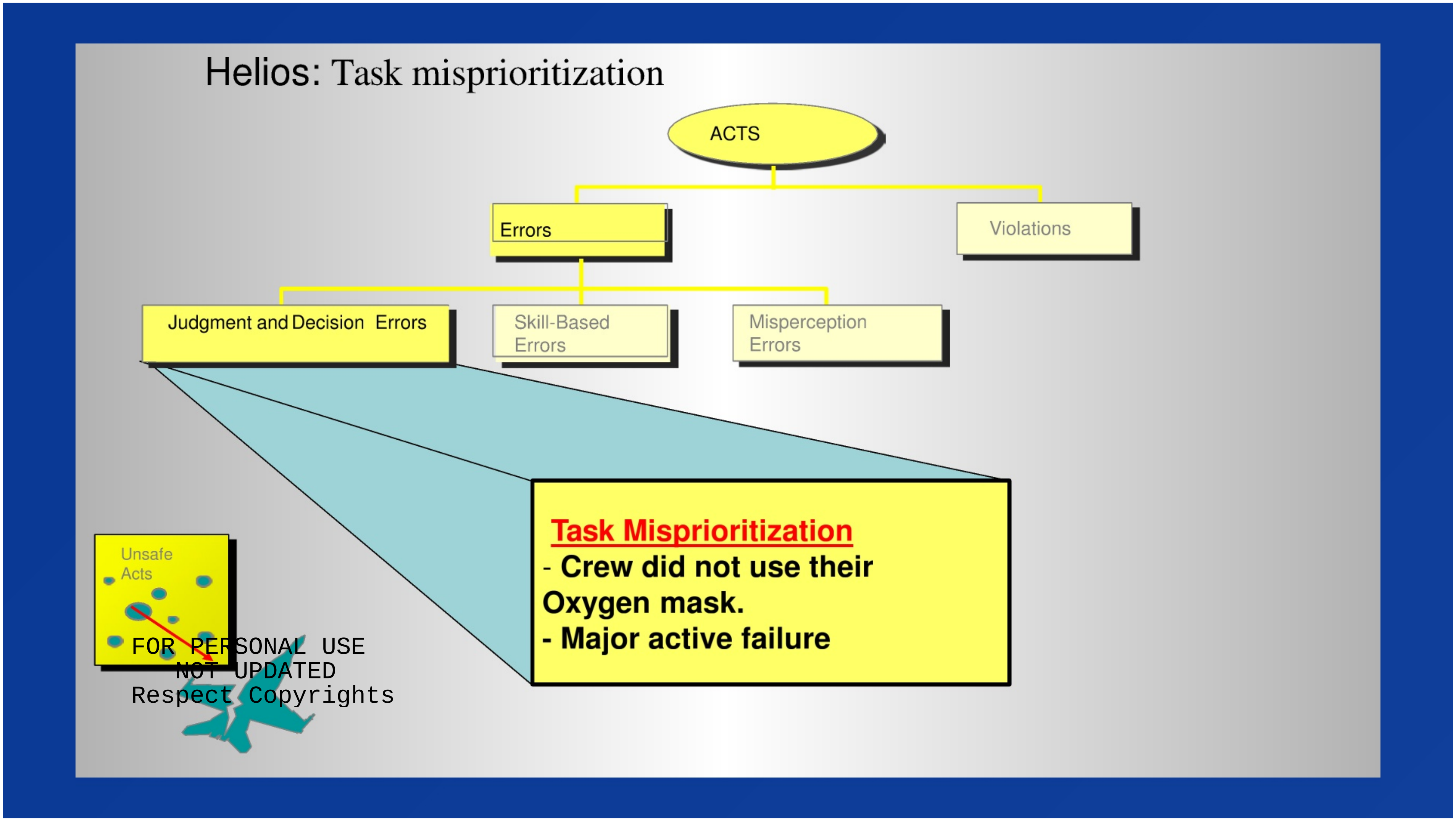
Respect Copyrights

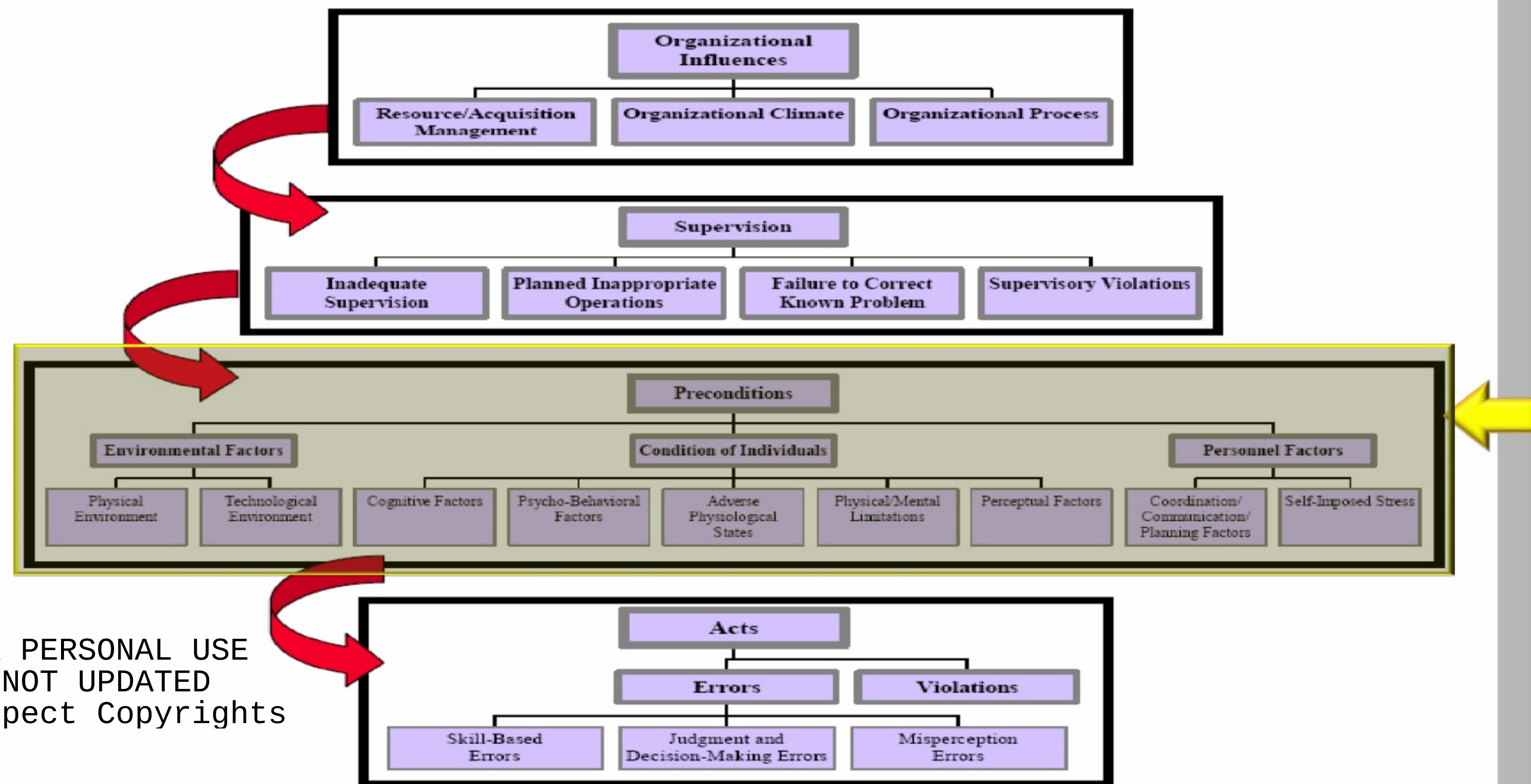

Helios: Task misprioritization
ACTS
Errors
Violations
Judgment and Decision Errors
Skill-Based Errors
Misperception Errors
Task Misprioritization
- Crew did not use their Oxygen mask.
- Major active failure
Unsafe Acts

