

Rapid Prototyping & Validation of Human Factors in a Model Based Naval Systems Engineering Application

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Agenda

- Definitions
- Designing for Usability
- Human Factors in Model Based System Engineering
- HCI Fast Prototyping – ModVIS experience
- Benefits
- Conclusions



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Definitions

- **Combat System (C/S)**
 - System that performs combat mission on a naval military unit, employing an integrated suite of sensors, weapons, and C4I capabilities;
- **Human Factors (HF)**
 - Set of disciplines that define human constraints in the design of a system;
- **Integrated System Functional Model (ISFM)**
 - Human factors studies' results become part of the System functional Model;
- **HCI Fast Prototyping**
 - From System Model an automatically generated preliminary version of Human Computer Interface panels
- **MODVis**
 - MODEL Visualization and Validation : a tool developed by Selex-SI for graphic and textual representation of System Model

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Human Factors Design in Naval Applications

Human Factors based design has seen increasing interest in Naval Applications due to :

- **Reductions** of embarked **Crew** Members.
- **Increasing** number and complexity of **equipments** and **capabilities** for flexible employment of modern multi-role ships.
- The **acceptance** of the whole integrated system is based on **Usability** assessment by the operational Navies members.

Human Computer Interaction Design

- The idea of Human Computer Interaction design is to reduce the distance between systems and the users by designing them to be **usable**.

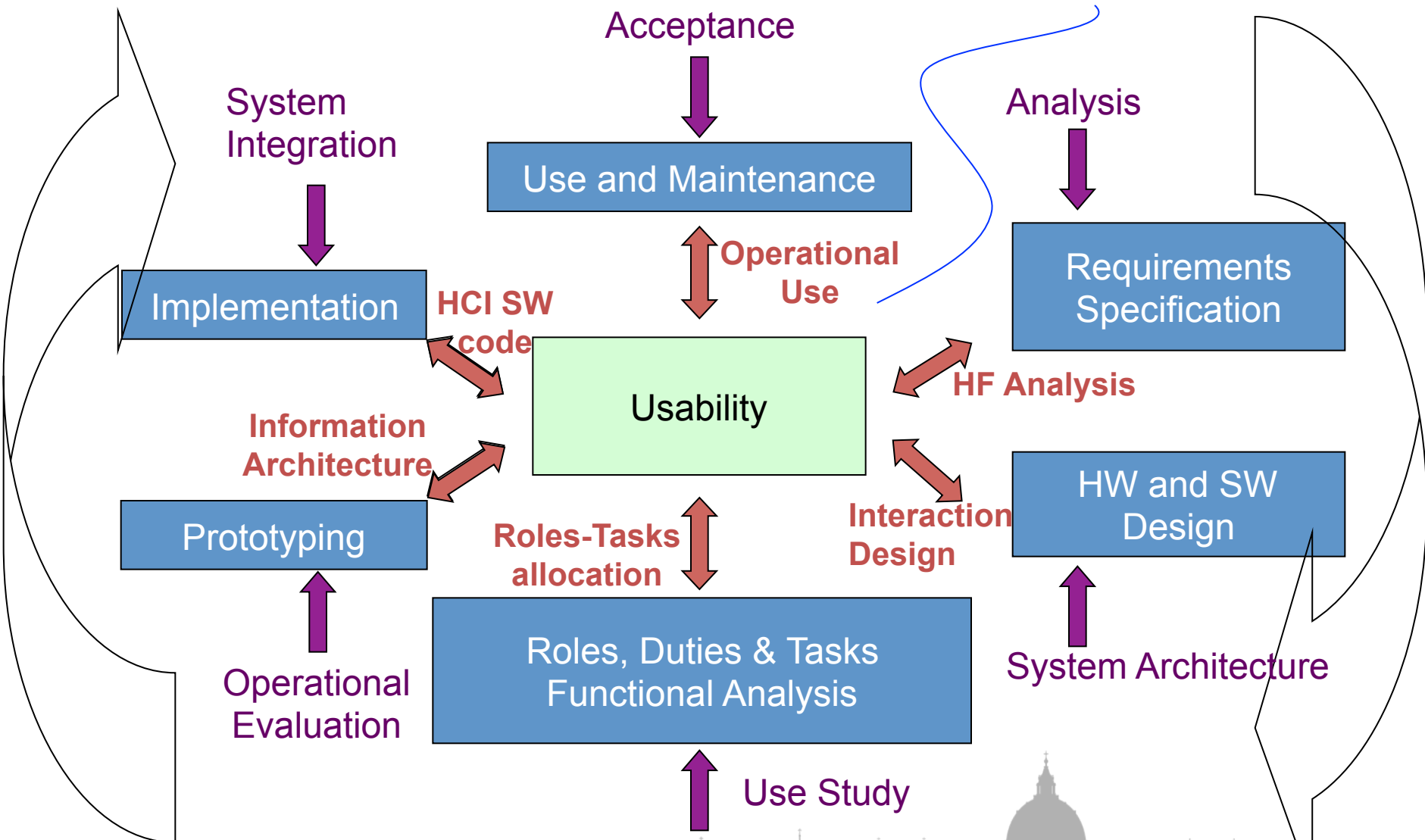
- Key Questions:
 - User (cognitive and physical capabilities) -- Who ?
 - Technology -- By ?
 - Usability -- How ?
 - User's Tasks -- What ?
 - Context of Use -- Where ?

Usability Attributes

Important Usability attributes to be reached in Naval Systems:

- Learnability,
- Efficiency,
- Memorability,
- Robustness,
- Satisfaction.

