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Usability & Human Factors Engineering

Return on investment in use of human factors in offshore systems

"Closing the gap between conceptual design and engineering, field construction activities and operations"

Harrie J.T.Rensink, R.e., Eur.Erg.

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Agenda

- SI HE Client portfolio
- Why Usability and HFE in projects?
- EMIS ® HFE quality system
    - Examples of *Smart design tools*
- Added value & Critical Success Factors

Objectives

- To improve awareness for ‘human centered design’
    - integrated *front end* engineering activity
    - ‘*first time right*’ principle
    - economical and non-economical benefits

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Reduce total delivered costs
Cost leadership
Create value proposition
Client intimacy
Operational/HSE excellence
Enhancing portfolio
Licence to operate
Engaging and developing people
Enhance profitability

MHMS implementation

Human centred desig
Green-/ brown field Projects

New Systems Technology
IT usability engineering

Operational excellence

Human Performance Improvement

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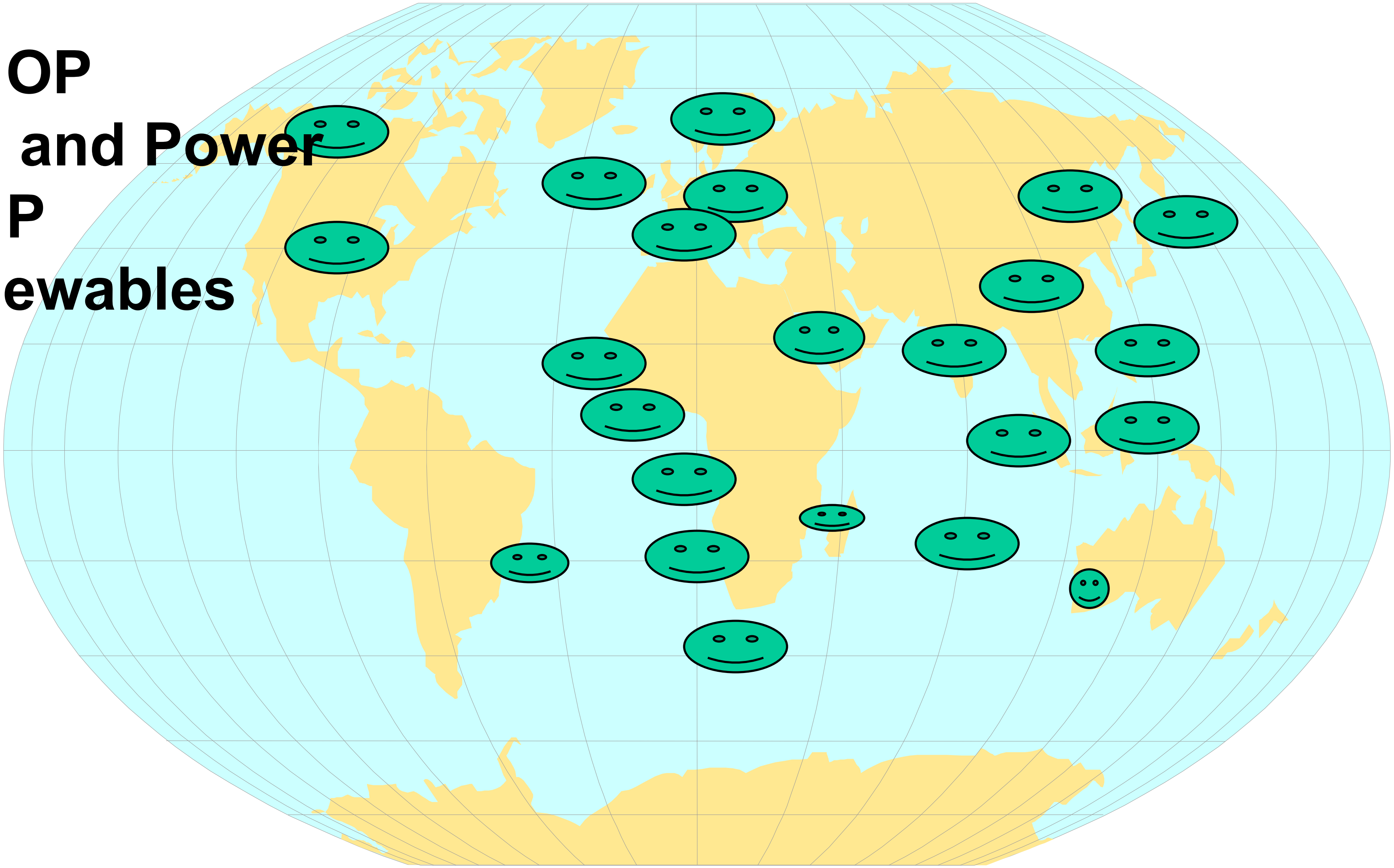
Client Portfolio & Projects

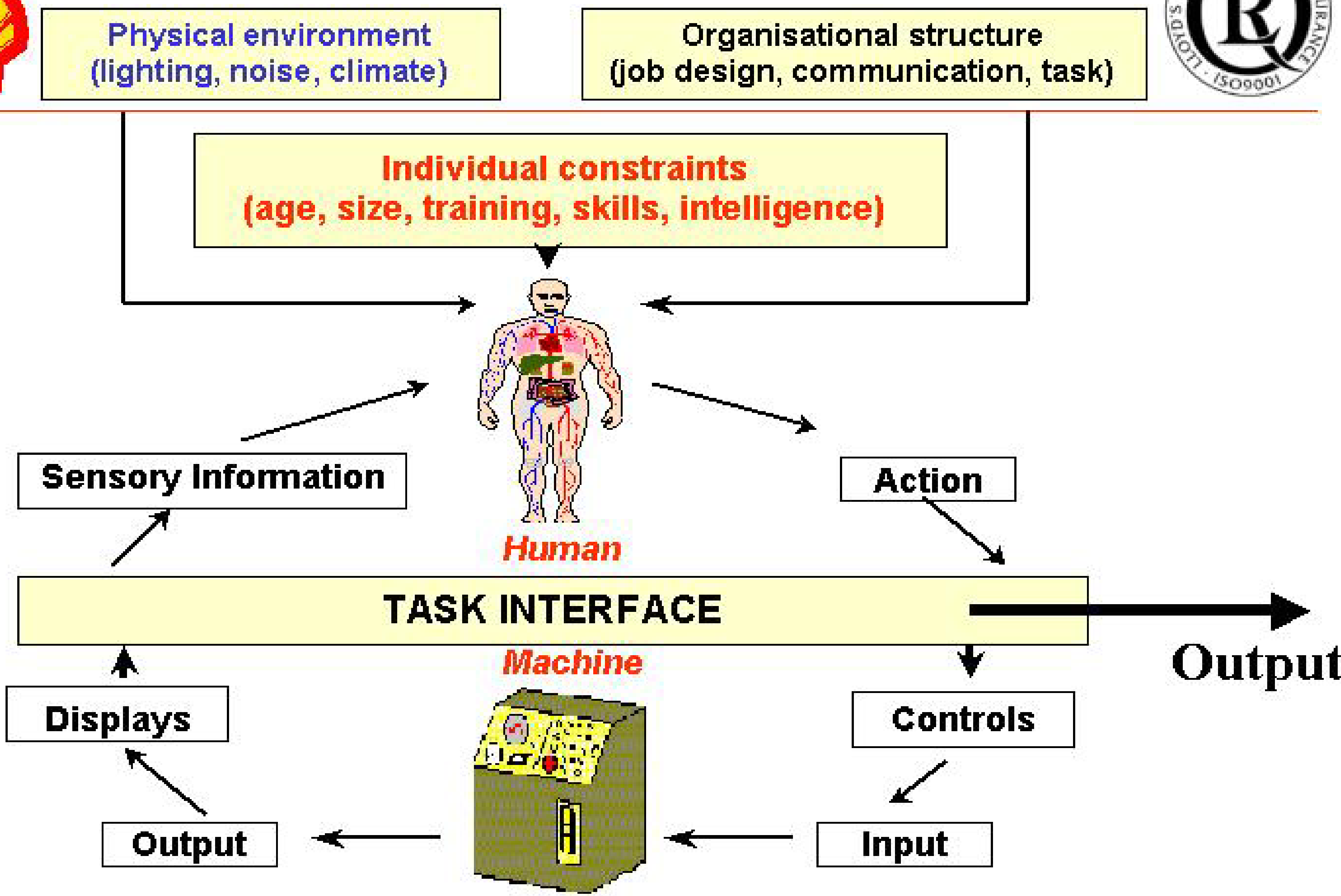
SC, OP
Gas and Power
E & P
Renewables



Business Objectives

- Eliminate *intrinsic* Human Machine Interface reliability-, efficiency, usability- and H & S risks
- Improve project profitability via:
    - Front end engineering
    - Use of ‘first time’ right ‘smart’ design tools
    - Use of “knowledge floor”
    - Structured “buy in” process of stakeholders

Human Machine Interface Model



Physical Interface

Cognitive Interface

Business case

Why improving operations and maintenance tasks?

Conclusion pre start-up safety review Hycon (1988)

"It has to be concluded that during engineering stage the opportunity could have been further exploited to optimise the design without increasing CAPEX in many cases.