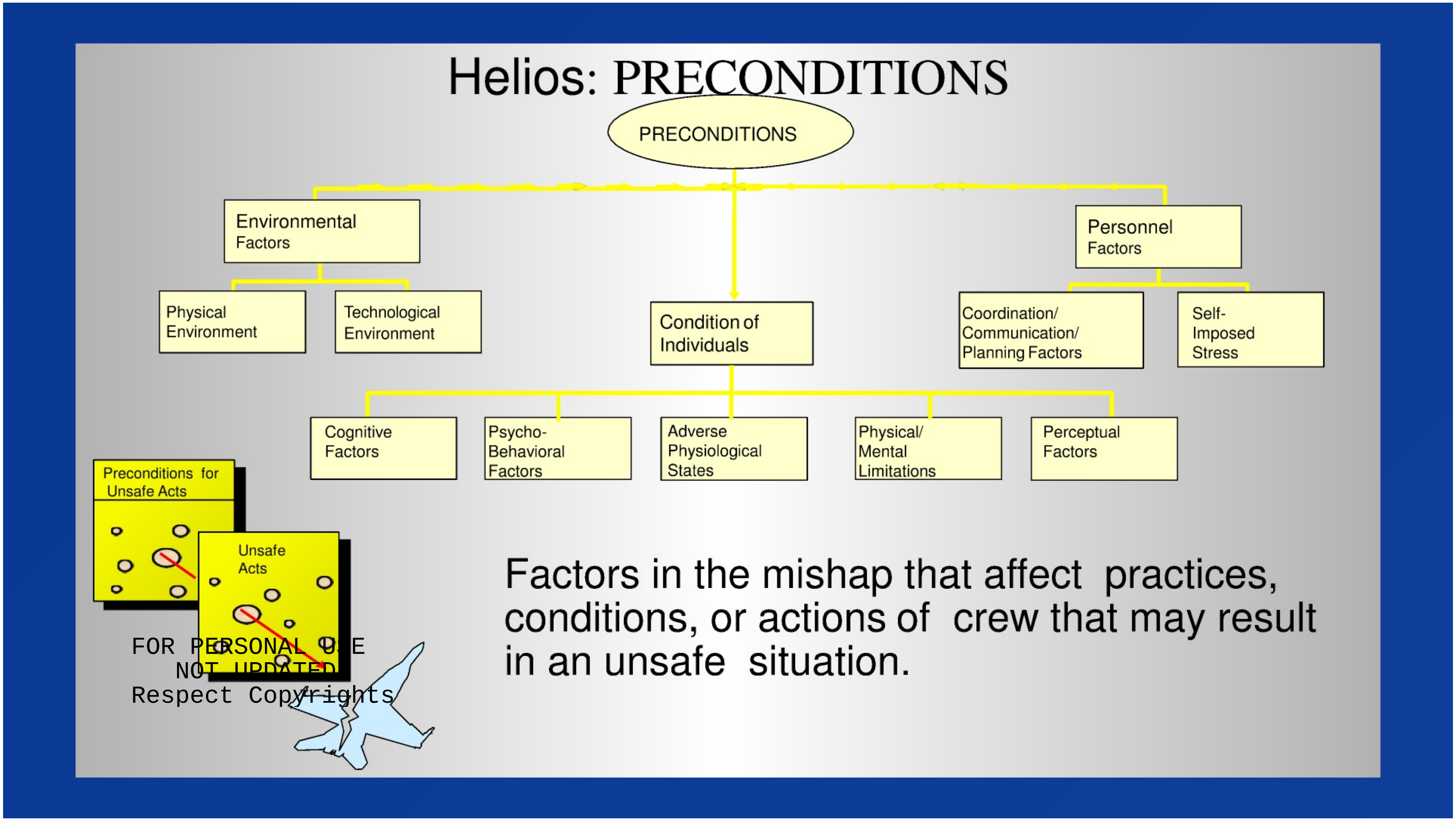
- Operations manual:

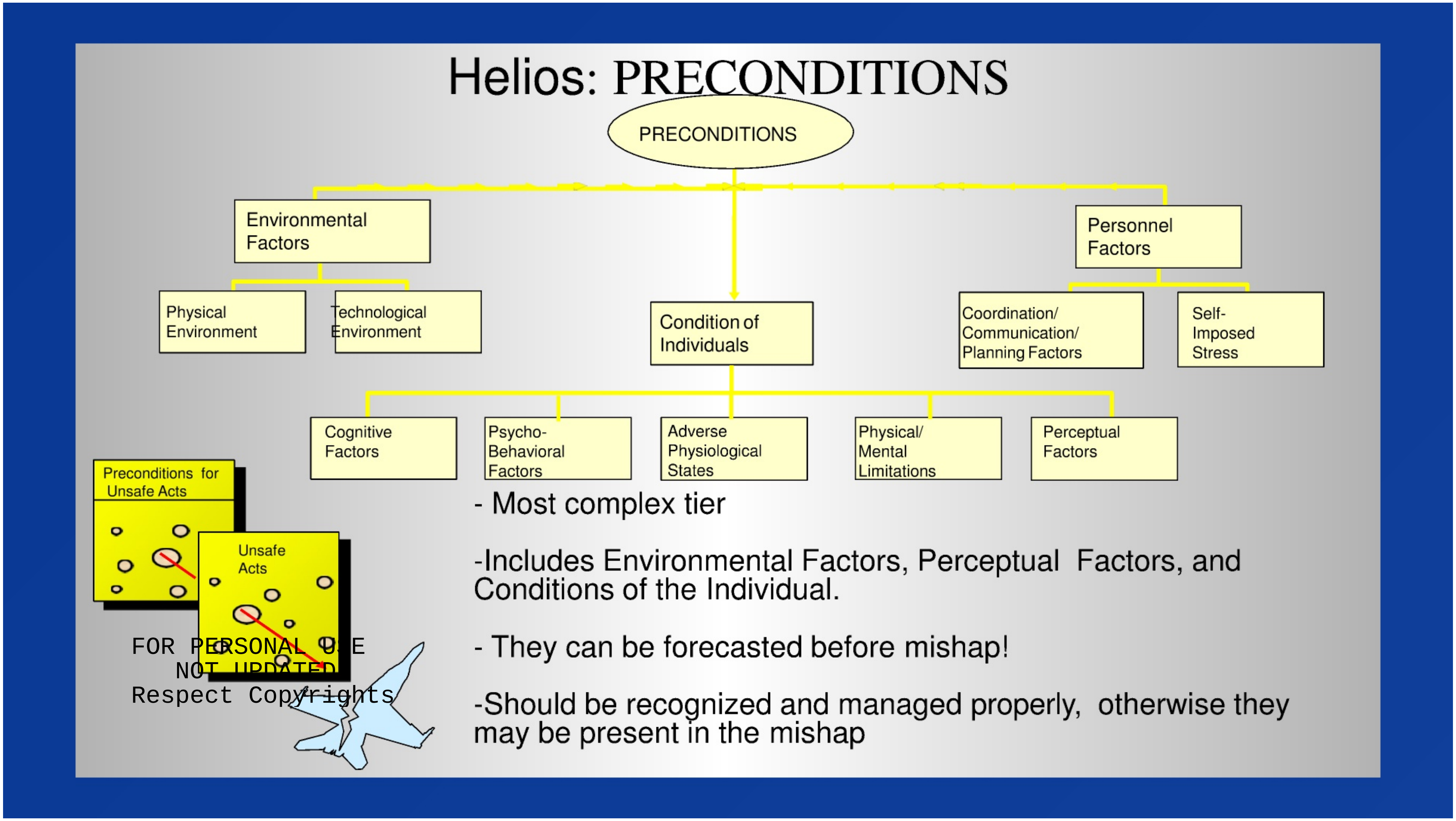
"The flight crew should don oxygen masks as a first and immediate step when the cabin altitude warning horn sounds.

