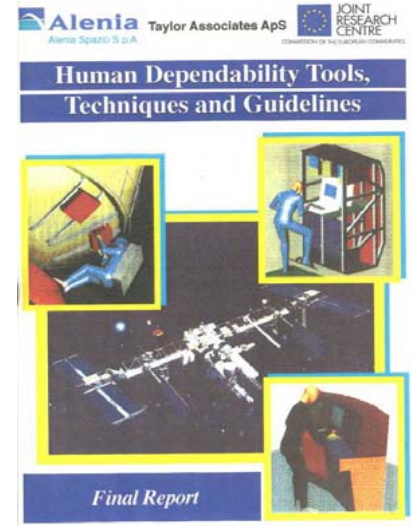
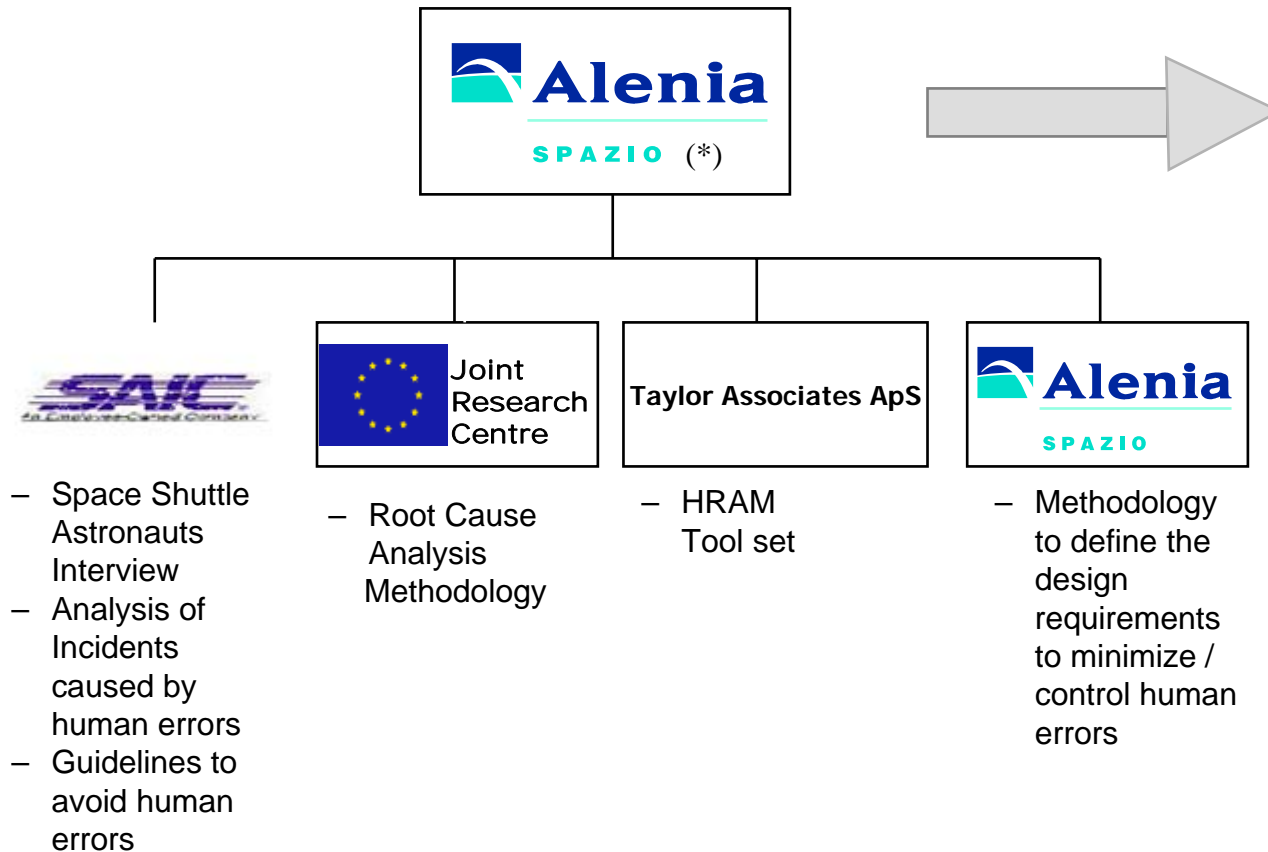