Usability



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Human Factors in System Engineering Approach

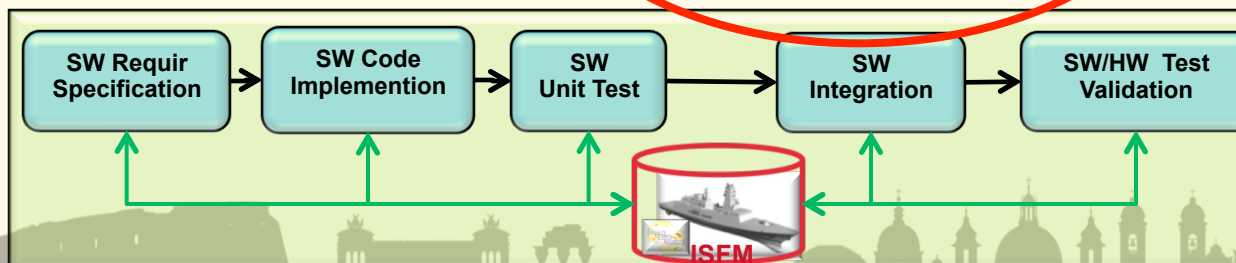
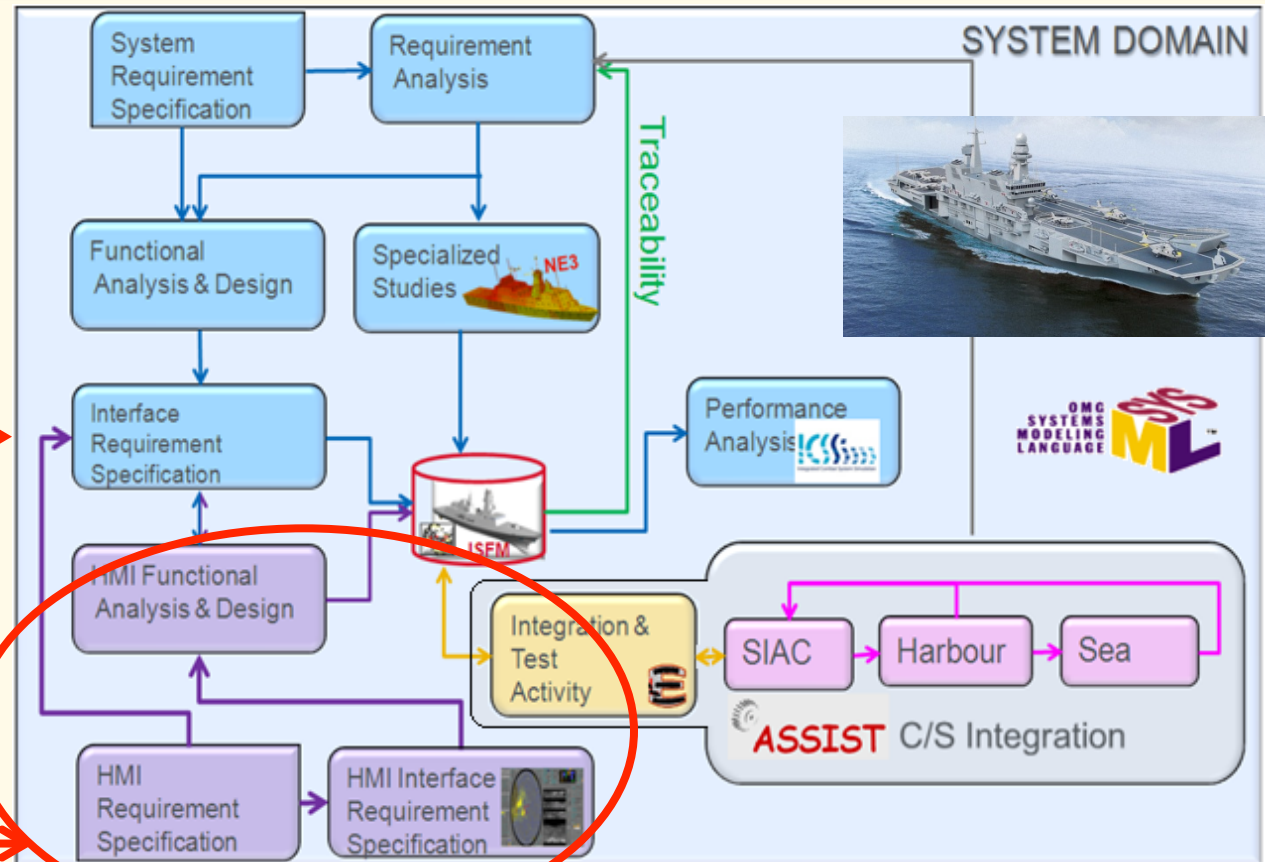
SYSTEM OF SYSTEM DOMAIN