This refers particularly to the fields of operability, accessibility and maintainability."

Business case

Why improving operations and maintenance tasks?

Lessons learnt RAYONG refinery project (1996)

“Basic concept not an operationally friendly machine”.

Business case

Why improving operations and maintenance tasks?

RAYONG project (1996) lessons learnt

Instrumentations

- DCS graphics were designed by main contractor with minor input of Ops. at an early stage
- too much information on screens
- to go through 5 screens to get to an alarm
- far too complex which complicates start up
- alarms poorly specified
- risk of panel men loosing confidence in system!

Business case

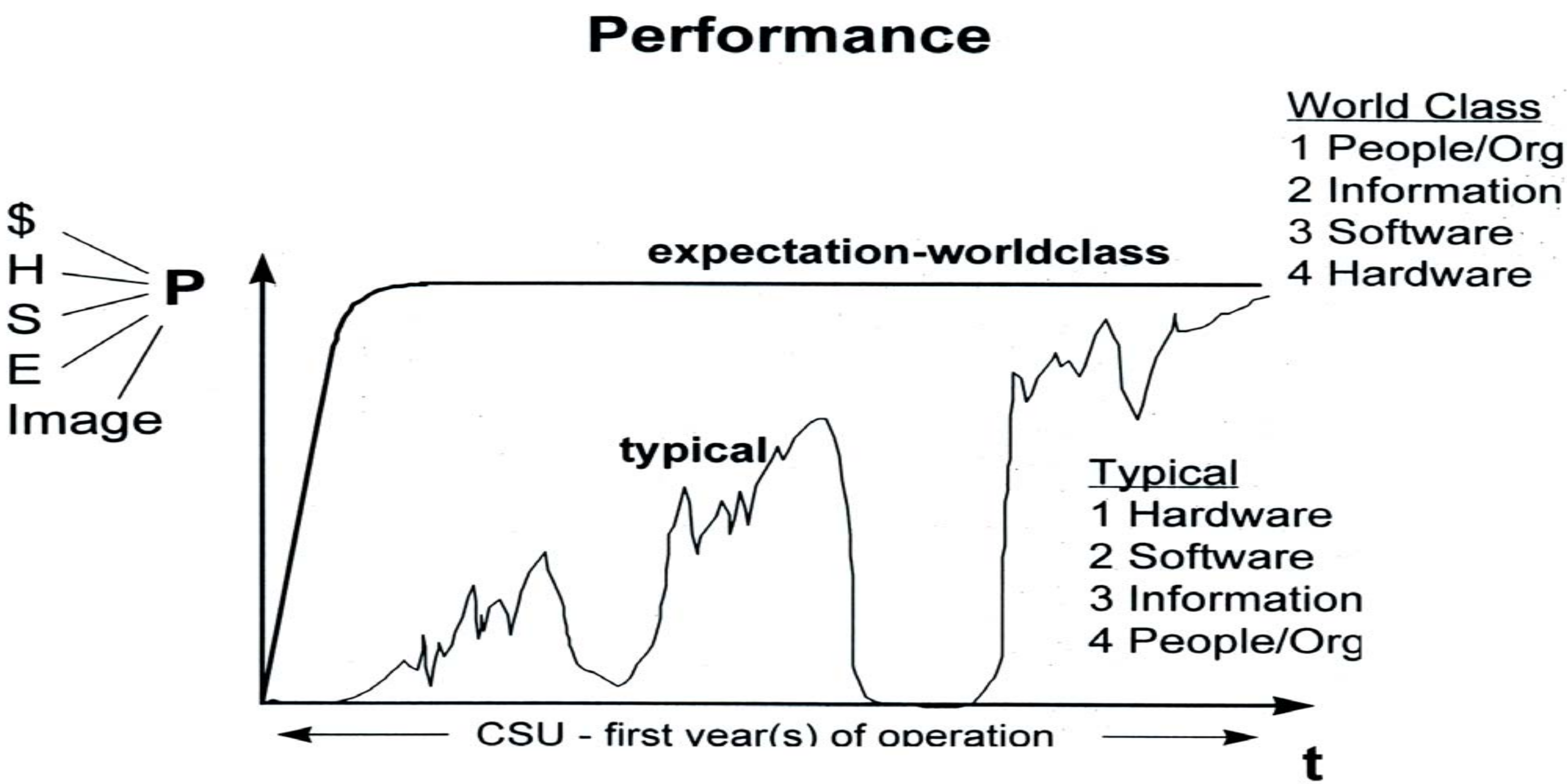
Why improving operations and maintenance tasks?

Project management issues

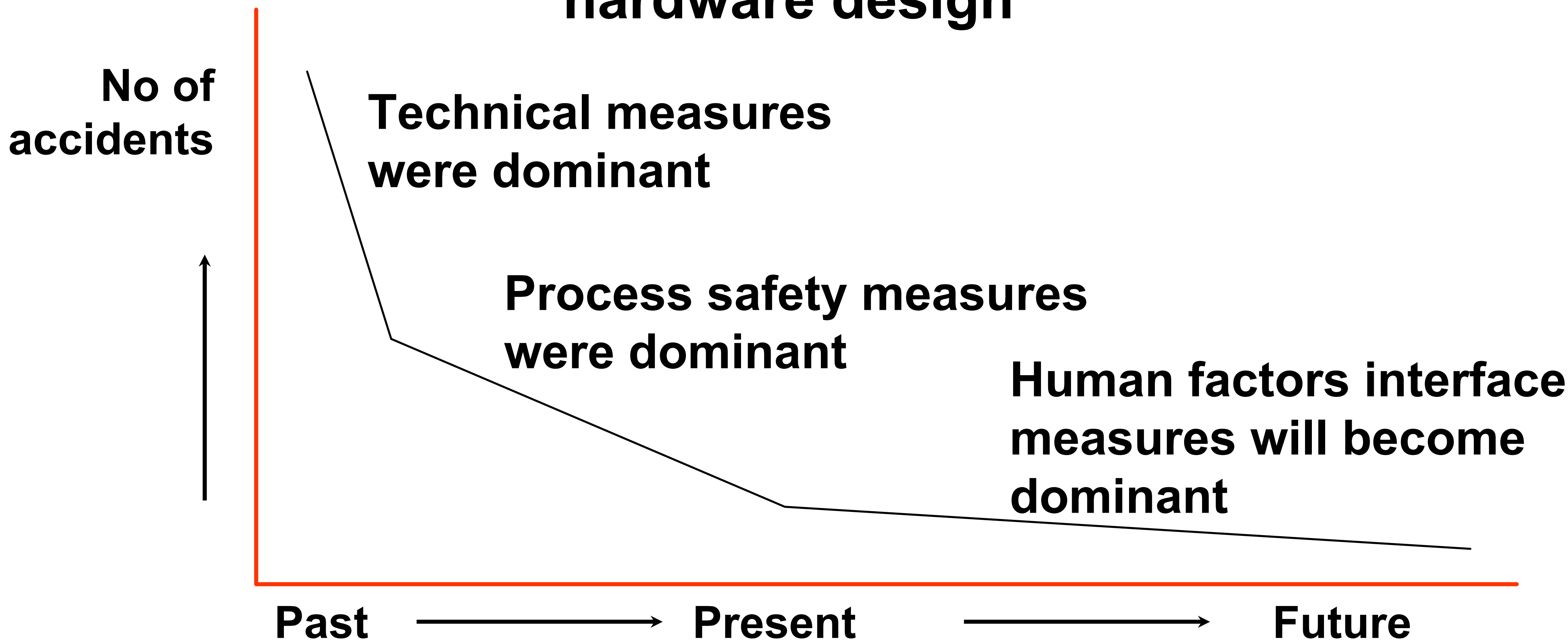
- 60 % of bottlenecks identified during Model review sessions are related to Operability and Maintainability

- Re-vamp/- design effort first 2 years after start up often related to solve operational and maintenance misfits as a result of insufficient input during Conceptual design

World class Projects



Literature "Development HSE improvements in hardware design"



Conclusion 'traditional' design process

- No balanced input of process, safety, OPS. and Maintenance criteria during conceptual design
- Poor (too late) dilemma handling
- Limited input in conceptual design of future Ops./M. tasks
- Insufficient & ineffective input of "work floor" experience
- HMI specifications are no part of BOD/BDEP documents
- Lack of 'change mgt.' approach in critical , i.e new designs