Human error prevention: where we are and where do we need to go ” a space industry perspective”



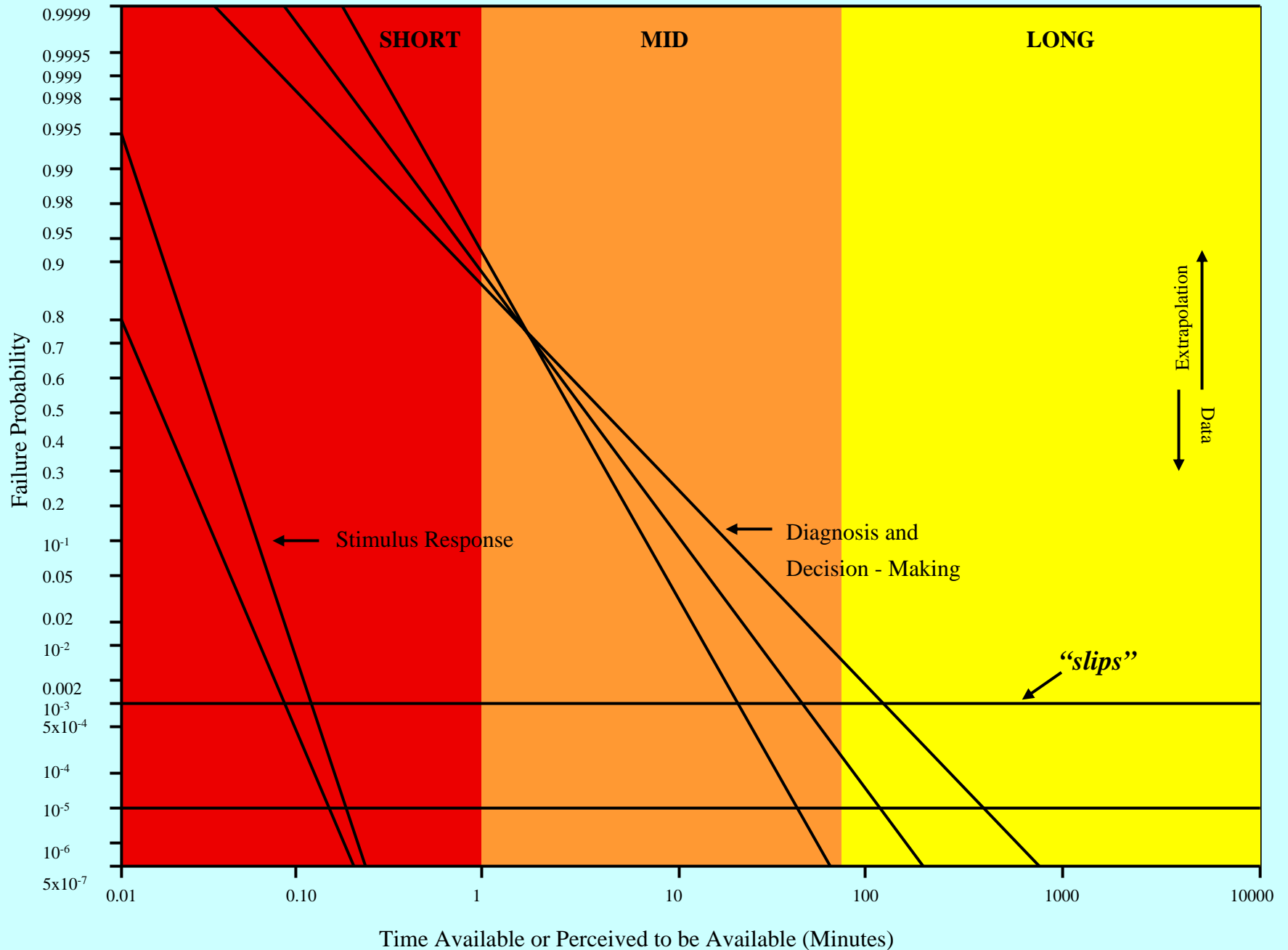
THALES

- **Research Activity results for Flight Space System**
- **Other research needing**