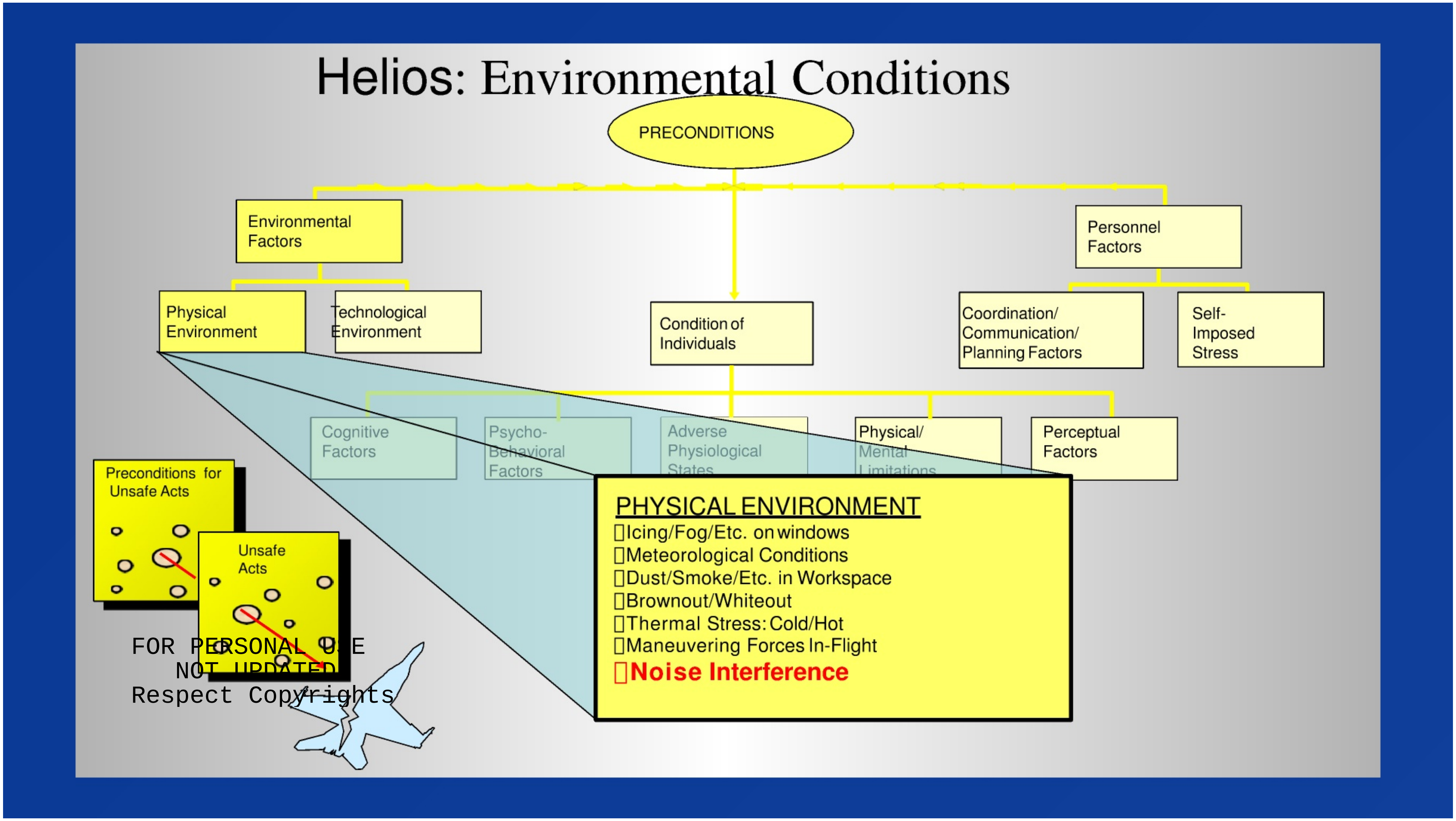
This action is necessary to prevent incapacitation of the flight crew due to lack of oxygen, which could result in loss of control of the airplane".