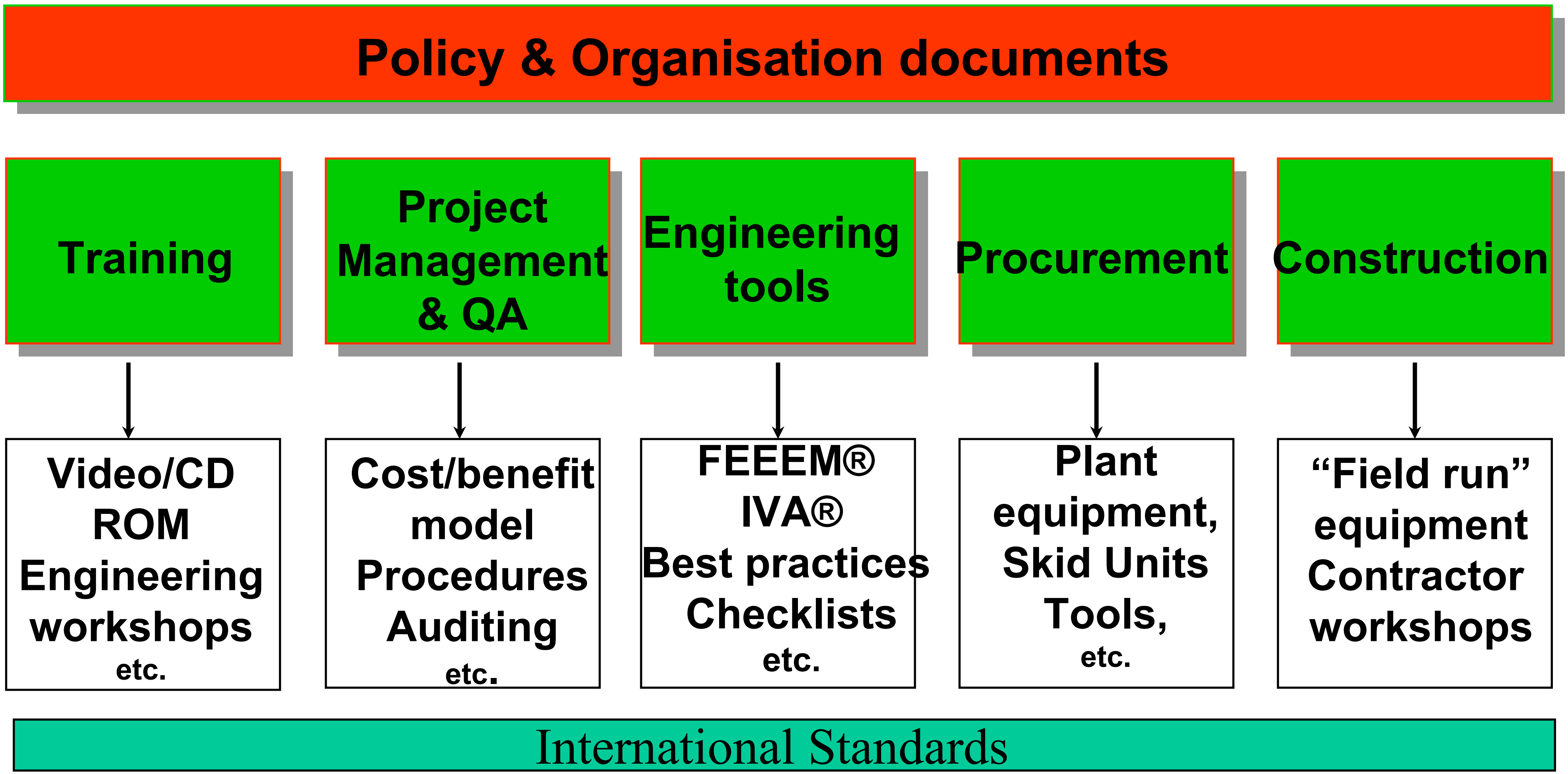
↓

Sub optimal design of operational/maintenance tasks

↓

Increase of project & life cycle costs

Ergonomic Management & Information System (EMIS®)



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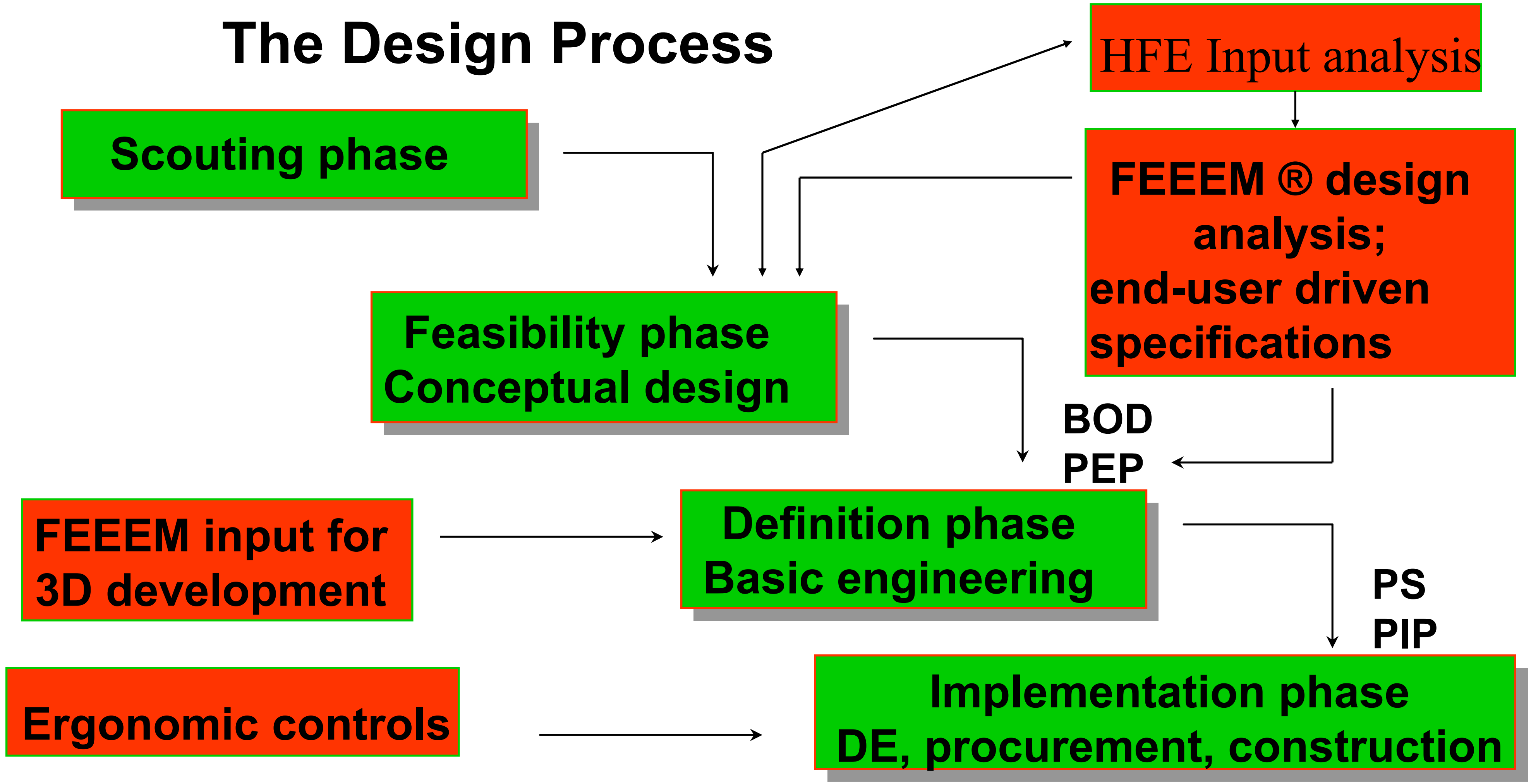
The Design Process



Evaluation of system efficiency after start up → Post Implementation Review

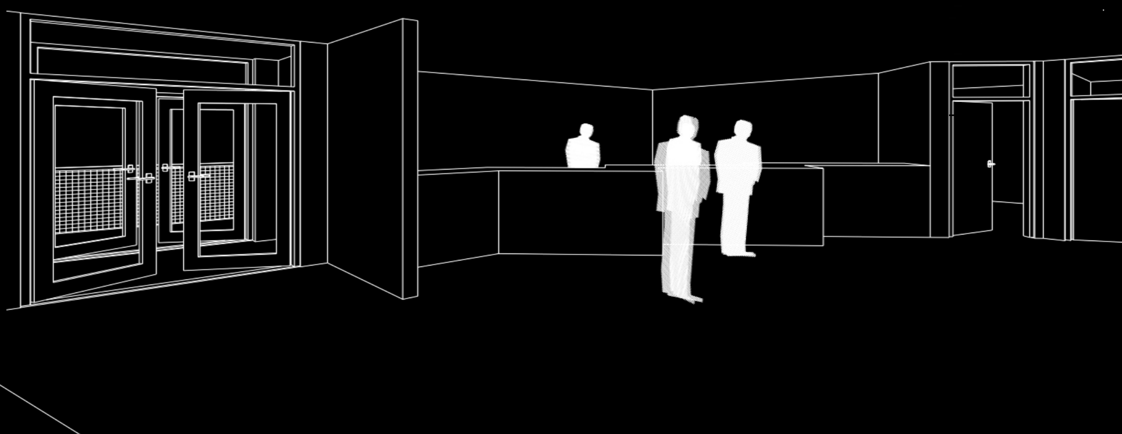
Examples *Smart* design tools

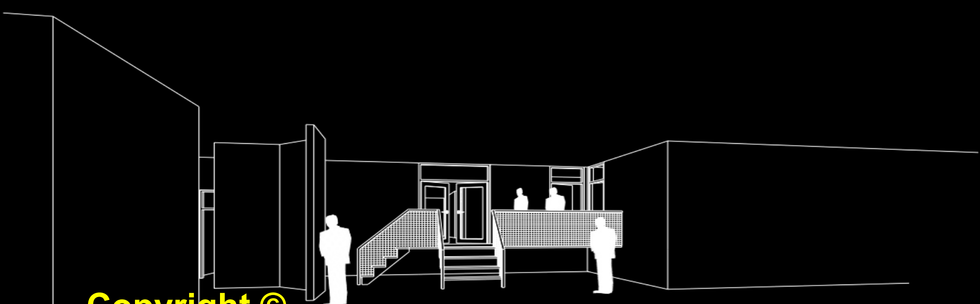
1. Functional Control room building and DCS cockpit design (FEEEM ® analysis)
    - Link analysis and Relation diagram
    - 3 D CAD visualizations