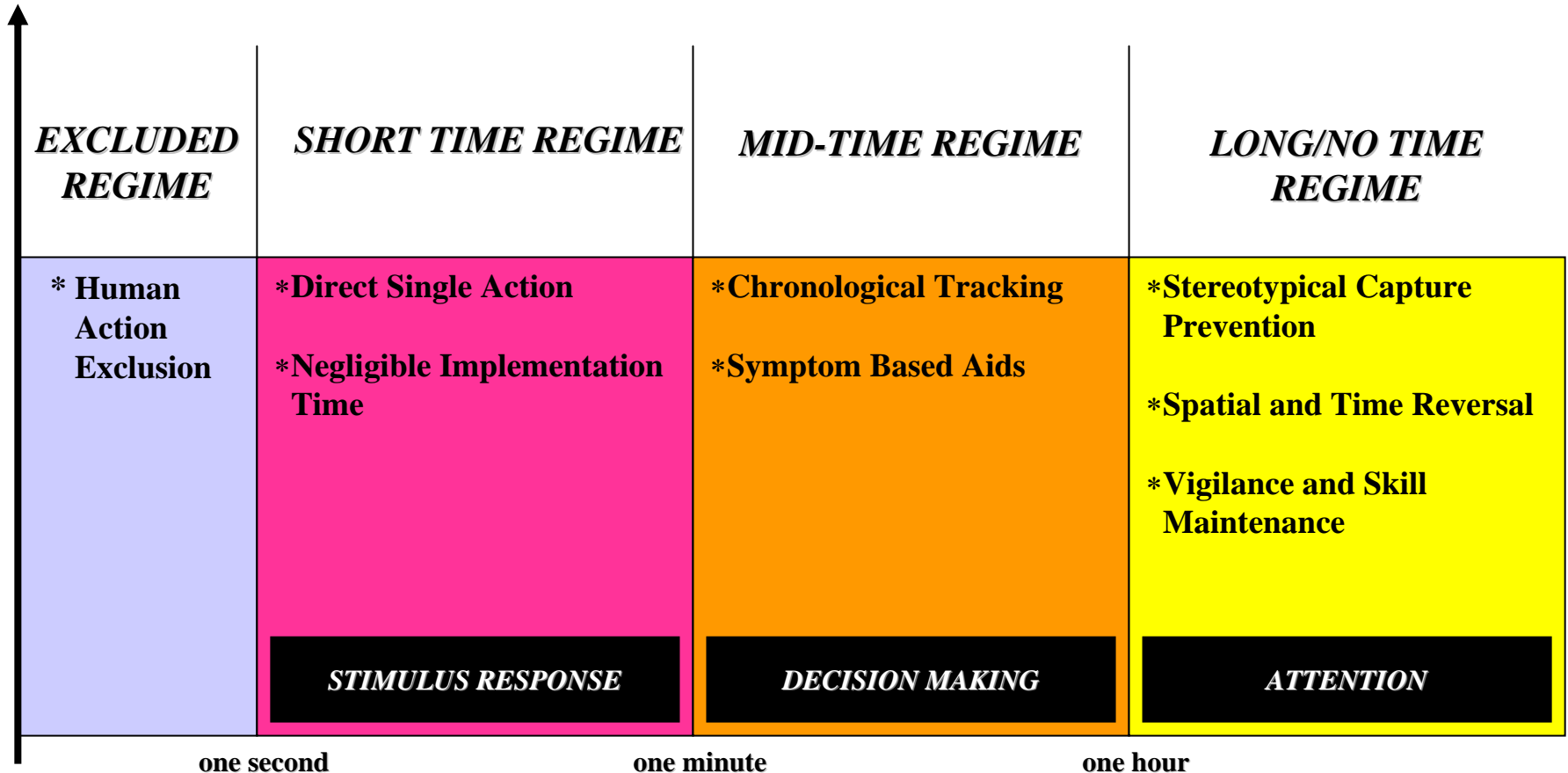


(*) Thales Alenia Space Italy former name

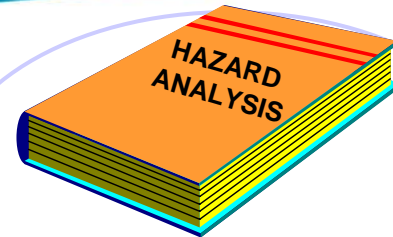
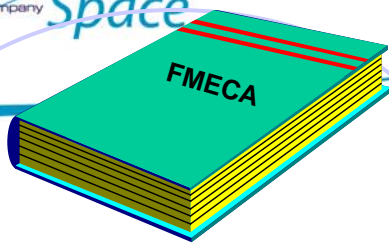
HUMAN ERROR PROBABILITY VERSUS TIME AVAILABLE