Mission Needs



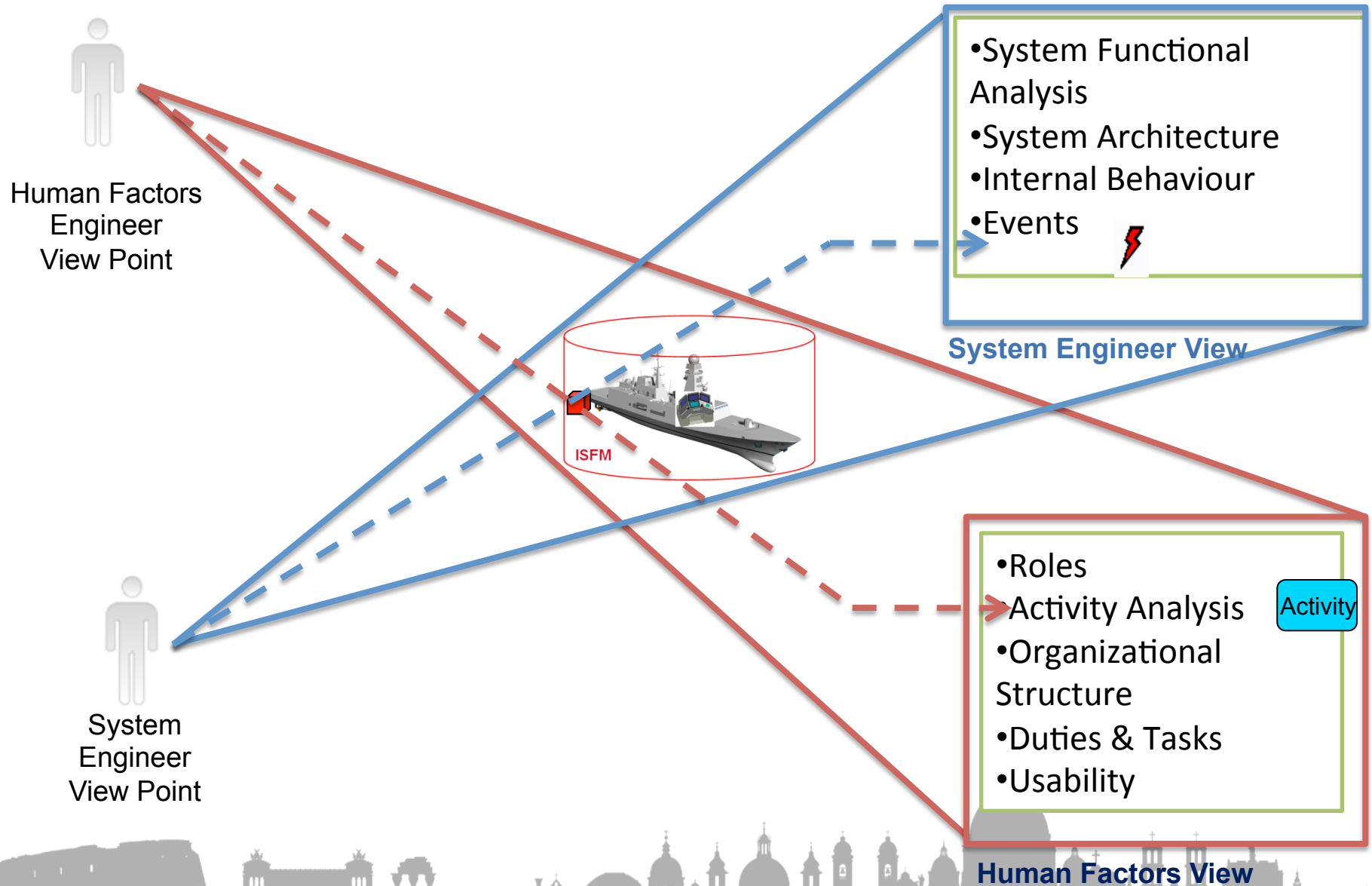
Human Views



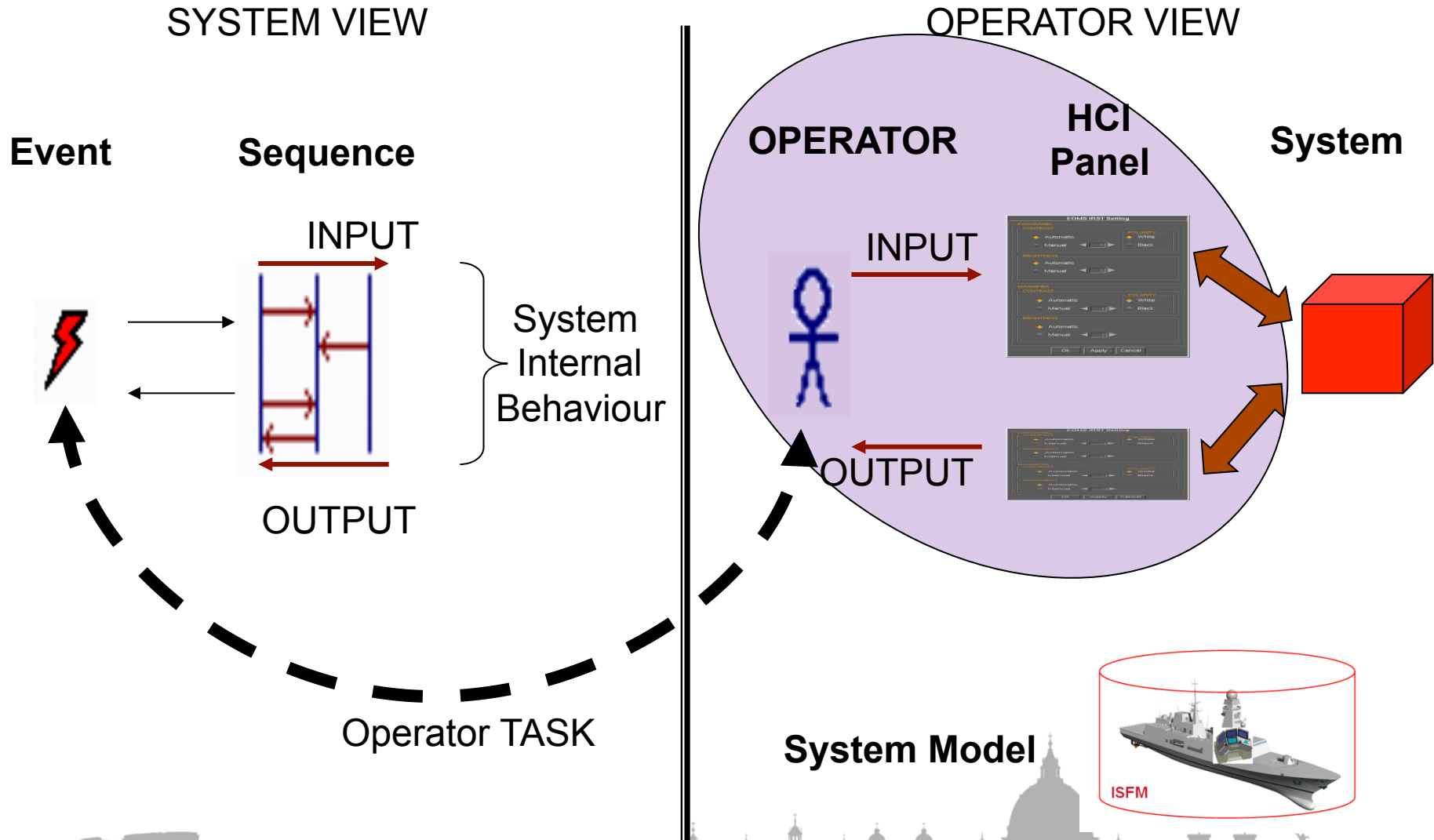
CMS SOFTWARE DOMAIN



Integrated System Functional Model View Point



Human Factors and System Views



OPERATOR TASK ANALYSIS