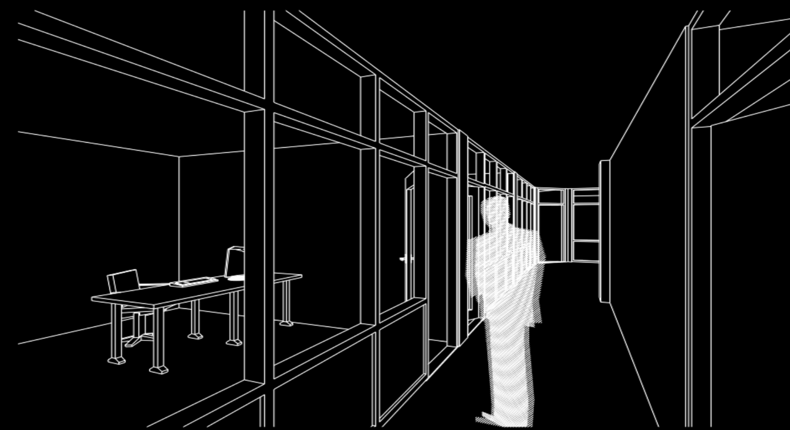
2. Plant lay out and Valve operations (IVA®)

3. Graphical design lay out process (AH coding ®)

Upgrader Main Control room Centre and Workshop Building
Athabasca Oil Sands Downstream Project
Shell Canada, Calgary







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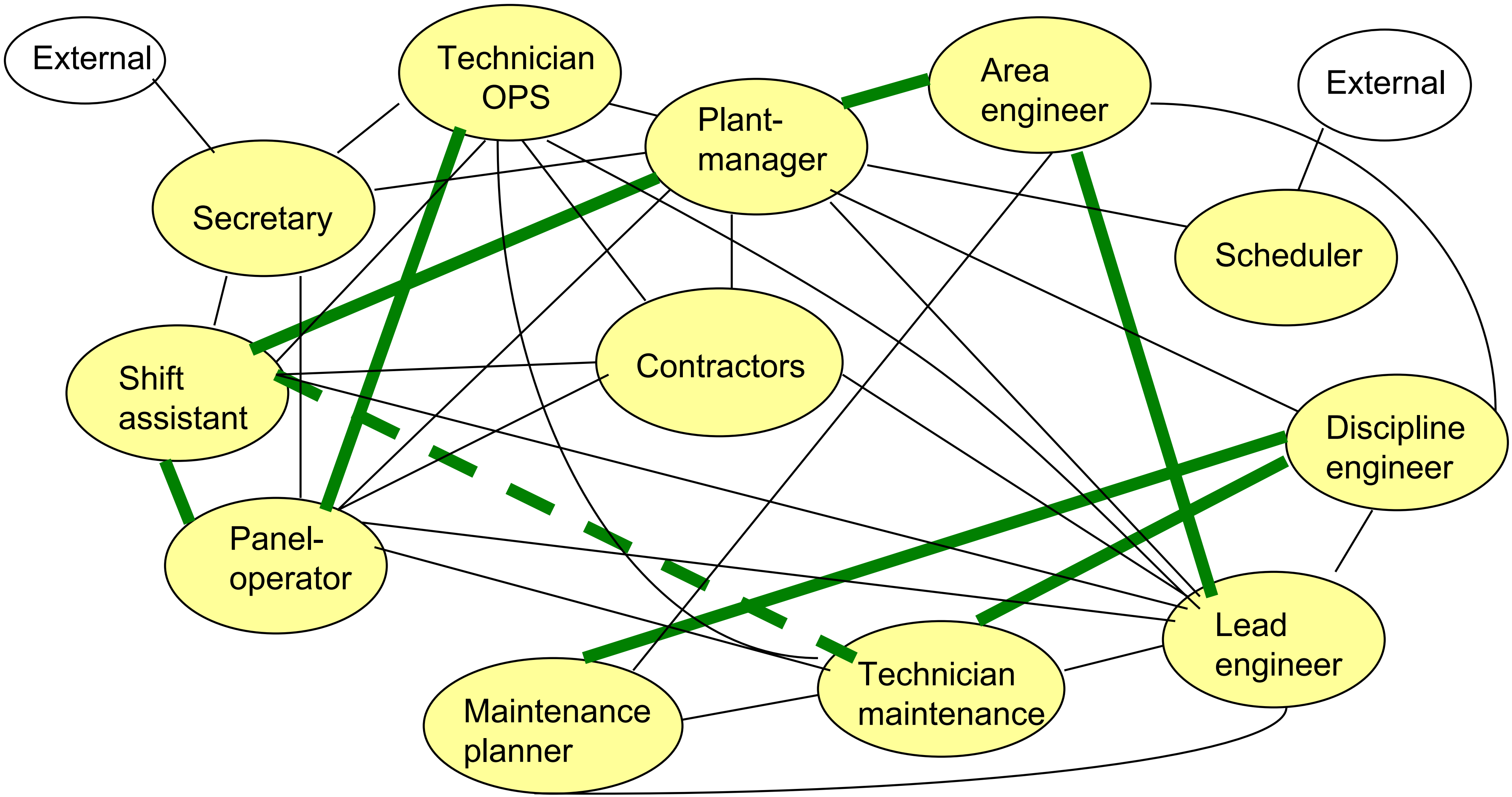
Link-analyses CCR / Engineering Functions frequency daily communication



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INTERFACE RELATIONSHIP MATRIX FOR CENTRAL CONTR

	Function	Area (sq.m.)*	Control Room	Storage (Bottles)	Exercise Space	Rackroom	OC (7x)	AMC (4x)	OE (5x)	Planning (2x)	UPS	Supervisory Comp.	Comm. Auxiliary	Shift Supervisor	Ext. Entrance to Bldg	Kitchen for Ops	Library/copier/fax	Permit	Smoke Area	Washrooms	Lab	Trai
1	Control Room	240		H	M	L	M	L	L			M	L	M		H	L		L	M		L
2	Storage (Bottles)	3	H																			
3	Exercise Space	8	M																			
4	Rackroom	75	L								L	H	L									
5	OC (7x)	105	M				H	H	H					M			M					M
6	AMC (4x)	60	L				H	H	M	H				M			M					
7	OE (5x)	75	L				H	M	H	L				L			M					
8	Planning (2x)	30						H	L	H				L			M					
9	UPS	65				L																
10	Supervisory Comp.	40	M			H																
11	Comm. Auxiliary	30	L			L																
12	Shift Supervisor	20	M				M	M	L	L							M					
13	Ext. Entrance to Bldg																					
14	Kitchen for Ops	35	H																			
15	Library/copier/fax	25	L				M	M	M	M				M								
16	Permit	20																				
17	Smoke Area	~~15~~	L																			
18	Washrooms	55	M																			
19	Lab	25																				
20	Training/Simulator	30	L				M															
21	Showers	10	L																			
22	Maint. Craft Offices**	90						M		M												
23	First Aid	10																				
24	Cloak Room/ERT	50													M / H							
25	Storage for Stationery	5	M																			
26	Meeting Room (2x)	60	M																			
27	Mech/HVAC	300				H																
28	Common Lunchroom	70																		H		
29	Janitor	5																				
30	Vending Machine	5																				
31	Optimization	20	H						H													

* Areas listed above represent an estimate of the space required for each function. These areas were estimated prior to development of layout drawings, and do NOT represent a