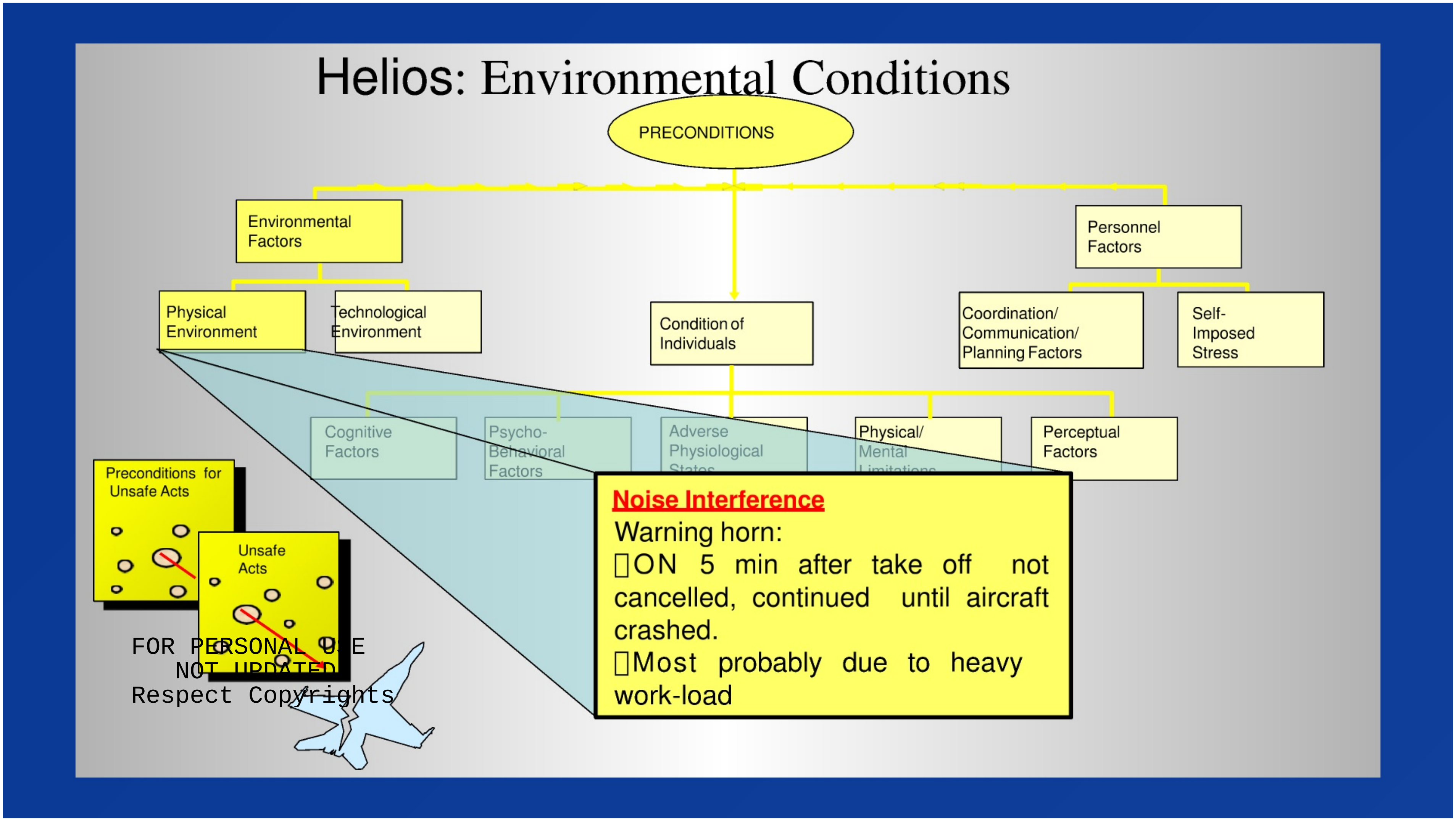
- HFACS Model picture

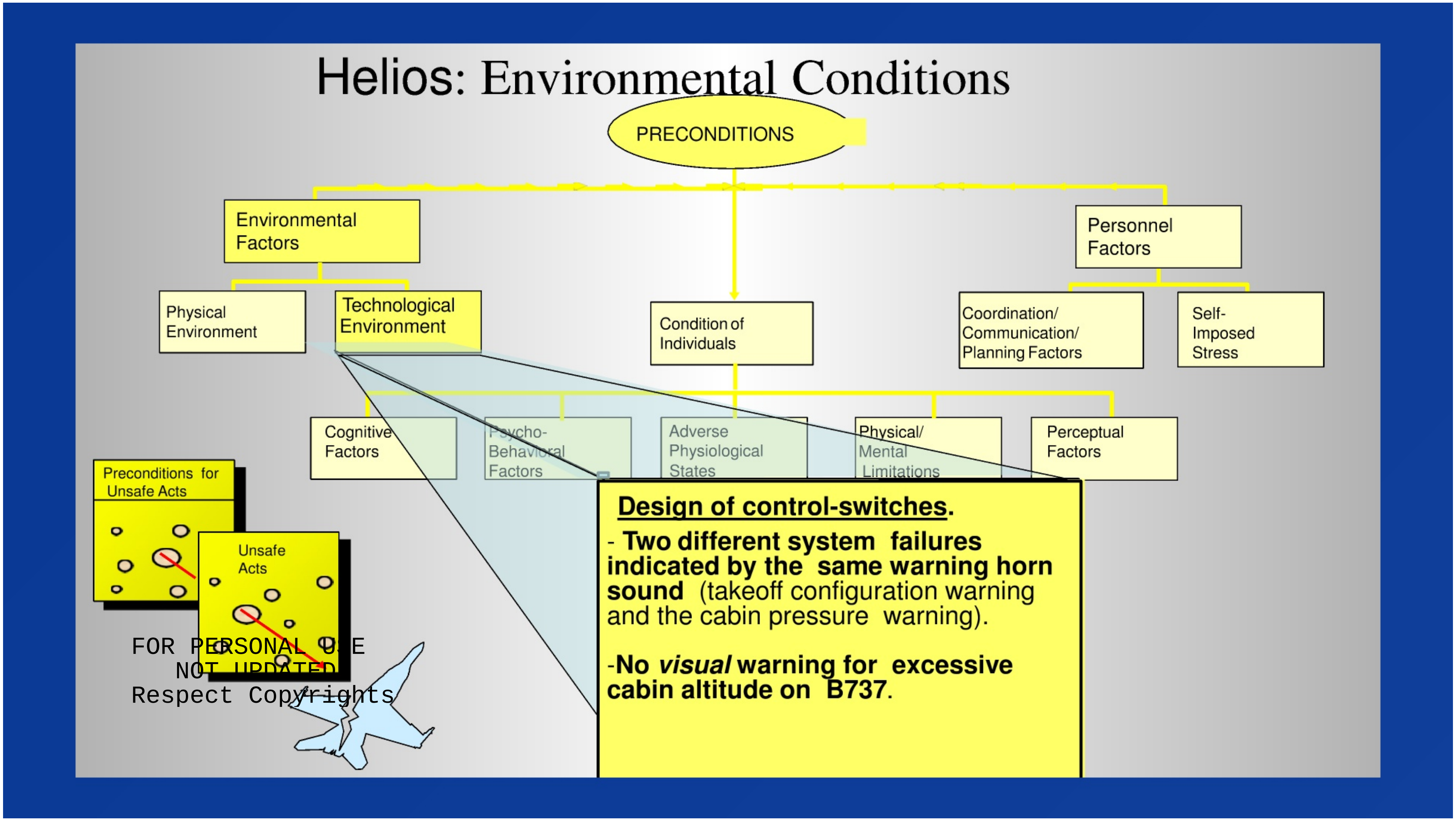



Helios: PRECONDITIONS
PRECONDITIONS
Environmental Factors
Personnel Factors
Physical Environment
Technological Environment
Condition of Individuals
Coordination/ Communication/ Planning Factors
Self-Imposed Stress
Cognitive Factors
Psycho-Behavioral Factors
Adverse Physiological States
Physical/ Mental Limitations
Perceptual Factors
Preconditions for Unsafe Acts
Unsafe Acts
Factors in the mishap that affect practices, conditions, or actions of crew that may result in an unsafe situation.


Helios: PRECONDITIONS
PRECONDITIONS
Environmental Factors
Personnel Factors
Physical Environment
Technological Environment
Condition of Individuals
Coordination/ Communication/ Planning Factors
Self-Imposed Stress
Cognitive Factors
Psycho-Behavioral Factors
Adverse Physiological States
Physical/ Mental Limitations
Perceptual Factors
Preconditions for Unsafe Acts
Unsafe Acts
- Most complex tier
-Includes Environmental Factors, Perceptual Factors, and Conditions of the Individual.
- They can be forecasted before mishap!
-Should be recognized and managed properly, otherwise they may be present in the mishap


Helios: Environmental Conditions
PRECONDITIONS
Environmental Factors
Personnel Factors
Physical Environment
Technological Environment
Condition of Individuals
Coordination/ Communication/ Planning Factors
Self-Imposed Stress
Cognitive Factors
Psycho-Behavioral Factors
Adverse Physiological States
Physical/ Mental Limitations
Perceptual Factors
Preconditions for Unsafe Acts
Unsafe Acts
PHYSICAL ENVIRONMENT
Icing/Fog/Etc. on windows
Meteorological Conditions
Dust/Smoke/Etc. in Workspace
Brownout/Whiteout
Thermal Stress: Cold/Hot
Maneuvering Forces In-Flight
Noise Interference


Helios: Environmental Conditions
PRECONDITIONS
Environmental Factors
Personnel Factors
Physical Environment
Technological Environment
Condition of Individuals
Coordination/ Communication/ Planning Factors
Self-Imposed Stress
Cognitive Factors
Psycho-Behavioral Factors
Adverse Physiological States
Physical/ Mental Limitations
Perceptual Factors
Preconditions for Unsafe Acts
Unsafe Acts
Noise Interference
Warning horn:
ON 5 min after take off not cancelled, continued until aircraft crashed.
Most probably due to heavy work-load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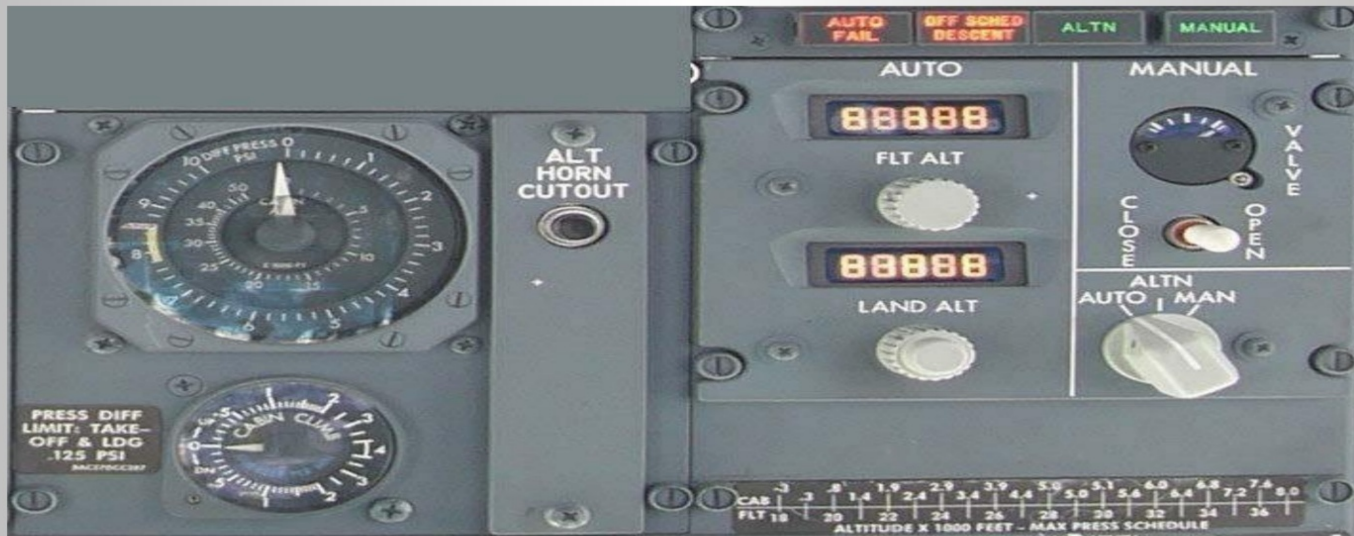
Design of control-switches.
- Two different system failures indicated by the same warning horn sound (takeoff configuration warning and the cabin pressure warning).
-No *visual* warning for excessive cabin altitude on B737.

Helios: Environmental factors



More Technological Factors B737-300 (first flight 1984):

-When Pressure system is on MAN mode, a **GREEN** light turns on.

-Green does not typically imply that something is out of the ordinary!

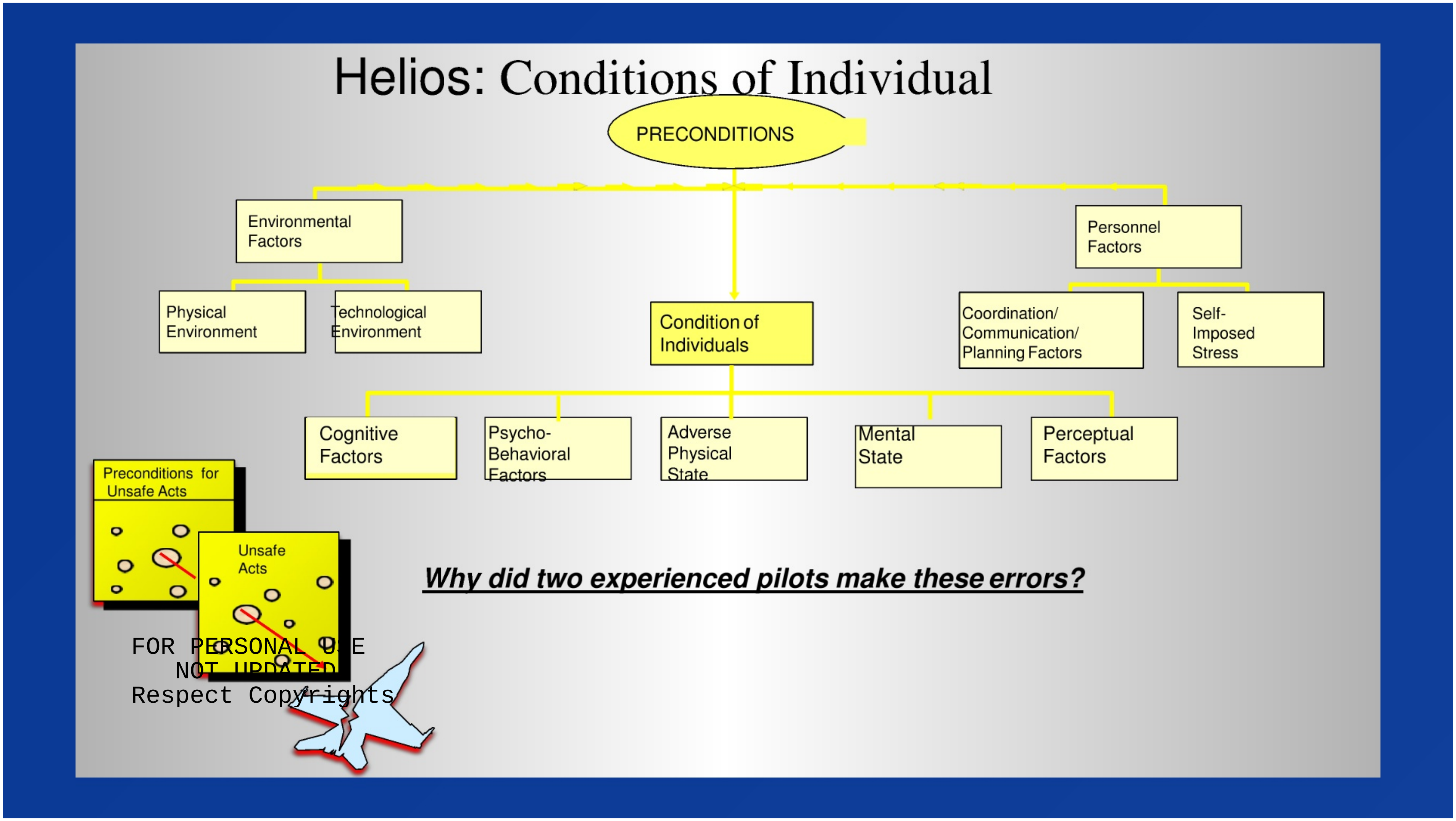
-**RED**? Might have attracted crew's attention?