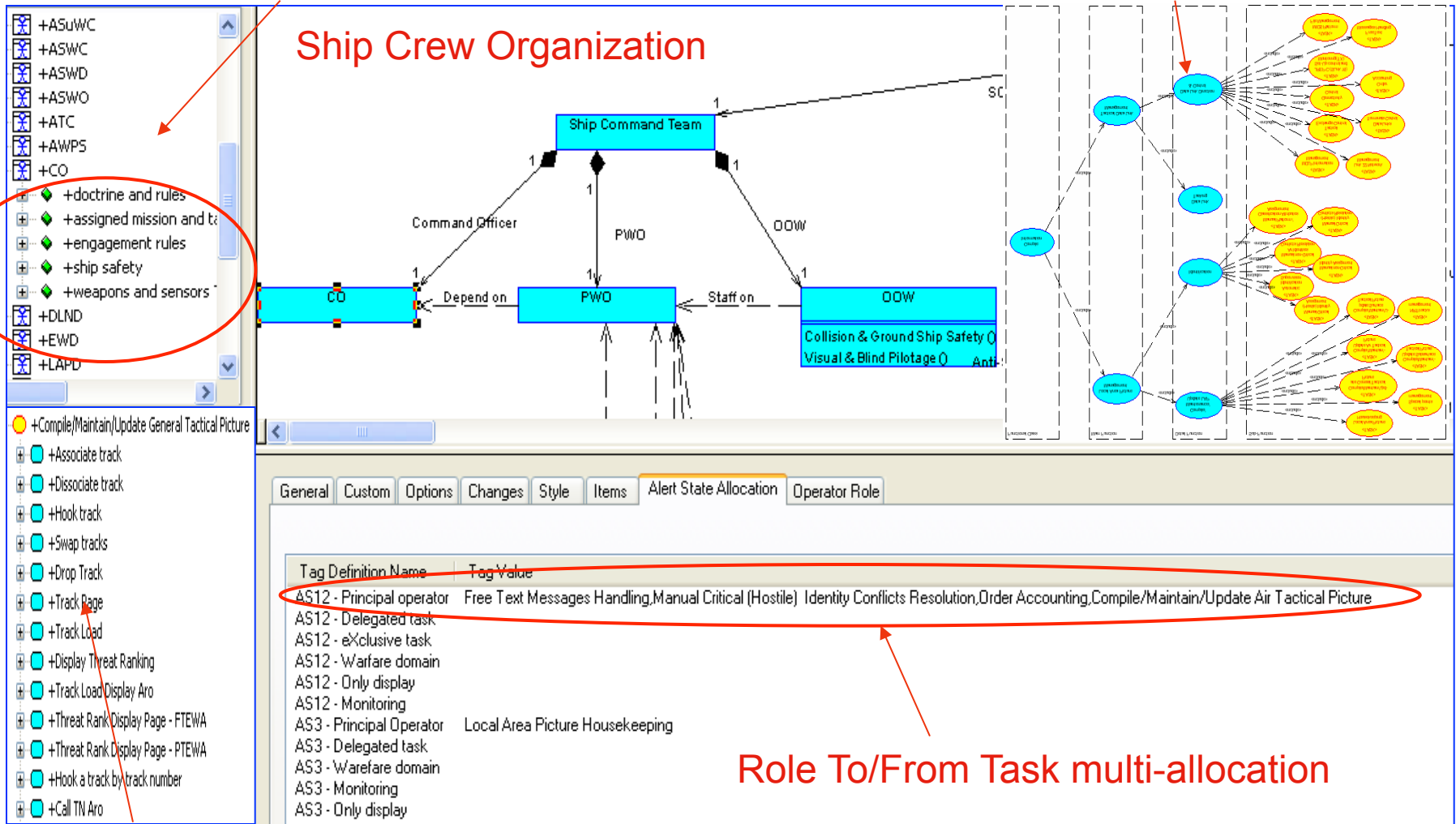


Human Factors Modelling Overview

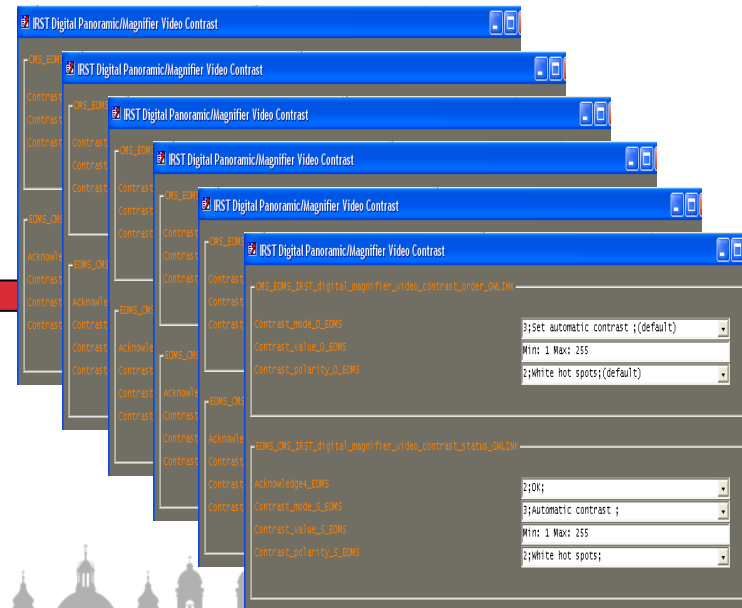
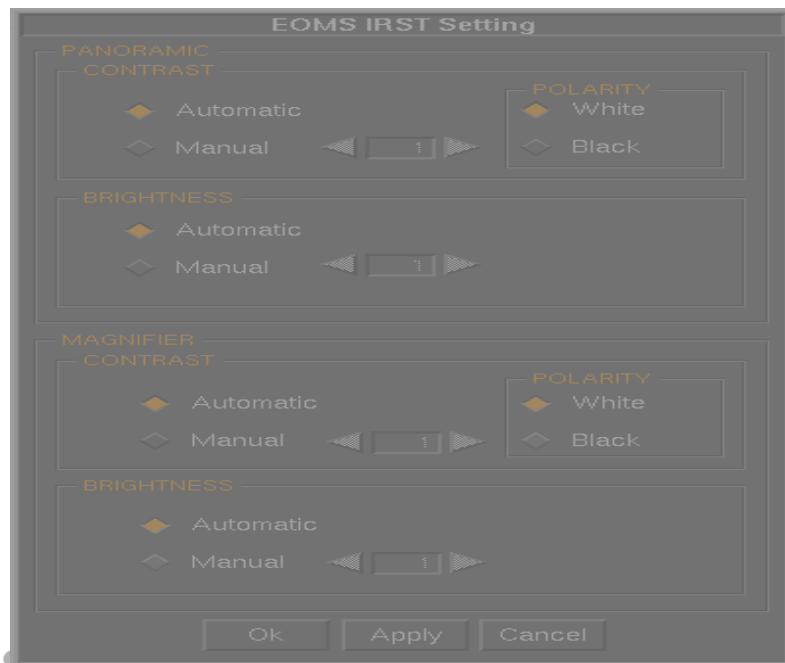
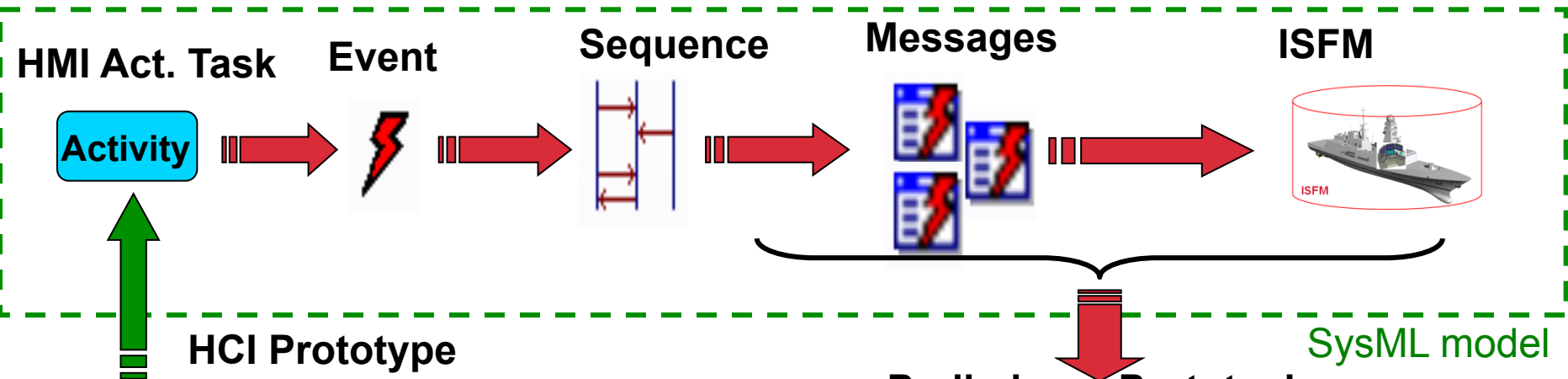
Role Definition and duty