** Maintenance Craft Offices: (3x20) + (1x30) = 90

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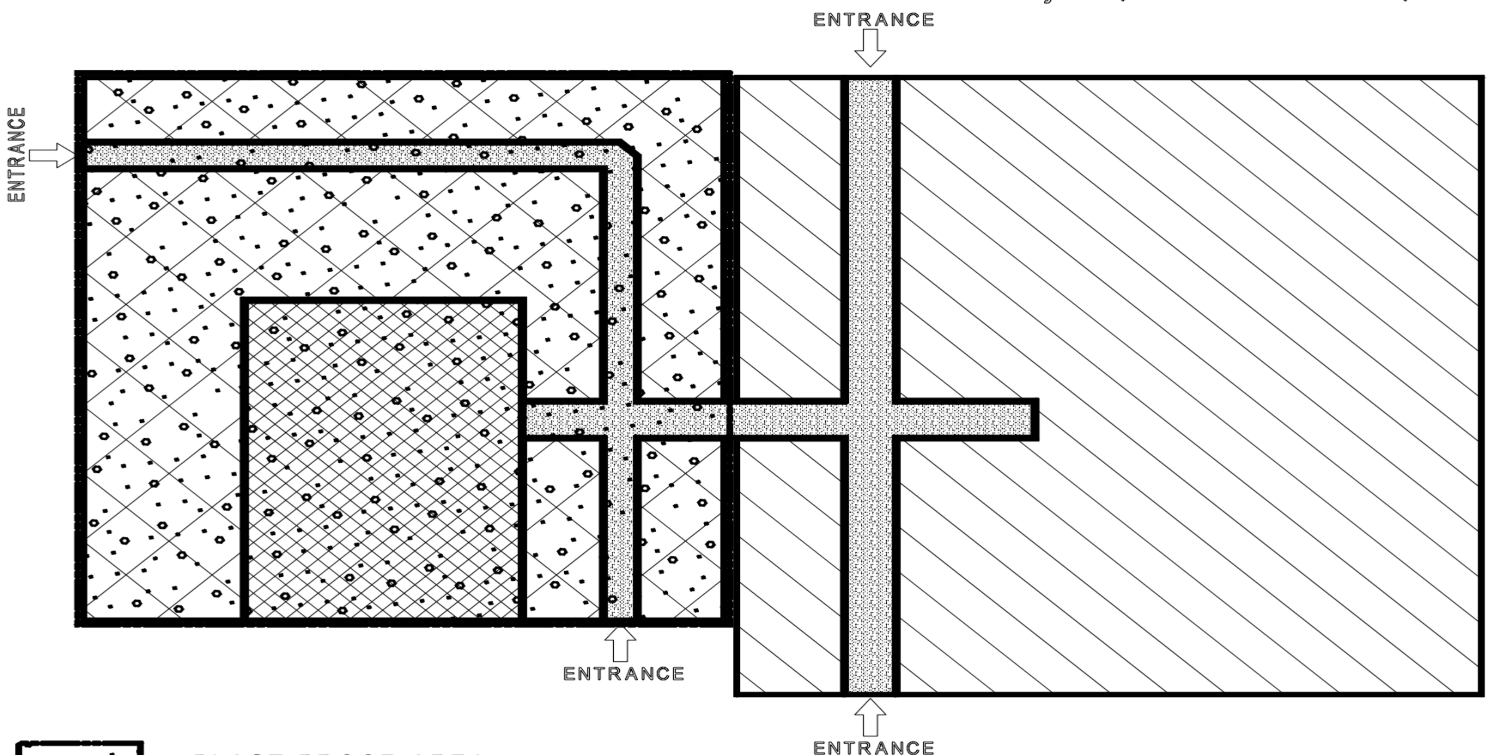
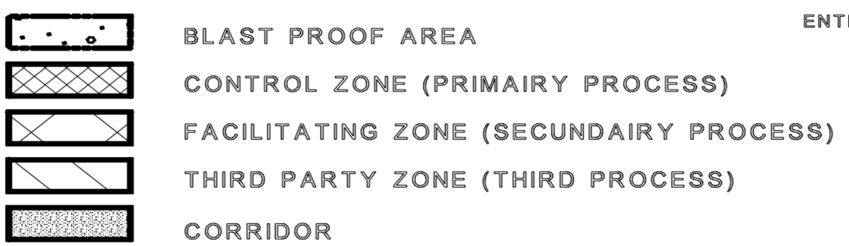
BLOCK MODEL

Upgrader Main Controlroom Centre and Workshop Building
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary



Conceptual Design Guidelines

* Building concept allows for minimum blast proof area.
* To improve communications and optimise logistics, lay out is based on the functional requirements defined by the relation diagram analysis.
* The lay out of the control room building is designed to ensure acces to panel room is restricted to operations team and essential other users only principle is reflected by the one door entree only.
* The lay out of the panel room allows routine verbal communications between the various sections.
* The configuration of the console's allows 2 persons to function effectively during up set or emergency
* The lay out of the cockpit shaped console's allows sufficent space for integrated writing and reading tasks, thereby minimising other VDU workplaces in control room area, enhancing a quiet atmosphere.



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UPGRADER MAIN CONTROLROOM CENTRE AND WORKSHOP BUILDING
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary
BLOCK MODEL

Date 20-04-2000 Revision - Scale -

no 1 of 6

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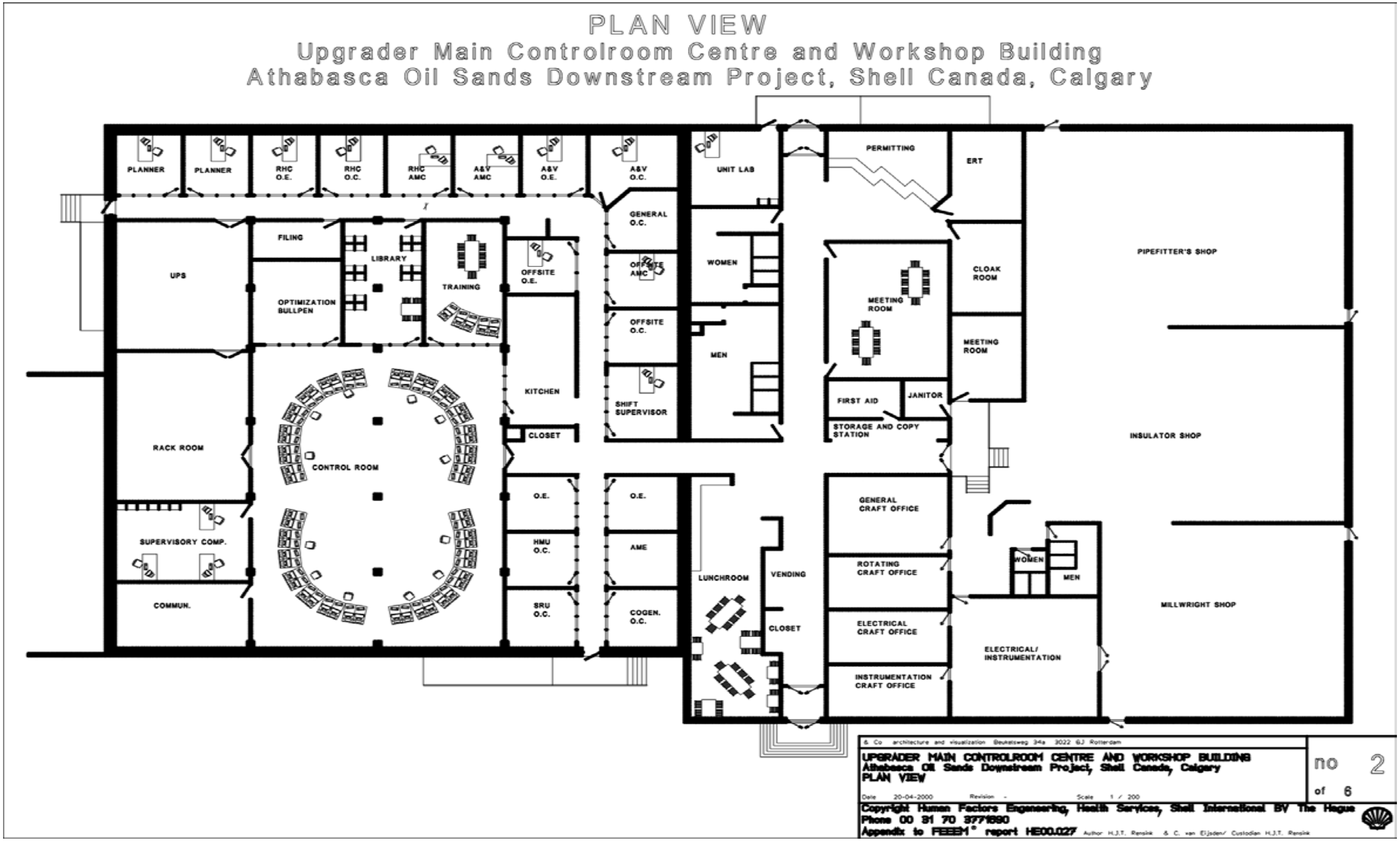