Helios: Recommendations to FAA

Following the accident, new auditory and visual warnings were fitted:

Separate Cabin altitude and Takeoff configuration warnings.

Use of RED colour!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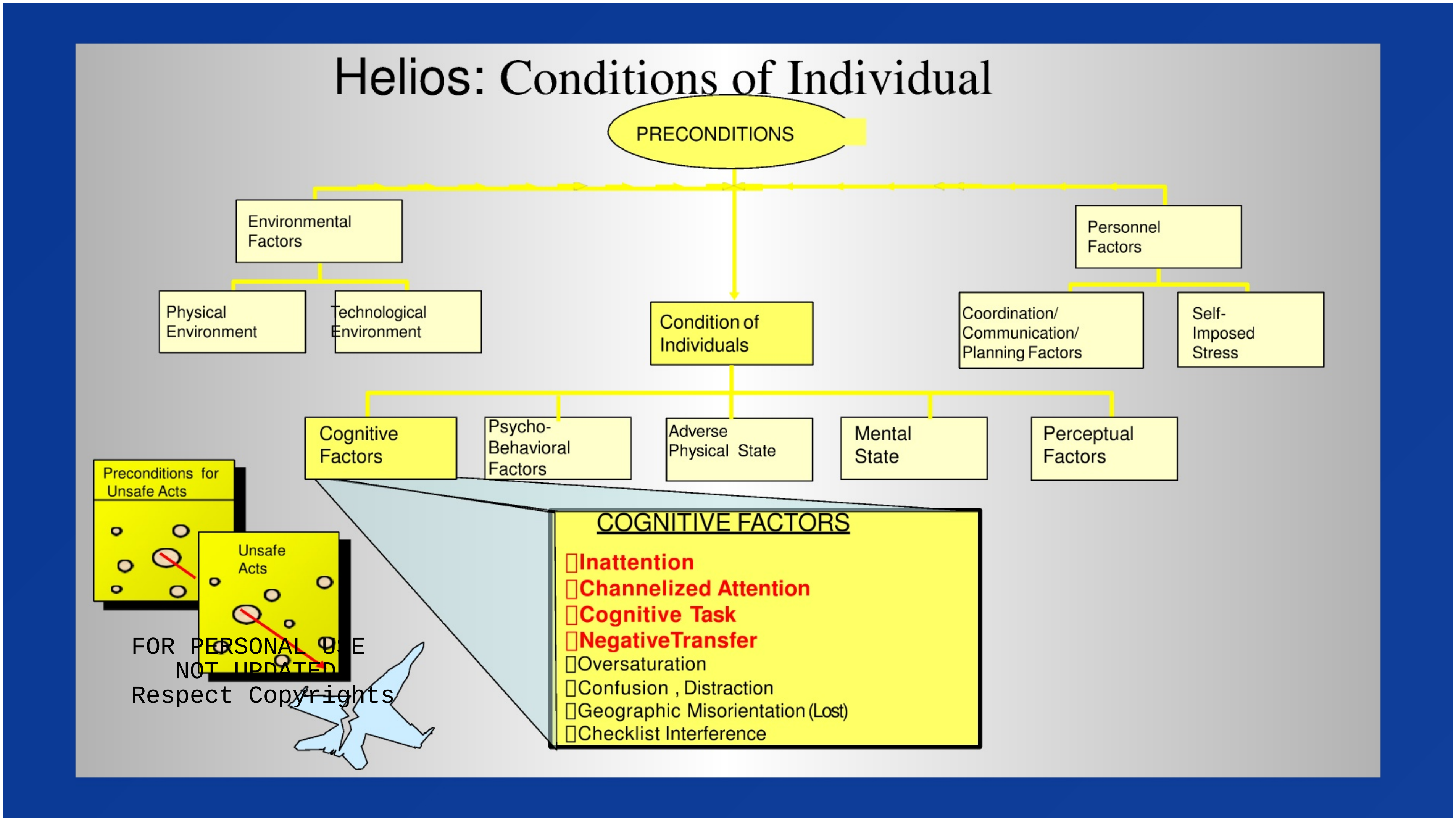
Unsafe Acts
Why did two experienced pilots make these errors?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COGNITIVE FACTORS
Inattention
Channelized Attention
Cognitive Task
NegativeTransfer
Oversaturation
Confusion , Distraction
Geographic Misorientation (Lost)
Checklist Interference

Helios: Conditions of Individual

Why did two experienced pilots make these errors?

Inattention:

- highly repetitive tasks reduce conscious attention of the crew
- “Looking without seeing” during check list
- Automatic execution is affected by assumptions i.e. perception biased by expectation.
- This may explain why FO missed noticing that the pressure system was on the MAN instead of AUTO, because he expected it to be in the AUTO!

Helios: Conditions of Individual

Why did two experienced pilots make these errors?

Channelized attention:

- Occurs when all conscious attention is focused only on some cues, other cues are ignored.
- Preoccupied with one task (i.e. trouble-shooting the source of the Equipment Cooling problem), Cpt even left his seat.
- Other important visual cues excluded: Oxygen masks deployment indicator and Master Caution.

Helios: Conditions of Individual

Why did two experienced pilots make these errors?

Negative Transfer:

- A highly learned behavior learnt/used in previous situation, is inappropriate for the specific event.
- Automatic reaction results from experience and frequency of encounter.
- Automatic reaction may be inappropriate for a specific situation.

Helios: Conditions of Individual

Why did two experienced pilots make these errors?

- A pilot, during his career, is likely to only hear the warning horn when there is a takeoff configuration error, not cabin pressure problem.