ARCHETYPE GUIDELINE

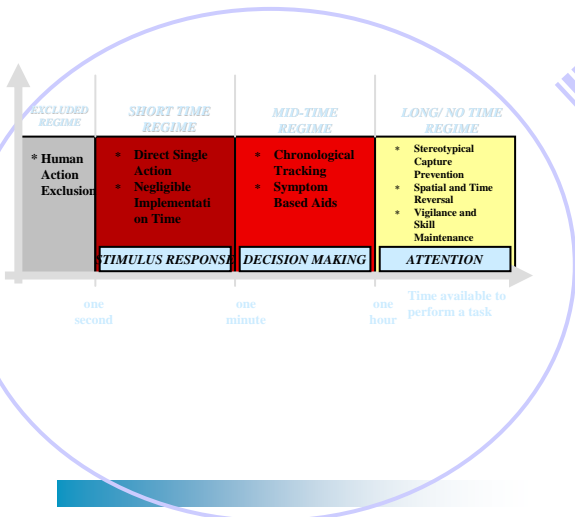


Time available to perform the task



**METHODOLOGY
FOR THE DEVELOPMENT
OF DETAILED DESIGN
RECOMMENDATION**

**SIMPLE ACTION
ERROR TAXONOMY**



H.E.A.S.T. SOFTWARE TOOL



7

- **EASY ACCESS TO PARADIGM AND TAXONOMIES** THROUGH VISUALIZATION OF DEDICATED LISTS (E.G. TIME REGIME LIST, ERROR MODE LIST, ERROR CAUSE LIST, ETC.)
- A **EASY ACCESS TO EXPLANATION OF TERMS** USED IN PARADIGM AND TAXONOMIES
- **EASILY FIND THE LINK BETWEEN ERROR MODES AND CAUSES**
- **HELP THE ANALYST IN ASSOCIATING ERROR MODES AND CAUSES TO THE ACTIONS** THAT THE OPERATOR HAS TO PERFORM AND IN IDENTIFYING THE APPROPRIATE RECOMMENDATIONS.

HEAST - Data Form1 - Copyright Alenia Spazio S.p.A.

Alenia SPAZIO **COLUMBUS**
Human Error Analysis

SELECT TIME REGIME AND ARCHETYPE GUIDELINE

Rationale for Archetype Selection :
The action is a scheduled activity. Therefore the time regime prevention, that avoids that, between two adjacent contr

Time Regime: **Long Time** Time Regime Explanation

Select Archetype Guideline

Notes :
The necessary equipme

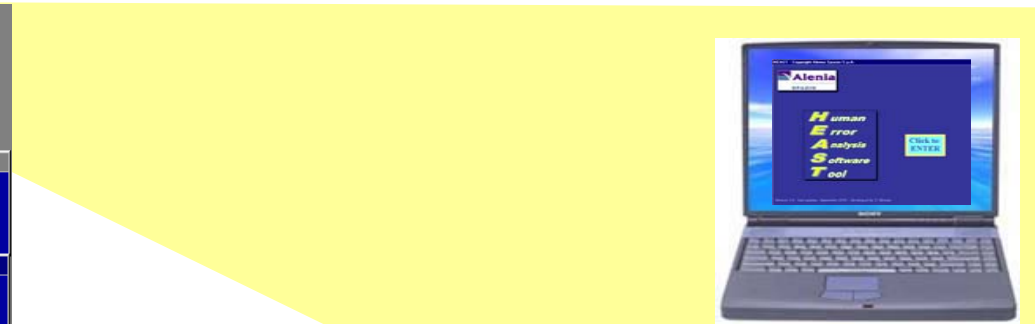
Archetype Guideline: **Spatial and Time-Reversal Prevention** Archetype Guideline Explanation

Stereotypical Capture Prevention
Spatial and Time-Reversal Prevention
Vigilance and Skill Maintenance