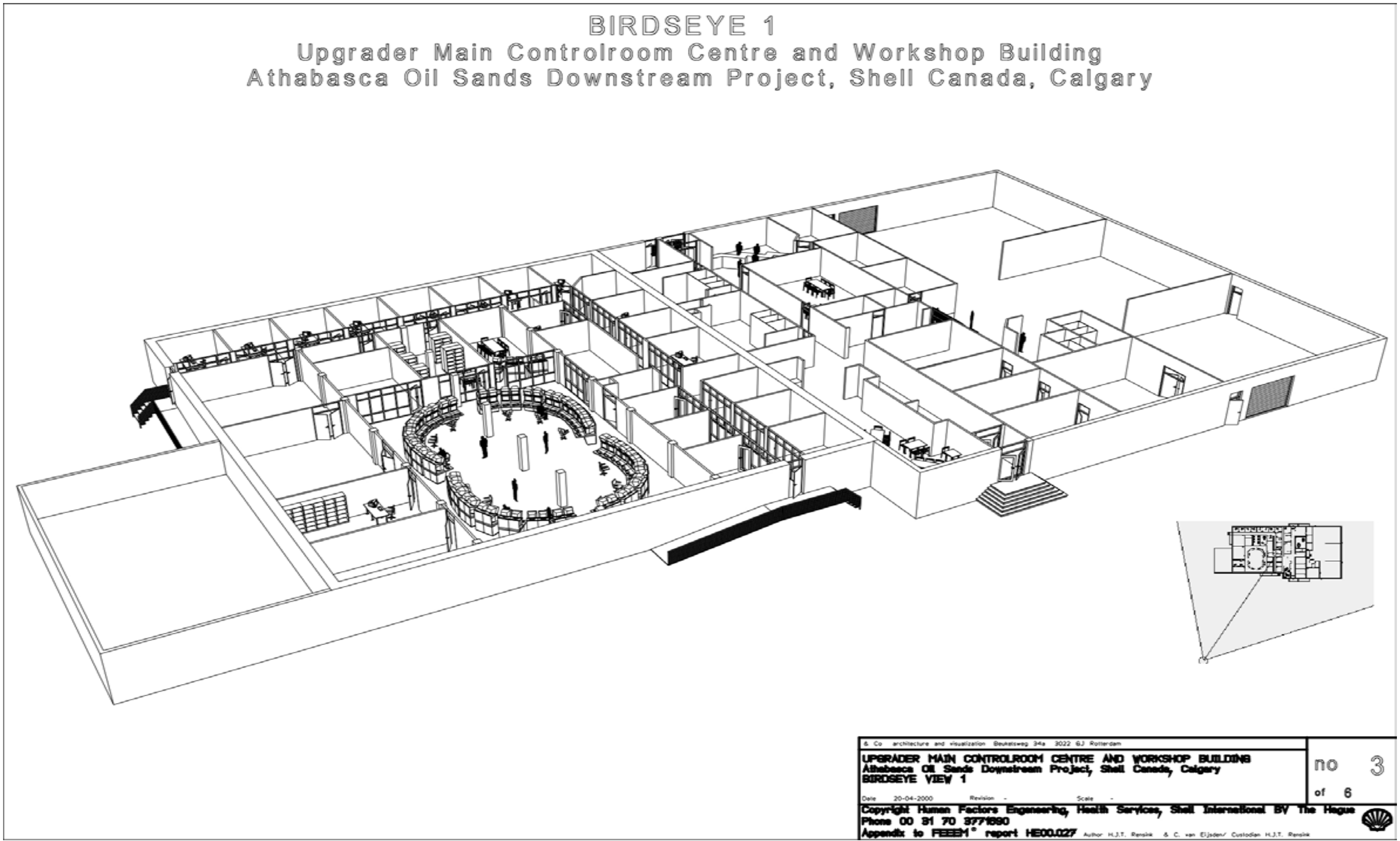

BIRDSEYE 1
Upgrader Main Controlroom Centre and Workshop Building
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary
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UPGRADER MAIN CONTROLROOM CENTRE AND WORKSHOP BUILDING
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary
BIRDSEYE VIEW 1
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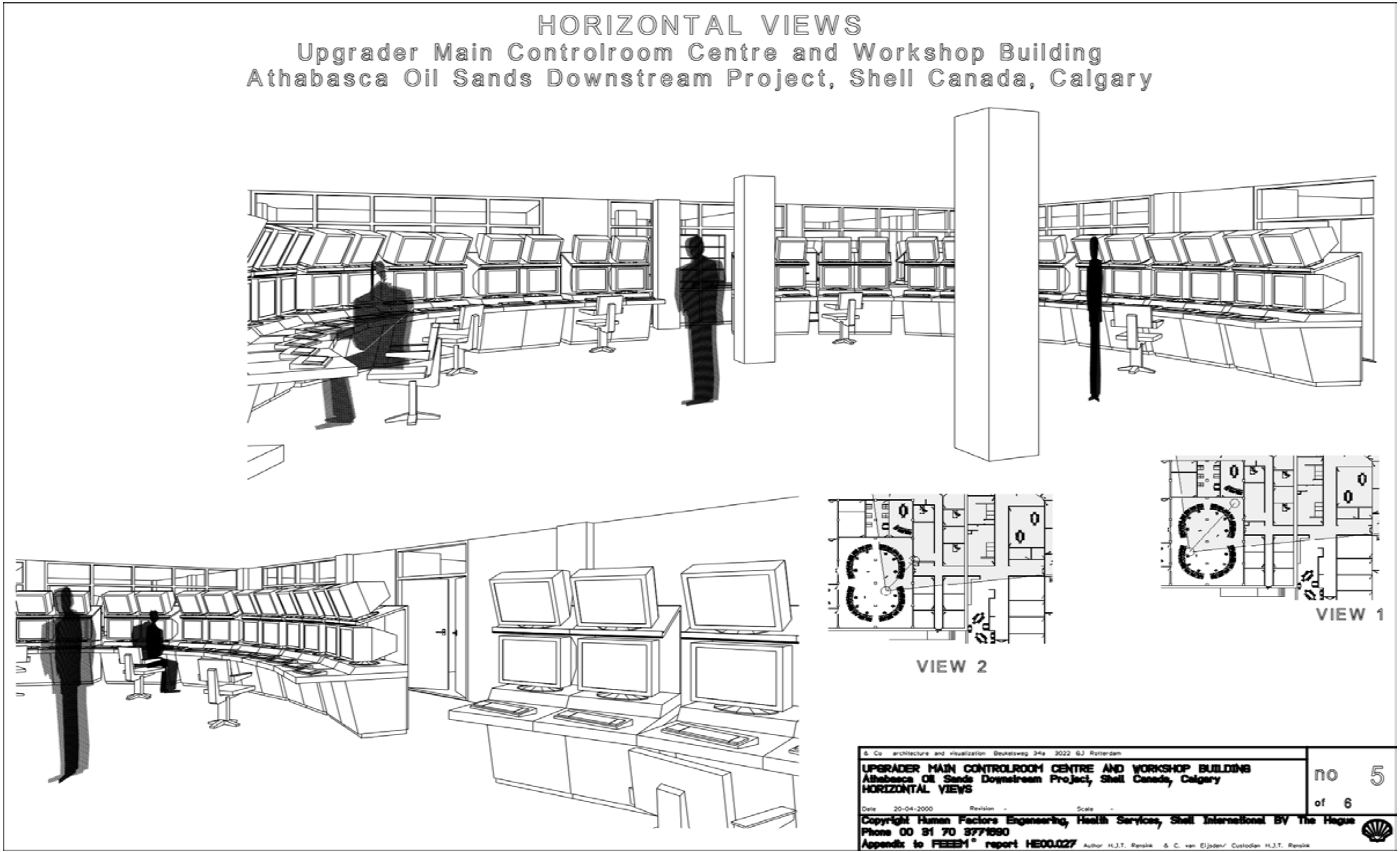
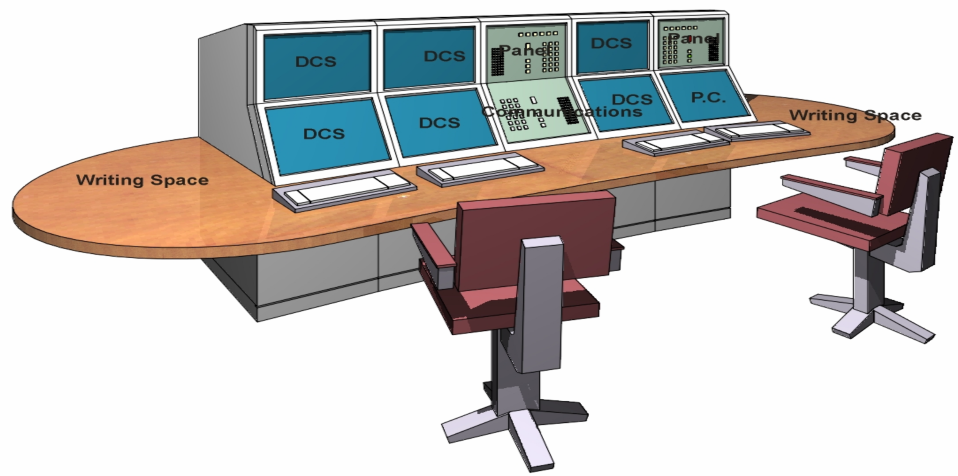


ERGONOMICS

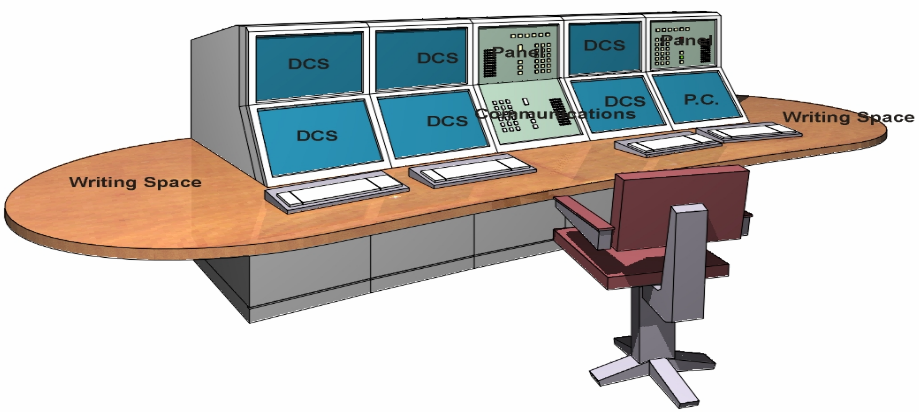
"Cockpit-design" DCS console's principles