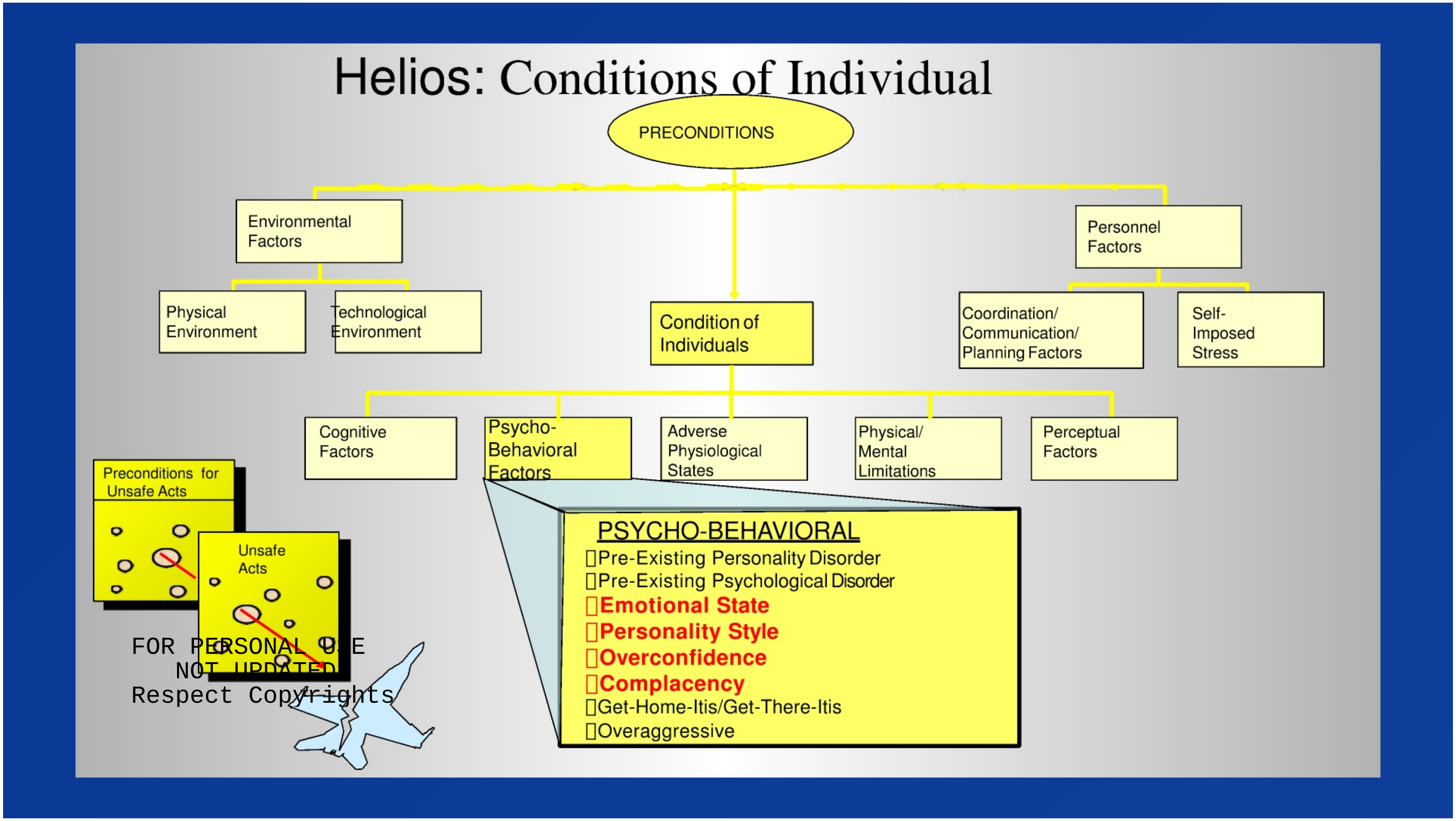
- With onset of warning horn

  -> Declarative Memory (stores facts and events) and Muscle memory (skeletal muscle activity that becomes automatic with practice)

  -> automatically linked the horn to take-off configuration problem (previously encountered)

  -> automatic reaction to adjust throttles & power......

  -> Inappropriate! .... Should have descended!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PSYCHO-BEHAVIORAL
Pre-Existing Personality Disorder
Pre-Existing Psychological Disorder
Emotional State
Personality Style
Overconfidence
Complacency
Get-Home-Itis/Get-There-Itis
Overaggressive

Helios: Conditions of Individual

<u>Psycho-behavioral factors:</u>

- <u>Personality style of Captain:</u>

  Authoritarian? Typical command attitude? Different cultural backgrounds? East German Vs Cyprus

- <u>Personality style of FO</u>:

  Training reports showed tendency to over-react / lose confidence in difficult situations

  "Standards achieved, but with room for lots of improvement. Some difficulties met in complex tasks. Do not rush through check lists."

Helios: Conditions of Individual

Psycho-behavioral factors:

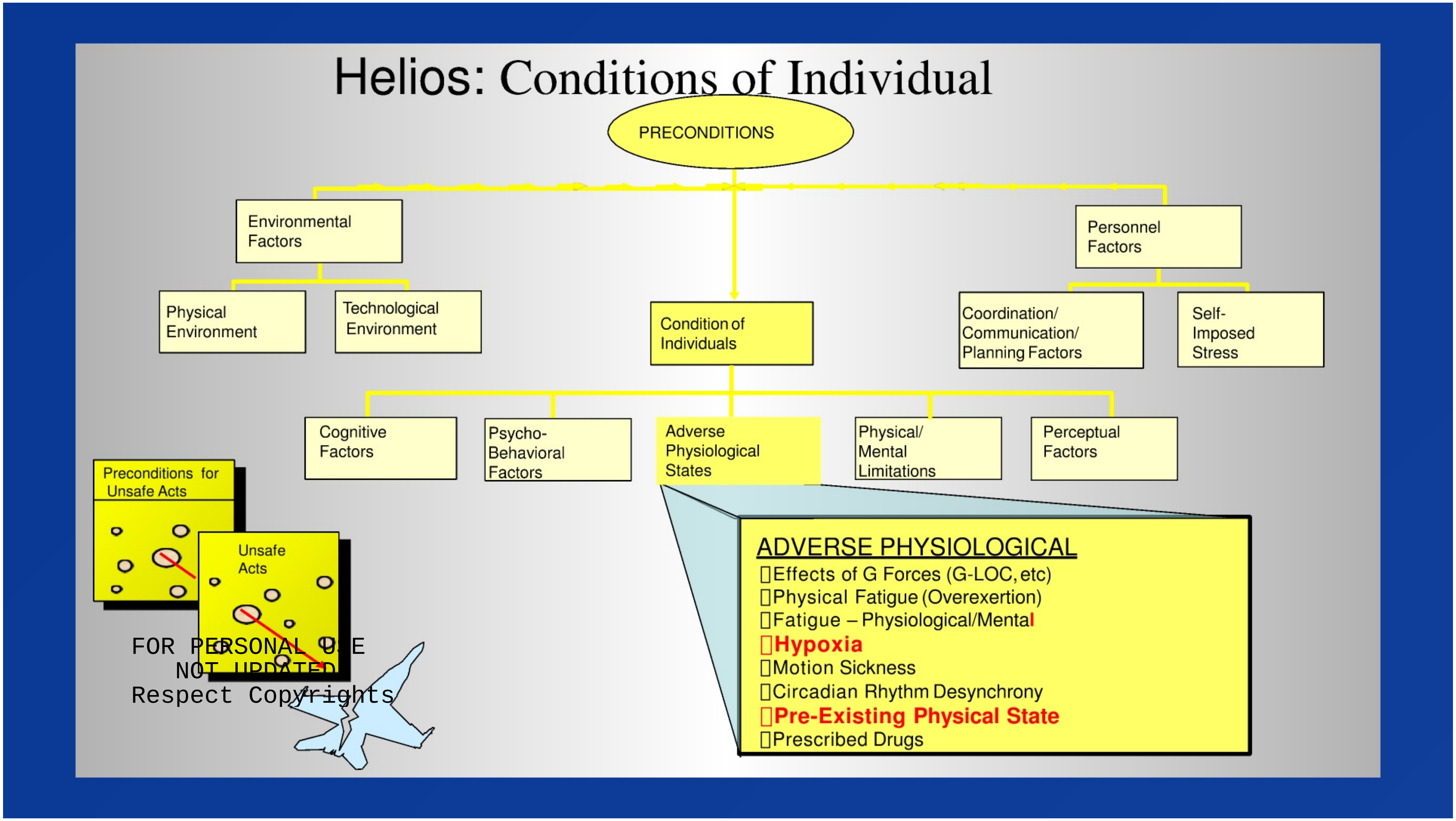
- Emotional state of FO

Happy personal life, but unhappy with Helios, looking for a new job.

- Complacency of FO?:

Overconfidence, undermotivation, sense that “others have the situation under control”.

FO performed no action, not even to silence the warning horn, while cpt was communicating with the ground engineer just after the warning horn sounded.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ADVERSE PHYSIOLOGICAL
Effects of G Forces (G-LOC, etc)
Physical Fatigue (Overexertion)
Fatigue – Physiological/Mental
Hypoxia
Motion Sickness
Circadian Rhythm Desynchrony
Pre-Existing Physical State
Prescribed Drugs

Helios: Conditions of Individual

***Adverse physiological state* :**

Pre-existing physical illness:

- Post-mortem exam of FO's heart, revealed extensive atherosclerosis (90% occlusion in LAD and Cx).
- This may have attributed to the possibly earlier symptoms of Hypoxia.