Task Function Analysis

Ship Crew Organization



From SysML Model to HCI Prototype



System Requirement Development Views

System Development

Human Factor Development



+CMS-MTP-OPR-3950
NRT Manual initialisation

+Real/Not Real Track Management

+NRT tracks management

+Non real time track management

+Create NRT Air Point Track

+Facade for Operator Action Management

+CreatePointNRT_ARP

+HCI_TPM_CreatePointNRT_ARP_MSG

- header : Message_Header_Type
- oaSubHeader : HCI_Header_Type
- positionXY : T_2DCartesianCoordinates
- arpSignature : T_UnsignedInteger32
- course : T_Float
- speed : T_Float
- altitude : T_Float
- combatSystemTime : T_CSTime
- environment : T_Environment
- identity : T_Identity
- ftn : T_UnsignedInteger32
- subSurfaceClassConfidence : T_SubsurfaceClassifConfidence

Create NRT Air Point Track

FTN		Course	0.0	deg
Identity	Unknown	Speed	0.0	kts
Ellipsoid	Ellips 0	Altitude	0.0	hft

RU	Time
OS Hook	Curr 0 / 0 / 0
	0 : 0 : 0 Z

Position

XY Bearing/Range Lat/Long

Xpos 0 nm

Ypos 0 nm

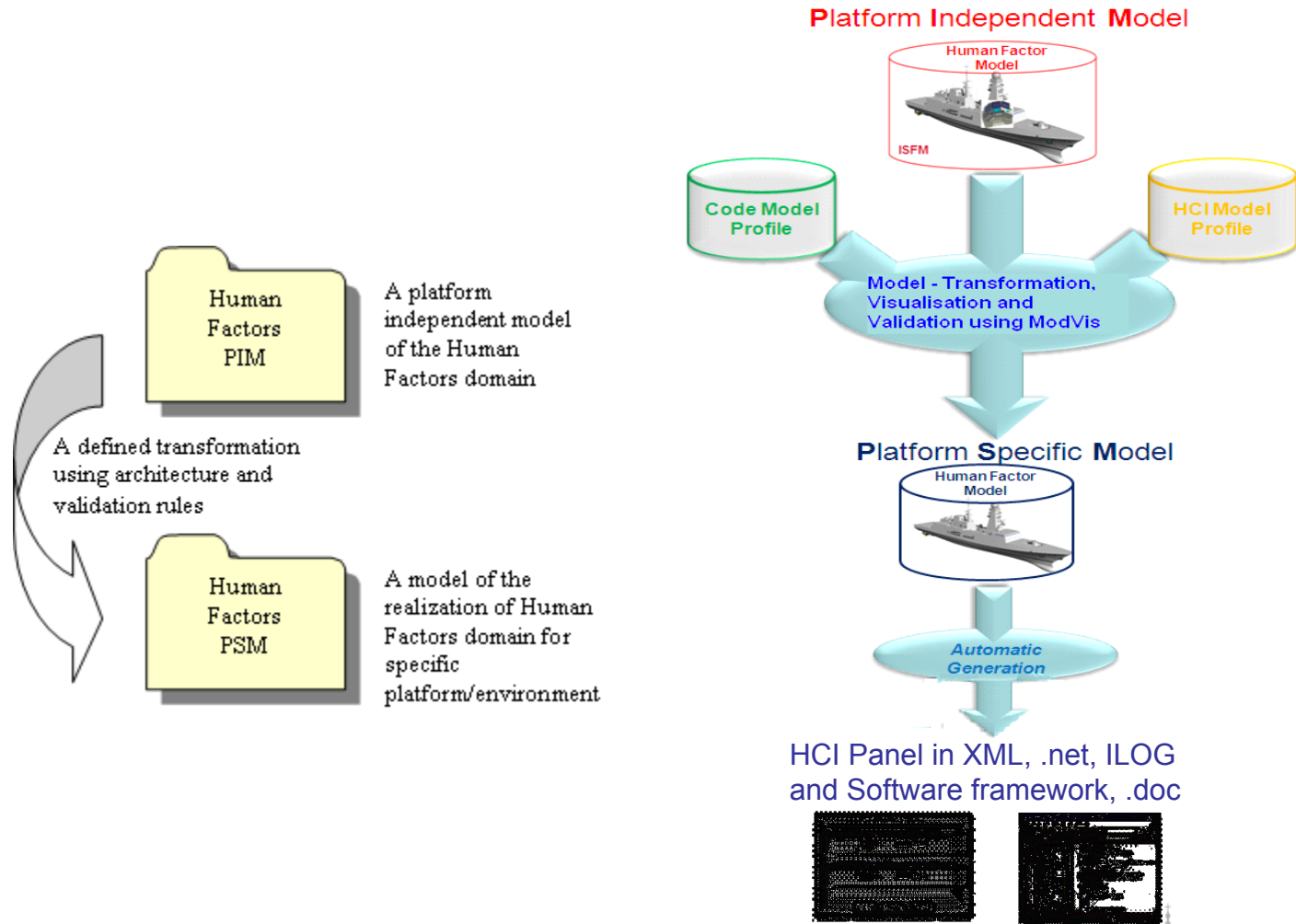
Memo TB

Ok Cancel Apply

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From PIM to PSM





- ModVis is a .net application which generates software framework and HCI panels.
 - ModVis can generate panels in XML format or in any other graphic format (e.g. IBM-ILOG, QT) providing the relevant libraries.
 - ModVis also provides documents (e.g. .doc files) and the software links to messages.
- ModVis prompts the systems engineer to log in as the desired role or as the operator of interest.
- ModVis queries the model and displays the actors who are part of the use cases. This process is dynamic and hence any addition/deletion is consequently modified in ModVis.
- Modvis analyses the tasks, activities associated with the chosen operator and adds the appropriate buttons, panels.
- ModVis displays outputs on the associated HCI facility (e.g. Screen, MultiFunctionKeyboards).