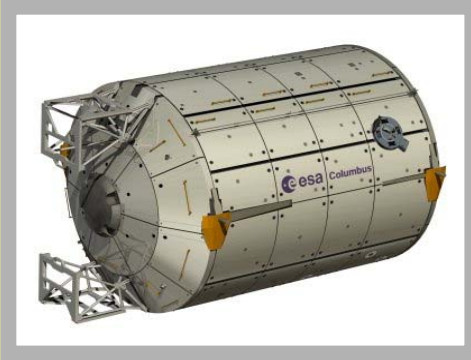
SELECT ERROR MODE

Add New Record Delete Record Print Single Record

Go to First Go to Last Record Go to Previous Go to Next Back



CASE APPLICATION



COLUMBUS ISS Manned Module

HEAST - Data Form Error Modes - Copyright Alenia Spazio S.p.A.

Open Error Cause List Delete Selected Error Mode Close HELP

Error Mode:

Error Mode	Error Mode Explanation
Premature	
Delay	An operation is performed later than intended.
Omission	The action/ operation is not performed.
Premature	An operation/ action is performed earlier than intended.
Too far	The action is performed in such a way that an object or mechanism d
Too much force	A manual operation is carried out too strongly, using simple manual f
Wrong command	This error mode applies especially to cases where computers are use
Wrong direction	This error mode applies when the operation is addressed towards a w
Wrong implement	The operation is carried out in a wrong way.
Wrong object	The operation is performed on the wrong object.
Wrong path	The action is performed in such a way that an object follows the wro
Wrong position	The operator or the object operated can be in the wrong position.
Wrong value	A wrong value is typed, read, selected, acquired, etc.

Record: 1 of 4 (Filtered)

HEAST - Data Form Error Causes - Copyright Alenia Spazio S.p.A.

Open Detailed Error Cause List Delete Selected Error Cause Close HELP

Error Mode:

Premature

Error Cause: none

Error Cause:

HEAST - Data Form Detailed Error Cause - Copyright Alenia Spazio S.p.A.

Delete Current Record Close HELP

Detailed Error Cause: none Allocation Area: Electrical Design - Flight Procedures

Recommendation:
In case of EFS jumpers, before starting the connection, the crew shall follow a dedicated procedure to verify that APCU power conversion is off and APCU output relays are deadfaced. Also in case of ISPR electrical connection the crew shall verify that the 120 V power line is deactivated.

Reference Document:
COL-ESA-RQ-013 "APM Human Factors Engineering Requirements" para 7.3 "Electrical Design for Protection of Crew"

Record: 1



HUMAN ERROR ANALYSIS

Report Number: HEA-04

Space System Type: Attached Pressurised Module **Phase:** Flight Operations

Analysis Reference: Operating Safety Analysis

Safety Hazard Reference: WC.3.1/3 - L.17/18 - SM.1.39.4 - IR.1.12 - RR.2.4

Criticality Category Associated to the Scenario:

I:

II:

III:

Scenario Description :

The scenario refers to functions and operations during : APM utility I/F connection between Node 2 and APM -connection of the electrical and fluidical utilities at ISPR I/F - maintenance (exchange of Water On-off valves WOOV, 3-way modulating valves 3-WMV, Water Pump Assembly WPA, Condensate Water Separator Fan CWS).

Action Description :

The crew has to perform the following operations: - connect EPS jumpers, TCS water jumpers and ECLSS jumpers between Node 2 and APM - connect all ISPR electrical and fluid utilities - remove/install ORU's for maintenance.

Scenario Final Consequences:

Loss of water from QD's (mismating of/ improper connection), leading to fire, or crew contact with powered line can cause loss of life.

Time Regime:

Short Time:

Medium Time:

Long Time:

Archetype Guideline:

Spatial and Time-Reversal Prevention

Rationale for Archetype Selection:

The task to be performed is a scheduled activity. Therefore the time regime to select is long-time in which the possible human errors can be controlled by the selected archetype. The spatial reversal prevention avoids that, between two adjacent controls, the wrong one is manipulated because of a lapse in attention.

Notes:

The necessary equipments for APM Node utilities connection operation (including Node/APM utilities jumpers) are in the Node2.