Helios: Conditions of Individual

***Adverse physiological state* :**

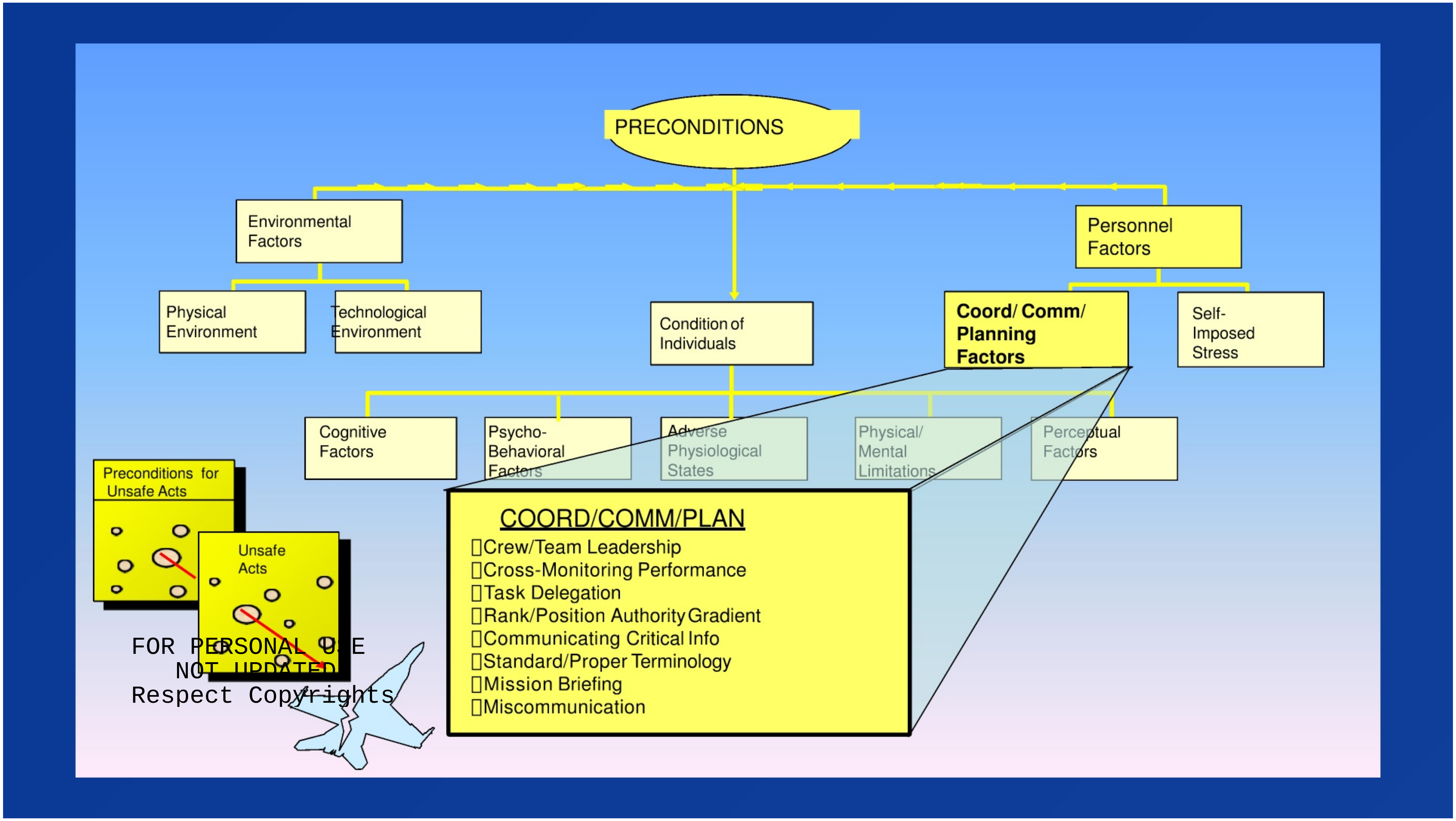
Incapacitation of crew due to Hypoxia:

One of the direct causes of the accident.

The combination of hypoxia and distractions generally increases stress levels.

Stress is known to decrease human cognitive function (memory, attention, decision-making, risk management, communication skills) particularly vulnerable to errors.

	ALTITUDE FT	
Indifferent	0-10000	Minimal impairment, decreased visual dark adaptation
Compensatory	10000- 15000	Body tries to compensate for hypoxia with Increased pulse and respiratory rate: - Fatigue, irritability, headache, - Decreased judgment - Difficulty with calculations
Disturbance	15000- 20000 Within the first 15 min of the flight	Body can not compensate for hypoxia: -Senses: impaired vision (acuity and accommodation), touch and pain sense is lost, hearing is lost last -Mental: slow thinking, poor judgement, can not recognise emergency situations -Euphoria, overconfidence, behaviour similar to alcohol intoxication - Physical movements impaired
Critical	20000- 23000 20 min after take off for 1 5 hours	Complete mental and physical incapacitation Loss of consciousness, convulsions, failure of respiration, death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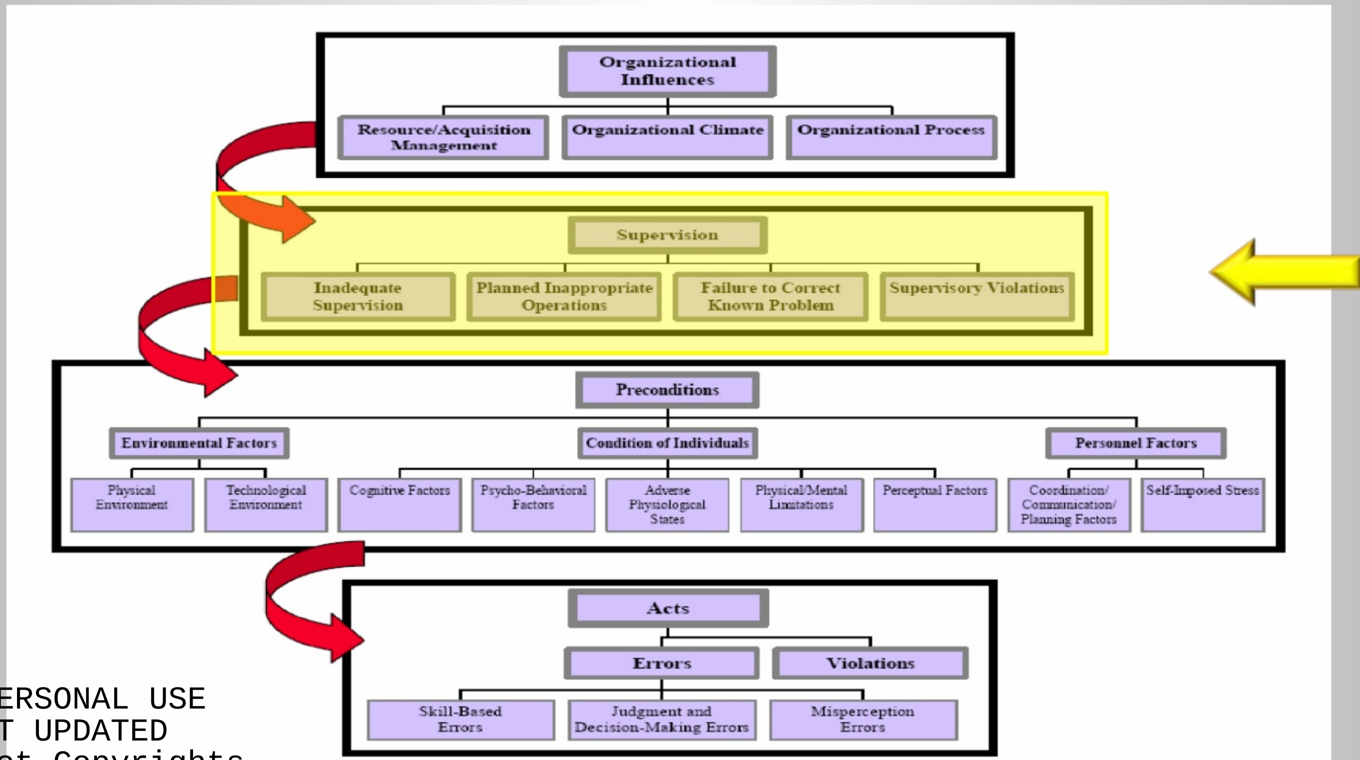
COORD/COMM/PLAN
Crew/Team Leadership
Cross-Monitoring Performance
Task Delegation
Rank/Position Authority Gradient
Communicating Critical Info
Standard/Proper Terminology
Mission Briefing
Miscommunication