Variant 2 : DCS Separated Through Instrument Panel And Communications Panel

Critical operation mode : **2** paneloperators



Normal operation mode : **1** paneloperator



Based on : maximum DCS-screens in critical situations is 6 DCS screen's

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CONTROL ROOM ERGONOMICS
COCKPIT-DESIGN DCS CONSOLE'S PRINCIPLES
Variant 2
Design C. van Eijsden
Date 20-04-2000 Revision 30-05-2000 Scale -

no 2 of 3

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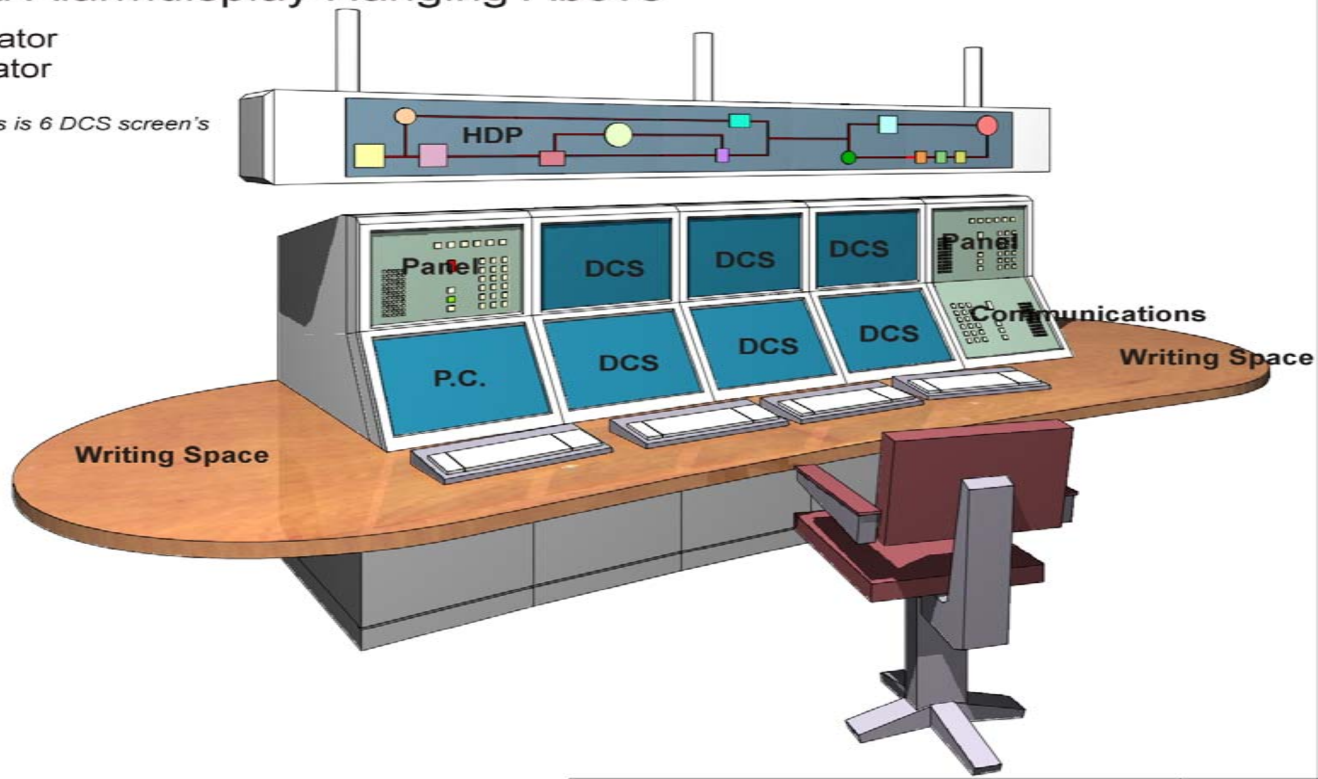
ERGONOMICS

“Cockpit-design” DCS console’s principles
Variant 3 : Using Hardwired Alarmdisplay Hanging Above

Normal operation mode : **1** paneloperator
Critical operation mode : **1** paneloperator

Based on : maximum DCS-screens in critical situations is 6 DCS screen’s



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COCKPIT-DESIGN DCS CONSOLE'S PRINCIPLES
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Smart tool for Improving Plant & Equipment lay out

Identification of Valves analysis (IVA ®)

An *up front* identification and categorization process of Valves according:

- Category 1; Critical valves
- Category 2; Operational valves
- Category 3; Non operational

Aim :

to delete misfits in *Critical* valve operations and to manage 'fit for purpose' design for all valves operations

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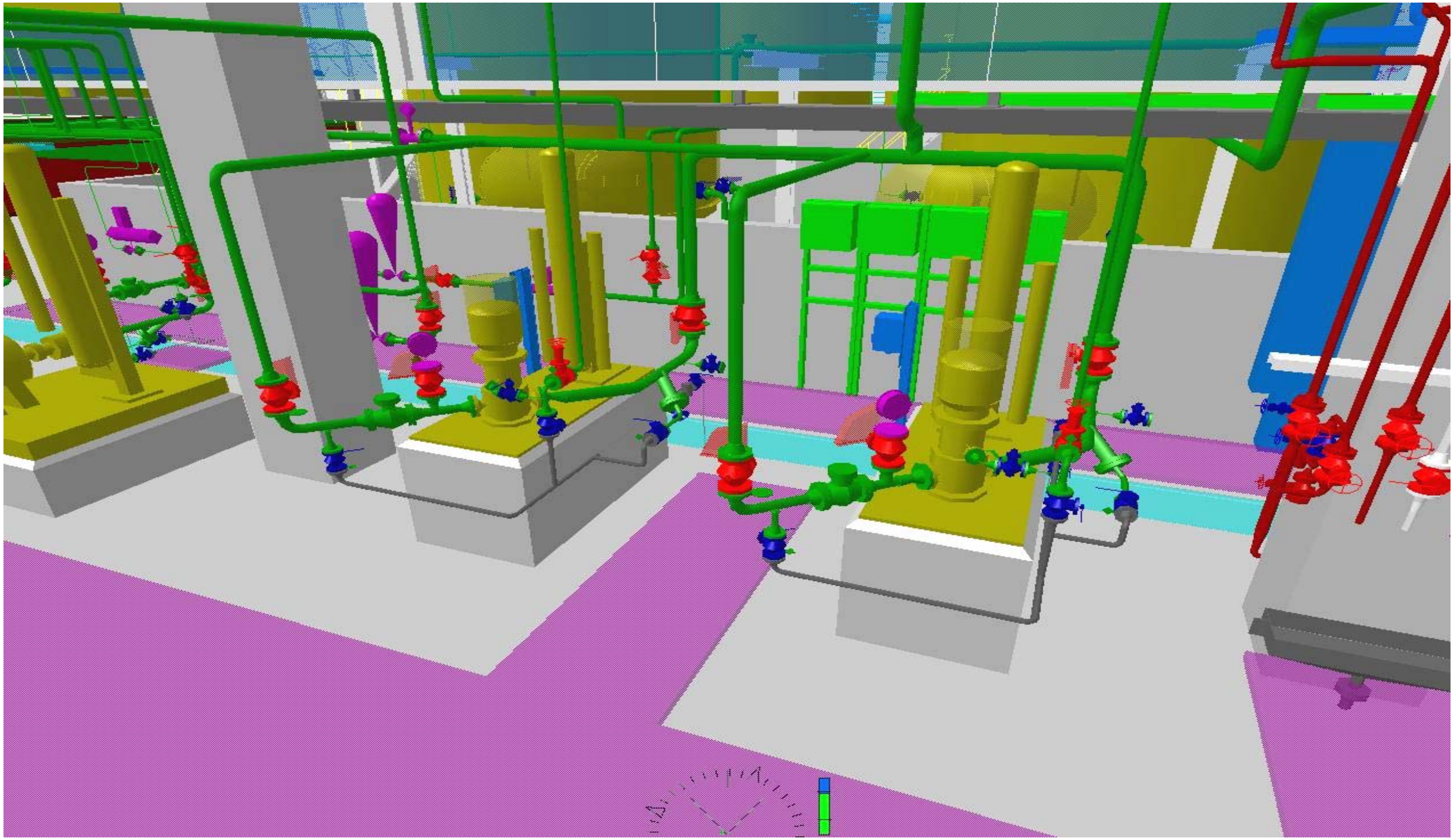
Assurance Category 1 valves via color coding in 3 D CAD