MODVis FrameWork

ModVis

Welcome to Operator Role Visualisation and Model Validation (ModVis)

Select the Artisan Project: Human Factor MultiProc

Select the Program: Programme 1

Select the type of view: Console View

LOAD SETTINGS EXIT

TID CONSOLE DISPLAY CONFIGURATION

CONSOLE_WIDTH: 15

CONSOLE_HEIGHT: 9

CONSOLE_POINT_Y_A: 1

CONSOLE_POINT_Y_B: 2

CONSOLE_POINT_Y_C: 3

FONT TYPE: [Font: Name=Arial, S] FONT

BUTTON DE-ACTIVATE COLOUR: Color [Yellow] COLOUR

COMMON FEATURES: Common functionalit ADD CLEAR

CONSOLE SAVE OPTIONS

EXIT CONSOLE: Esc

SAVE AS IMAGE: F1

SAVE AS XML: F2

SUPPORT SCREEN CONFIGURATION

SCREEN_WIDTH: 4

SCREEN_HEIGHT: 4

SCREEN PRESENTATION: Image

ILOG FILES LOCATION: \\serverartisan\Tra

FONT TYPE: [Font: Name=Aria] FONT

BUTTON DE-ACTIVATE COLOUR: Color [Yellow] COLOUR

COMMON FEATURES: Common function

GRAPHICS CARD INFO

CONSOLE: \\DISPLAY1

SUPPORT SCREEN: \\DISPLAY2

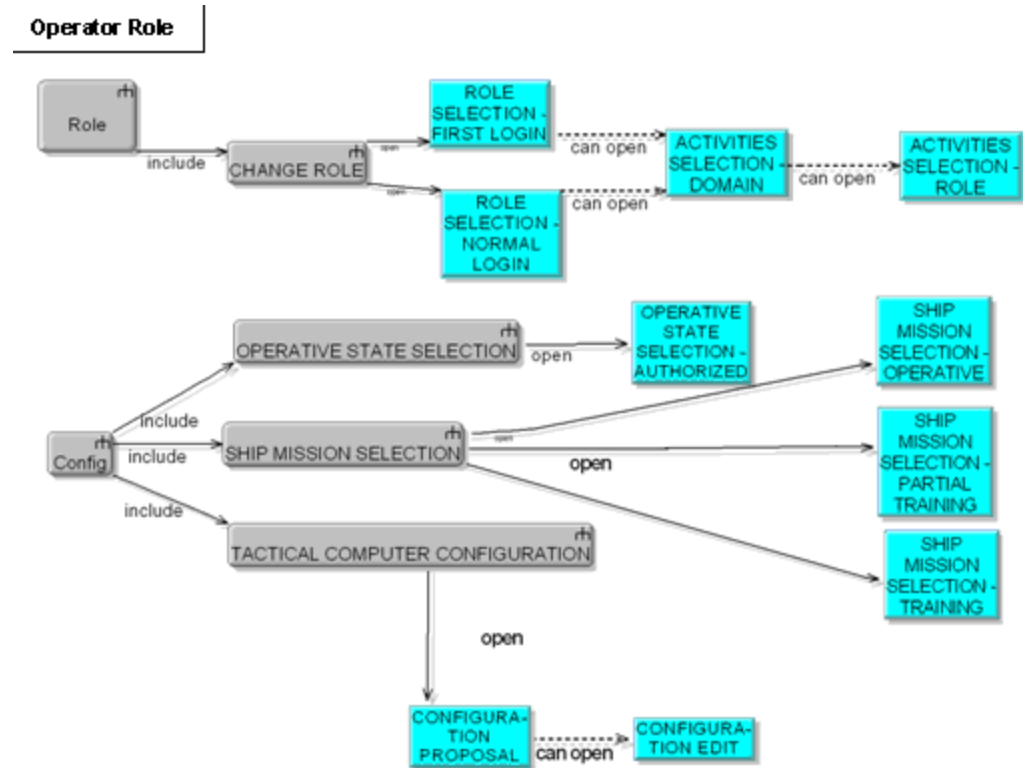
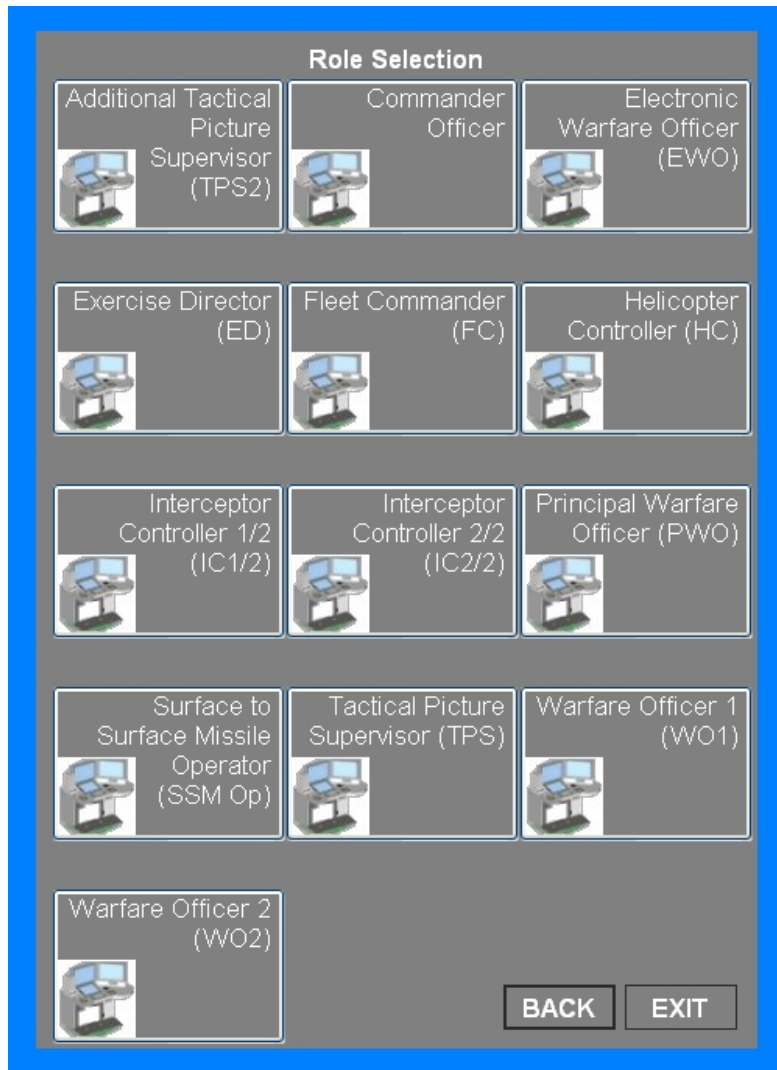
APPLICATION LOG