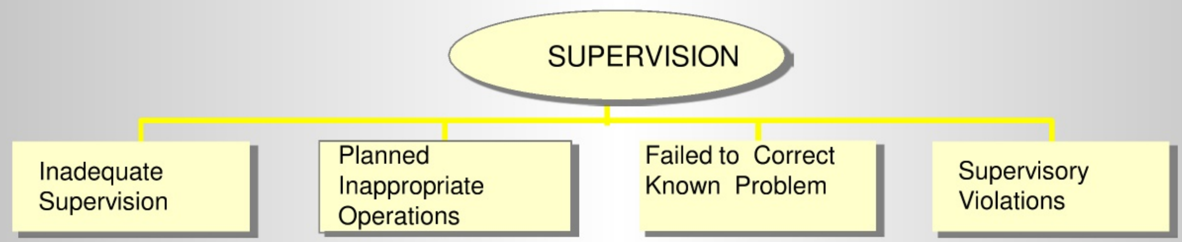
Helios: Personnel Factors

Communication between Cpt and Engineer:

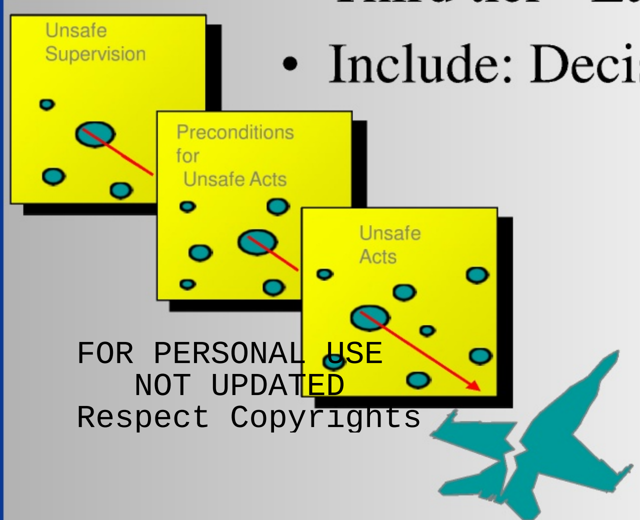
- Communication difficulties?
- Helios dispatcher suggested that the FO speaks with a second engineer in Greek.
- English as a second language in stress situation, may require words that are not part of the "normal" vocabulary
- Memory suffers during stress, the search and choice of words to express one's concern in a non-native language can be compromised.

• HFACS Model picture





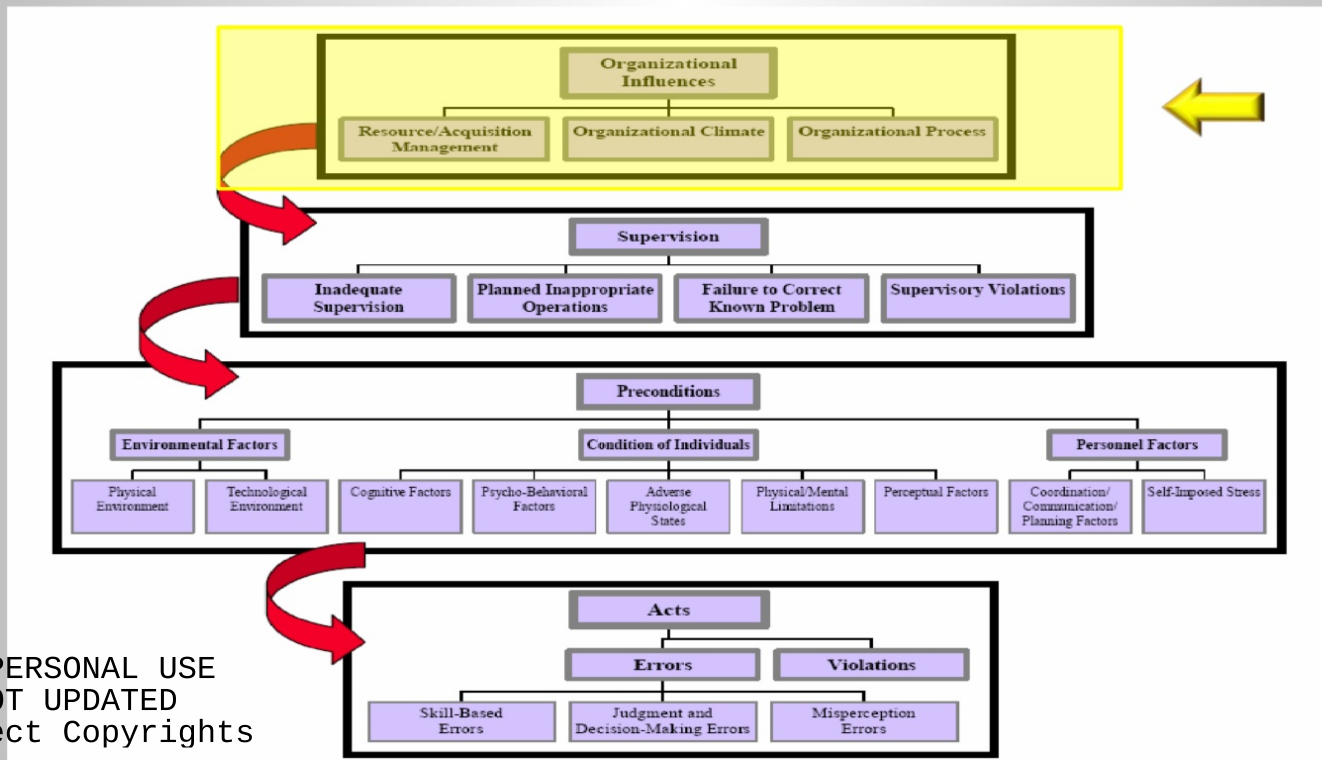
- Third tier - Latent conditions
- Include: Decisions or policies of the supervisory chain of command
  - E.g. Inadequate supervision, training issues, failure to correct known problems etc

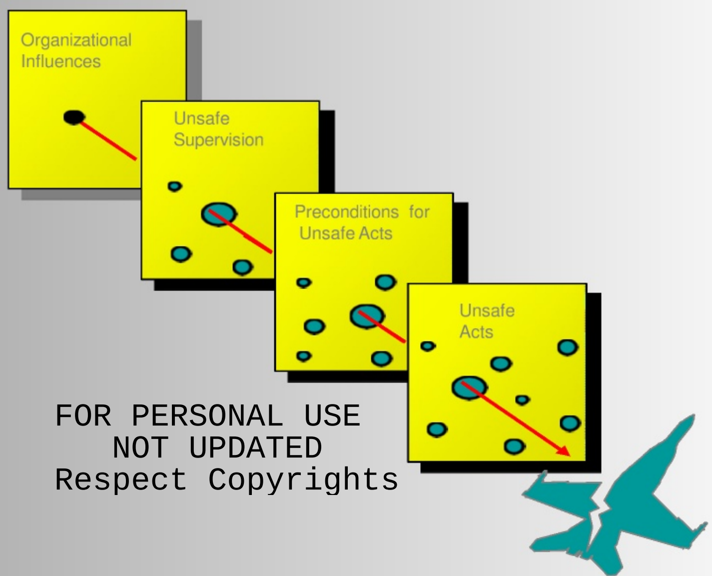


Helios: SUPERVISION

- Helios Crew Training approved by Cy DCA, carried out in accordance with the manual.
- Flight Crew Training included simulator training in Rapid Decompression, not in Gradual Decompression…flight crew not trained to monitor and detect this less-obvious situation
- Cabin Crew undertrained for the procedures after Oxygen Mask deployment, esp. when no descent.
- Lack of adequate training in hypoxia. Global problem!

- HFACS Model picture





- Fourth tier - Latent conditions
- Include: Resource management, organization climate, organization failures in all levels of the chain of command.

Helios: ORGANISATIONAL INFLUENCES

Helios company:

- High turn-over of ground engineers 3 days – 21 months
- Understaffed Engineering Dept
- 33% seasonal/part-time employees -> reluctant to report or solve problems

Helios: ORGANISATIONAL INFLUENCES

- UK CAA: level 1 & 2 findings, flight safety compromised due to "***the lack of operational management control***".
- Incomplete Management structure – vacant Training Standards Manager position
- ***"Not healthy"*** organization climate
- ***"Unapproachable management, profitability being the only interest"***

Helios: ORGANISATIONAL INFLUENCES

Dept Civil Aviation

- Safety and Regulations Unit of Cy DCA diachronically not organized & understaffed.
- Operates as a functional dept of MoC and not as an independent authority.

Boeing

- No measures taken by Boeing on response to previous pressurization incidents on B737.

HFACS

- Good guide when investigating human factors
- Good tool to identify system failures/hazards or "holes" in system
- Develop a risk minimization strategy to identify and correct the "holes" before the mishap occurs.


Questions?
CATHAY PACIFIC


Q&A
When?
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INTRO - History of HF & ICAO
Industry Applications & Social Psychology
HF Management, Organization & Incident/ Accident
Human Error & Human Performance
Investigation RCA & Analysis
Corrective, Preventative & Training & Conclusion
ICAO COSCAP