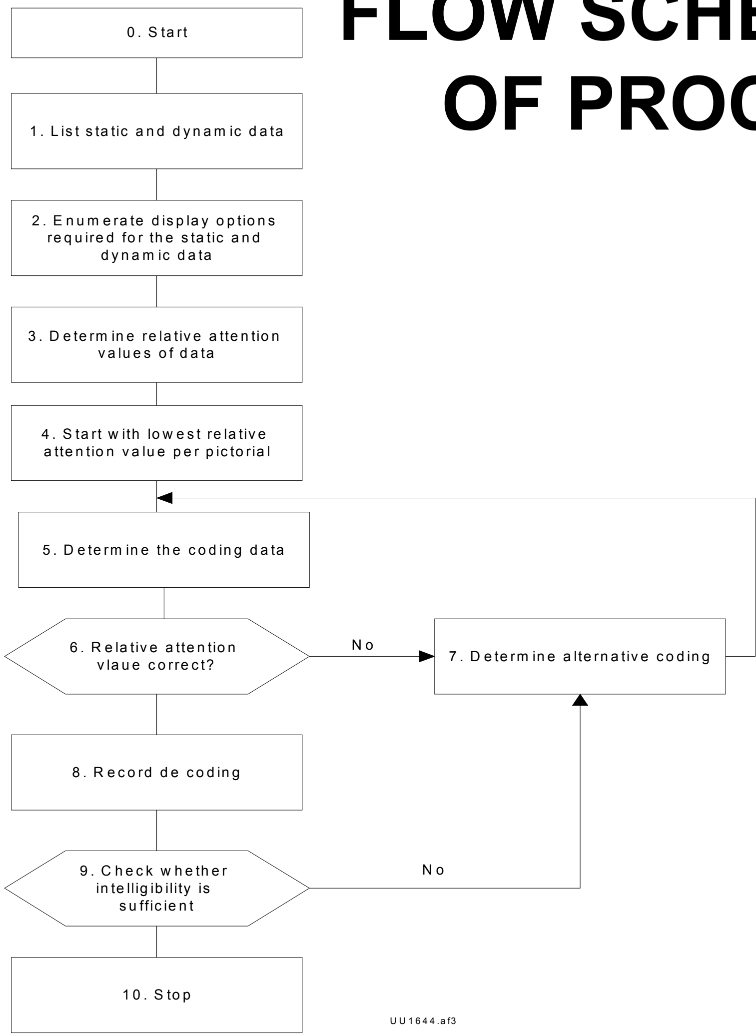
Graphical display audit results (reference project)

- Insufficient discrimination of alpha numeric characters is applied,
- Irrelevant information to the operator is shown,
- Generally accepted norms of application of colours are violated,
- Inconsistencies in static information presentation is present,
- Display design has been made decorative at the expense of their being readable and interpretable.

Conclusions

Graphical Display designs did not improve e.g. retrieval times, mis-readings and intuitive use of controls. The quality of the design of the Graphical Display leads to an unnecessary and unwanted higher risk for miss operations.

FLOW SCHEME FOR ERGONOMICS CODING OF PROCESS DATA FOR PICTORIALS



Benefits

Elimination of re-work.
Reduction of errors in ops.
Improved intelligibility of information
Reduction of search times.
Consistent reproduction of information
Standardization of pictorial layout.
Reduction of mental effort.
Intuitive and reliable operator control.

ATTENTION HIERARCHY (AH ®) CODING
SMART tool
Information presentation

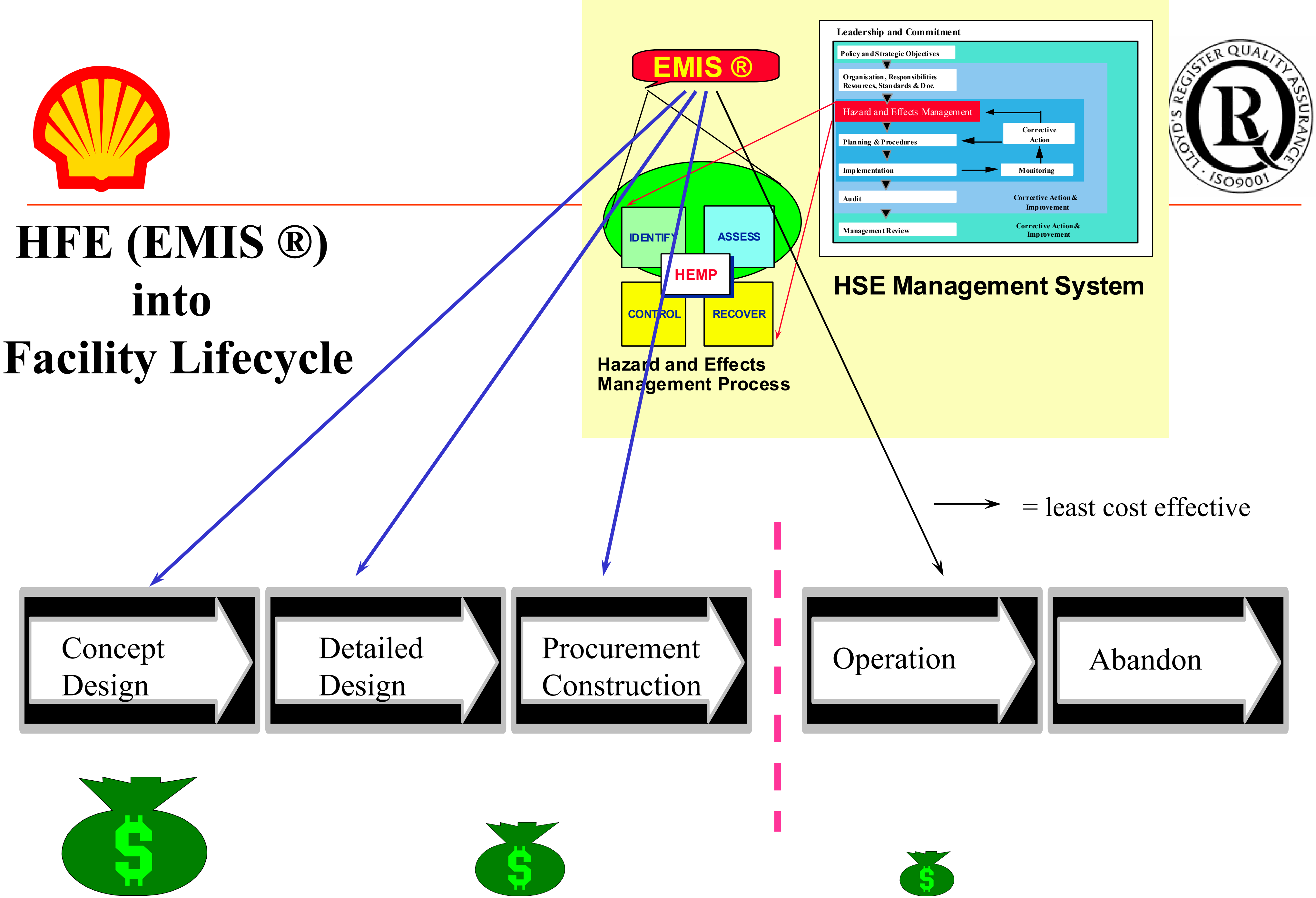
Low attention level → High attention level

CODING POSSIBILITIES

Location	Shape	SIZE	Background	Color
Decentral	Thin line	Small	Non	Grey
Domination increase	*Contrast increase*	*Domination increase*	*Contrast increase*	*Contrast increase*
Central	**Thick line**	SIZE	**Blinking**	**Red blinking**

Combination of location, shape, size, background and color

High attention level


HFE (EMIS ®)
into
Facility Lifecycle
EMIS ®
Leadership and Commitment
Policy and Strategic Objectives
Organisation, Responsibilities
Resources, Standards & Doc.
Hazard and Effects Management
Corrective
Action
Planning & Procedures
Implementation
Monitoring
Audit
Corrective Action &
Improvement
Management Review
Corrective Action &
Improvement
HSE Management System
IDENTIFY
ASSESS
HEMP
CONTROL
RECOVER
Hazard and Effects
Management Process
LLOYD'S REGISTER QUALITY ASSURANCE
ISO9001
= least cost effective
Concept
Design
Detailed
Design
Procurement
Construction
Operation
Abandon

Benefit areas Usability & HF Engineering

(reference EMIS.PMQ.07)

Relation to stakeholders

share holders & clients	Operability	Safety	personnel
		Health	
	Maintenance	Environment	society
	Reliability	Legislation	government
		Labour turnover	

Quantify and/or rank

Economical benefits User Centered Design

Based on historical data so far

• Reduction CAPEX	0.25% - 5%
• Reduction engineering hrs.	1% - 10 %
• Reduction re work: less rework, less late changes	1 % - 5%
• Reduction project duration time •reduced approval cycles	up to 40 %
• Reduction Ops./Maintenance TCoO	3 - 6 % per year

Non-economical benefits

Based on historical data so far

Improvement HSE/working conditions	H*
Improvement commitment end users	H
Improvement of client “buy in”	H
Improvement functional design; • versus gold plated design	H
Improvement competence of project team	VH
Competence improvement project team re. Ops./maintenance requirements	VH
Improvement communication Owner / Project team & EPC contractor	H

* impact ranking on issue: Low, Medium, High, Very High as per client feedback

Typical costs
Usability and HF Engineering
Based on historical data so far

Depending on complexity of project scope
0.004 - 0.9 % of Engineering costs (= 15 % CAPEX)

Critical Success Factors

- Awareness of cost/benefits
    - CAPEX reduction potential & TCoO commitment
- Management commitment *front end loading*
    - early availability of operational philosophy, staff
- Competence project participants
- Integration in Project QA system (Owner & EC!)
- Front end user participation
    - capture ‘work floor’ knowledge via FEEEM ® analysis process
- Multi-disciplinary dilemma handling
- Fit for purpose tools and procedures

When astronaut John Glen was asked what he was thinking about just before lift off from Cape Canaveral, he replied:

"Here I' am sitting on top of thousands of critical components and all of them made by the lowest bidder !"