☐ ERROR LOG

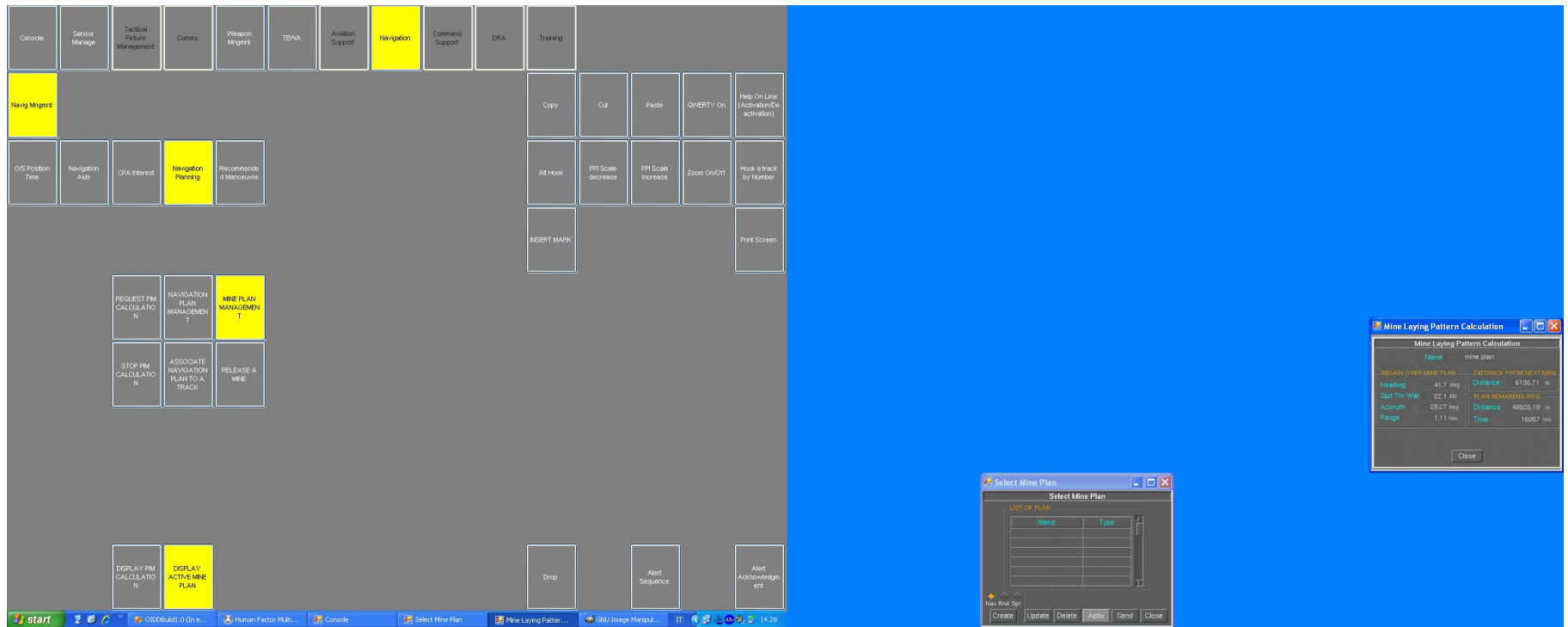
☒ EVENT LOG (Admin)

OK CANCEL

MODVis Operator View



MODVis Output (Console View)



The screenshot displays the MODVis Console View interface. The main area is a grid of function buttons. The 'Navigation' button is highlighted in yellow. Other buttons include Console, Sensor Manage, Tactical Picture Management, Comms, Weapon Mgmt, TDMA, Aviation Support, Command Support, DRA, Training, Copy, Cut, Paste, QWERTY On, Help On Line (Activation/Deactivation), OS Position Time, Navigation Aids, CPA Interest, Navigation Planning, Recommend a Manoeuvre, REQUEST PM CALCULATION, NAVIGATION PLAN MANAGEMENT, MINE PLAN MANAGEMENT, STOP PM CALCULATION, ASSOCIATE NAVIGATION PLAN TO A TRACK, RELEASE A MINE, DISPLAY PM CALCULATION, DISPLAY ACTIVE MINE PLAN, Drop, Alert Sequence, Alert Acknowledgment, INSERT MARK, and Print Screen.

Two floating windows are visible:

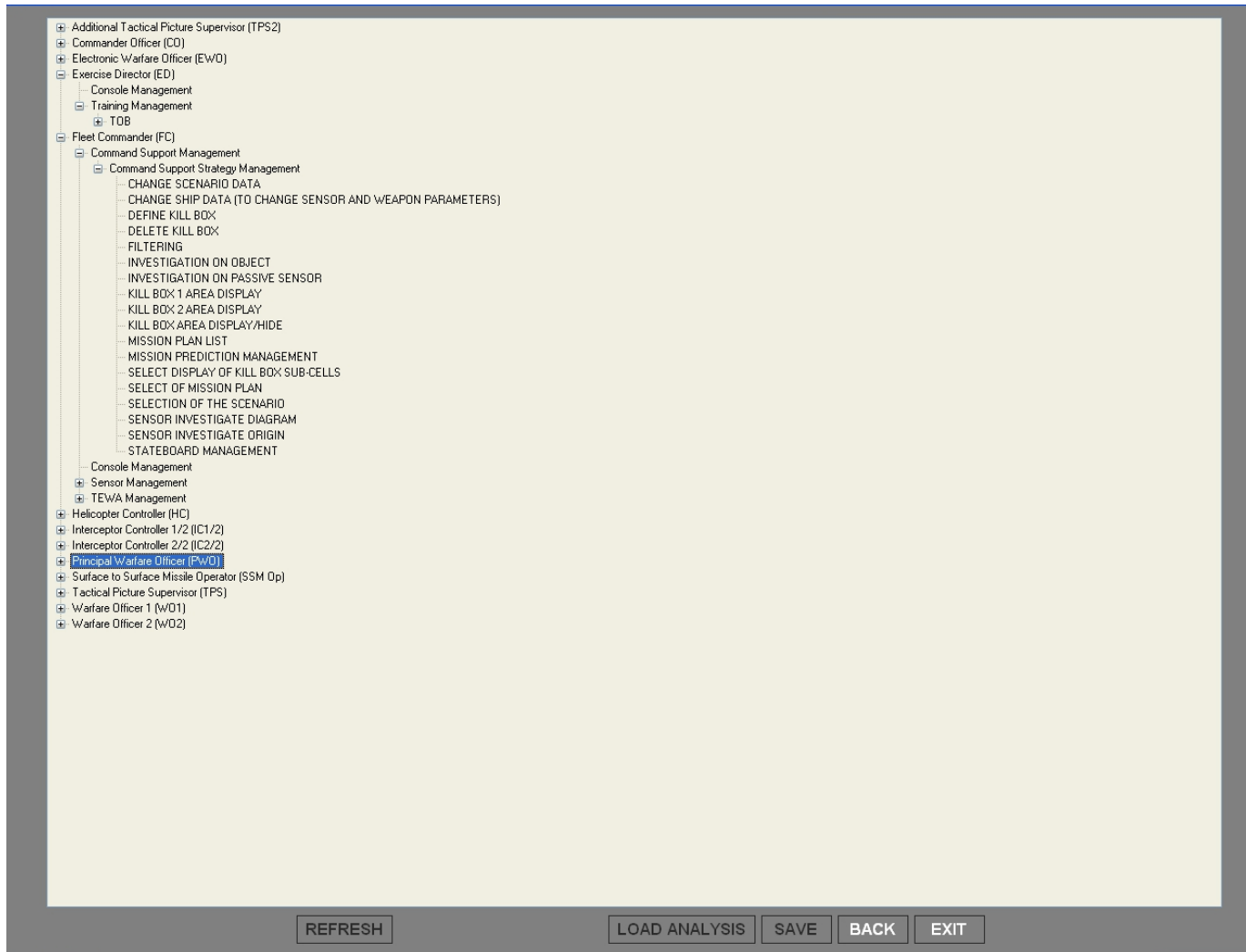
- Select Mine Plan**: A window with a table titled 'LIST OF PLAN' containing columns 'Name' and 'Type'. The table is currently empty. Below the table are buttons: Create, Update, Delete, Apply, Send, and Close.
- Mine Laying Pattern Calculation**: A window displaying calculation results for a mine plan.

Name	mine plan
RECALC OVER MINE PLAN	DISTANCE FROM BEST MINE
Heading	43.7 deg
Spd The Wat	22.1 kn
Acclmth	28.27 deg
Range	1.11 nm
Distance	6136.21 m
PLAN REMAINING AFD	
Distance	48626.19 m
Time	16057 sec

 A Close button is at the bottom.

The Windows taskbar at the bottom shows the Start button, taskbar icons for CDDBase 0.0 (in e...), Human Factor M... , Console, Select Mine Plan, Mine Laying Pattern..., GPU Image Manipu..., and the system clock showing 14:28.

MODVis Output (Tree View)



The screenshot displays the MODVis Tree View interface. The tree structure is as follows:

- Additional Tactical Picture Supervisor (TPS2)
- Commander Officer (CO)
- Electronic Warfare Officer (EW0)
- Exercise Director (ED)
 - Console Management
 - Training Management
 - TOB
- Fleet Commander (FC)
 - Command Support Management
 - Command Support Strategy Management
 - CHANGE SCENARIO DATA
 - CHANGE SHIP DATA (TO CHANGE SENSOR AND WEAPON PARAMETERS)
 - DEFINE KILL BOX
 - DELETE KILL BOX
 - FILTERING
 - INVESTIGATION ON OBJECT
 - INVESTIGATION ON PASSIVE SENSOR
 - KILL BOX 1 AREA DISPLAY
 - KILL BOX 2 AREA DISPLAY
 - KILL BOX AREA DISPLAY/HIDE
 - MISSION PLAN LIST
 - MISSION PREDICTION MANAGEMENT
 - SELECT DISPLAY OF KILL BOX SUB-CELLS
 - SELECT OF MISSION PLAN
 - SELECTION OF THE SCENARIO
 - SENSOR INVESTIGATE DIAGRAM
 - SENSOR INVESTIGATE ORIGIN
 - STATEBOARD MANAGEMENT
 - Console Management
 - Sensor Management
 - TEWA Management
- Helicopter Controller (HC)
- Interceptor Controller 1/2 (IC1/2)
- Interceptor Controller 2/2 (IC2/2)
- Principal Warfare Officer (Pw0)
- Surface to Surface Missile Operator (SSM Op)
- Tactical Picture Supervisor (TPS)
- Warfare Officer 1 (w01)
- Warfare Officer 2 (w02)

At the bottom of the interface, there is a control bar with the following buttons: REFRESH, LOAD ANALYSIS, SAVE, BACK, and EXIT.

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Benefits in the Project phases

- **Design Phase:**

- Consistent Check of HCI Data and System Data.
- Balance among information layout display and system information constraints

- **Development Phase:**

- HCI preliminary fast prototyping.
- HCI prototyping with integrated Interface Requirements System.

- **Integration Phase:**

- Follow the Operator actions from the Display Interface to the C/S message exchange and CMS Service calls.

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Conclusions

Human Factors aspects inside the System Model allows to :

- Fast check on system data for consistency.
- Use automatic tools for Fast Prototypes generation (e.g. ModVIS)
 - Support Software Requirements Specifications
 - Receive early feedbacks for usability life-cycle
 - Anticipate HCI SW development
- Automatically generate project documentation
- Verify the functional chains in Integration Phase
- Use of automatic SW test tools
- Exploit a key feature for re-use in similar projects

Questions and Answers



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