OUTPUT

HUMAN ERROR ANALYSIS

Report Number: HEA-04

Archetype Guideline: Spatial and Time-Reversal Prevention

Action Description:

The crew has to perform the following operations: - connect EPS jumpers, TCS water jumpers and ECLSS jumpers between Node 2 and APM - connect all ISPR electrical and fluid utilities - remove/install ORU's.

Error Mode/Cause/ Detailed Cause	Recommendation	Allocation Area	Reference Document
Premature	In case of EPS jumpers, before stating the connection, the crew shall follow a dedicated procedure to verify that APCU power conversion is off and APCU output relays are deadfaced. Also in case of ISPR electrical connection the crew shall verify that the 120 V power line is deactivated.	Electrical Design – Flight Procedures	COL-ESA-RQ-013 "APM Human Factors Engineering Requirements" para 7.3 "Electrical Design for Protection of Crew"
Ambiguous label	Each utility I/F connection shall be clearly labelled to indicate its function to the operator.	Utility I/F design	COL-ESA-RQ-013 "APM Human Factors Engineering Requirements" para. 11.8.3.9 - 11.8.3.10
Identification error	Connectors that are clearly different and physically incompatible shall be used for lines which differ in content (i.e. different voltages, different fluids). Each type of connectors shall have a connecting key clearly differentiated from other types to prevent incorrect connection with other accessible connectors, plugs and receptacles. Mating connectors shall also be provided with alignment pins or other devices to preclude a connector being inserted in other than the desired orientation.	Connectors design	COL-ESA-RQ-013 "APM Human Factors Engineering Requirements" para 11.8.3 "Connector Identification Alignment"
Error in procedure	The crew shall perform a visual inspection after TCS water lines and ISPR fluid lines connection, during TCS water lines opening and after ORU's (WPA, WOO, 3-WMV, CWSA) installation to detect leakage of water. The crew shall also follow a procedure to check, at the end, all connectors through positive indicators of connection.	Flight Procedure	TBD
No light	The vestibule and the APM shall be properly illuminated to allow the correct activity execution. Portable light is available for utilities APM/Node 2 connection/ disconnection.	Lighting	COL-ESA-RQ-013 "APM Human Factors Engineering Requirements" para 8.4 "Lighting"

HUMAN ERROR ANALYSIS

Report Number: HEA-04

Archetype Guideline: Spatial and Time-Reversal Prevention

Action Description:

The crew has to perform the following operations: - connect EPS jumpers, TCS water jumpers and ECLSS jumpers b - connect all ISPR electrical and fluid utilities - remove/install ORU's.

Error Mode:

Premature

Wrong object

Wrong object

Wrong implement

Omission

Error Cause:

none

Ambiguous label

Identification error

Execution error

Hindrance

Detailed Error Cause:

none

none

none

Error in procedure

No light

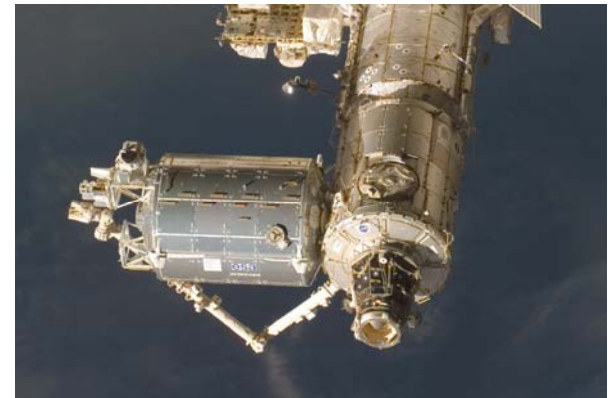
PURPOSE:

**TO IDENTIFY DESIGN AND OPERATIONAL REQUIREMENTS
TO REDUCE THE HUMAN ERRORS PROBABILITY DURING
THE MISSION OPERATIONS**

APPLICATION:

**DEDICATED HUMAN ERROR ANALYSYS HAS BEEN
DEVELOPED TO SUPPORT THE SAFETY ANALYSIS FOR
COLUMBUS PROGRAM.**

**13 OPERATIVE SCENARIO WITH 40 ERROR CAUSES HAVE
BEEN ANALYSED**



HUMAN ERROR ANALYSIS:

- ***IN THE EARLY PHASE, TO GENERATE GENERAL REQUIREMENTS TO REDUCE THE HUMAN ERROR PROBABILITY DURING MISSION OPERATIONS***
- ***DURING THE PROJECT DESIGN DEVELOPMENT PHASES TO IDENTIFY SPECIFIC HUMAN ERRORS AND RELEVANT CONTROLS.***
- ***DURING THE EXPLOITATION PHASE (i.e. ISS) HUMAN ERROR PREVENTION SHOULD BE ADOPTED TO MAINTAIN SAFETY STANDARD FOR CREW OPERATIONS***

AS THE SAFETY OF A SYSTEM IS DESIGNED ACCORDING TO THE SAFETY ANALYSIS IN A SIMILAR WAY THE INTERFACES BETWEEN THE CREW AND THE SYSTEM/OPERATIONAL PROCEDURE SHOULD BE DEVELOPED TAKING INTO ACCOUNT THE RESULT OF THE “HUMAN ERROR ANALYSIS”



HUMAN ERROR ANALYSIS SHOULD BE MANDATORY ANY TIME THE “HUMAN” IS INVOLVED IN CONTINGENCIES OR SAFETY CRITICAL OPERATIONS

ARE WE FORGHETTING SOMETHING ON SAFETY?

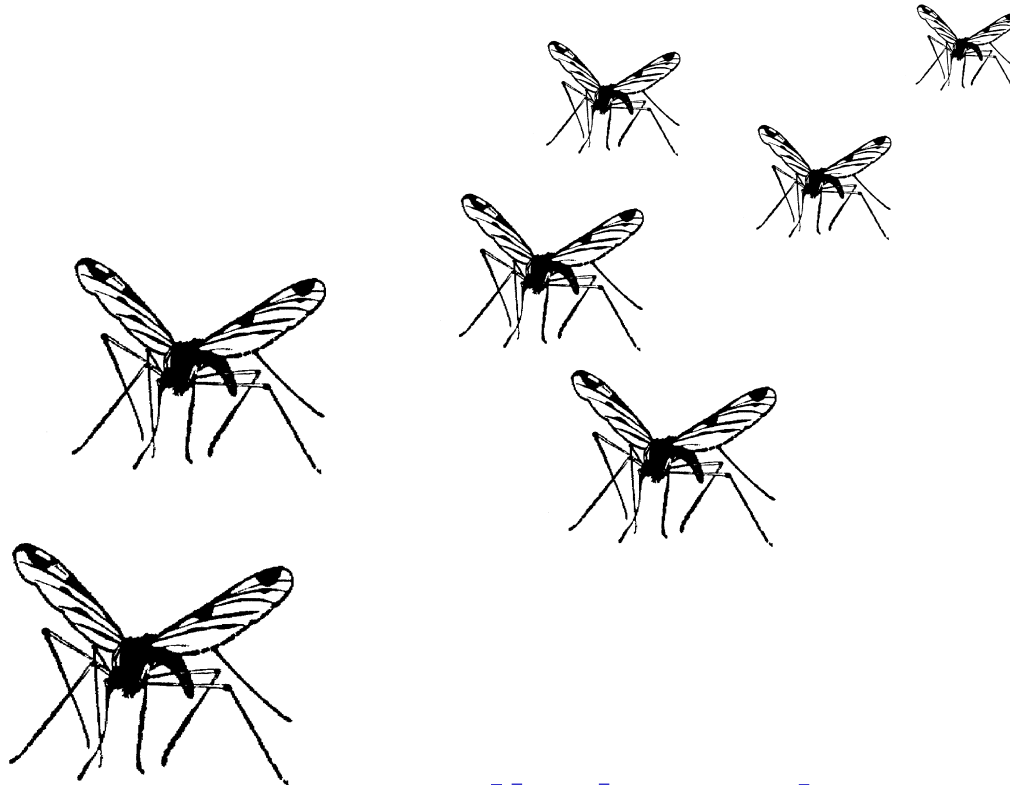
product realization: no problem on Human
errors ?

**THE
RISK**

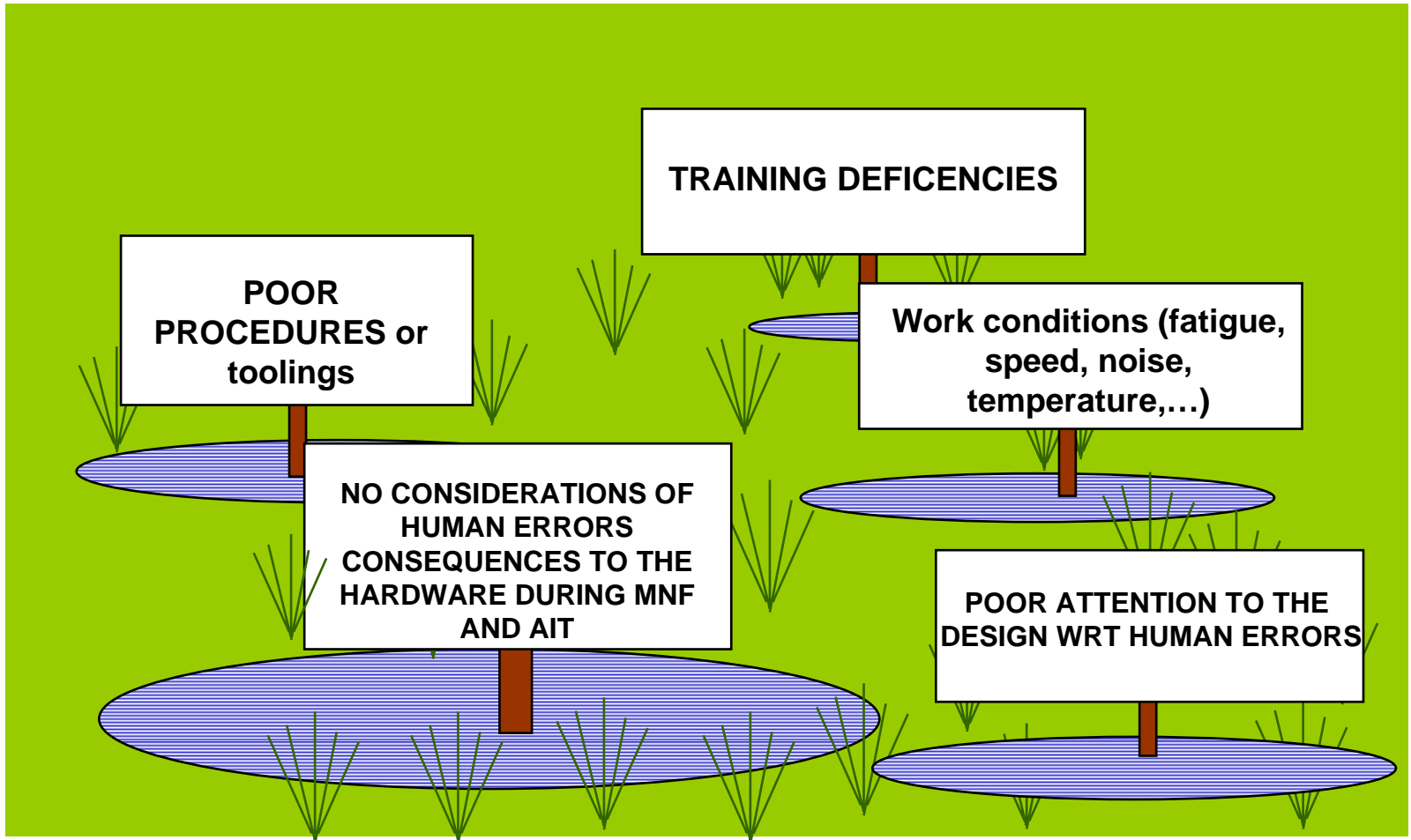


- **Following an NCR caused by the Human the relevant root cause is identified and the corrective action implemented to avoid reoccurrence. Typically the Training is the major driver for corrective actions or in some case the procedures updating. This approach does not permit the avoidance of Human mistakes or the reduction of their effect but just to reduce temporarily the occurrence of a known situation.**
- **Some techniques are used in some case (e.g. Poka Yoke) to prevent Human errors**

Avoid that the Human errors become ...



...eliminated one others will arrives



Typically not sufficient to reduce human errors :

to perform and perform again training

**Change is necessary to reduce the Human error
with a different concept**

**Research in this field is necessary to improve
the Quality and the Safety of the final product**