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Return on investment in use of human factors in offshore systems: “Closing the gap between conceptual design and engineering, field construction activities and operations”

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Return on investment in use of human factors in offshore systems

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


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Shell International Health Services
Usability & Human Factors Engineering

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
Shell International Health Services
Usability & Human Factors Engineering

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 design
Green-/ brown field Projects

Operational excellence

New Systems Technology
IT usability engineering

Human Performance Improvement
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 environment (lighting, noise, climate)
- Organisational structure (job design, communication, task)
- Individual constraints (age, size, training, skills, intelligence)

Sensory Information

Human

Task Interface

Displays

Output

Machine

Controls

Input

Action

Output
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

Performance

World Class
1 People/Org
2 Information
3 Software
4 Hardware

Typical
1 Hardware
2 Software
3 Information
4 People/Org

CSU - first year(s) of operation
Literature “Development HSE improvements in hardware design”

- Technical measures were dominant in the Past.
- Process safety measures were dominant in the Present.
- Human factors interface measures will become dominant in the Future.
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®)

Policy & Organisation documents

- Training
  - Video/CD
  - ROM
  - Engineering workshops etc.

- Project Management & QA
  - Cost/benefit model
  - Procedures Auditing etc.

- Engineering tools
  - FEEEM®
  - IVA®
  - Best practices Checklists etc.

- Procurement
  - Plant equipment, Skid Units Tools, etc.

- Construction
  - “Field run” equipment Contractor workshops

International Standards
The Design Process

Scouting phase

- FEEEM input for 3D development

Feasibility phase
- Conceptual design

Definition phase
- Basic engineering

Implementation phase
- DE, procurement, construction

HFE Input analysis
- FEEEM ® design analysis; end-user driven specifications

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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& Co. architectuur en visualisatieBeukelsweg 34a 3022 GJ Rotterdam
Link-analyses CCR / Engineering Functions
frequency daily communication
### INTERFACE RELATIONSHIP MATRIX FOR CENTRAL CONTR

| Function                          | Area (sq.m.) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|-----------------------------------|--------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Storage (Bottles)                 | 3            | H |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Exercise Space                    | 8            | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Rackroom                          | 75           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| OC (7x)                           | 105          | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| AMC (4x)                          | 60           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| OE (5x)                           | 75           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Planning (2x)                     | 30           | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| UPS                               | 65           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Supervisory Comp.                 | 40           | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Comm. Auxiliary                   | 30           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Shift Supervisor                  | 20           | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Ext. Entrance to Bldg             | 15           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Kitchen for Ops                   | 35           | H |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Permit                            | 20           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Smoke Area                        | 15           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Washrooms                         | 55           | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Lab                               | 25           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Training/Simulator                | 30           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Showers                           | 10           | L |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Maint. Craft Offices**            | 90           | M |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| First Aid                         | 10           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Cloak Room/ERT                    | 50           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Storage for Stationery           | 5            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Meeting Room (2x)                 | 60           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Mech/HVAC                         | 300          | H |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Common Lunchroom                  | 70           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Janitor                           | 5            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Vending Machine                   | 5            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Optimization                      | 20           | 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 t
** Maintenance Craft Offices: (3x20) + (1x30) = 90
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 access to panel room is restricted to operations team and essential other users only principle is reflected by the one door entry 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 upset or emergency.
- The lay out of the cockpit shaped console's allows sufficient space for integrated writing and reading tasks, thereby minimising other VDU workplaces in control room area, enhancing a quiet atmosphere.

BLAST PROOF AREA
CONTROL ZONE (PRIMARY PROCESS)
FACILITATING ZONE (SECONDARY PROCESS)
THIRD PARTY ZONE (THIRD PROCESS)
CORRIDOR
BIRDSEYE 1
Upgrader Main Controlroom Centre and Workshop Building
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary
HORIZONTAL VIEWS
Upgrader Main Controlroom Centre and Workshop Building
Athabasca Oil Sands Downstream Project, Shell Canada, Calgary
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
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
Smart tool for Improving Plant & Equipment layout

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
Assurance Category 1 valves via color coding in 3D 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

CODING POSSIBILITIES

Location
- Decentral
- Central

Shape
- Thin line
- Thick line

SIZE
- Small
- Dominated

Background
- Non
- Blanking

Color
- Grey
- Red blinking

Combination of location, shape, size, background and color

Low attention level
High attention level
HFE (EMIS ®) into Facility Lifecycle

Leadership and Commitment
- Policy and Strategic Objectives
- Management Review
- Corrective Action & Improvement
- Audit
- Organisation, Responsibilities, Resources, Standards & Risk

Hazard and Effects Management Process
- Hazard and Effects Management
- Planning & Procedures
- Implementation
- Monitoring
- Corrective Action & Improvement
- Management Review

EMIS ®
- IDENTIFY
- ASSESS
- CONTROL
- RECOVER

HSE Management System

Concept Design → Detailed Design → Procurement Construction → Operation → Abandon

= least cost effective

Cost Bags
- Concept Design
- Detailed Design
- Procurement Construction
- Operation
- Abandon
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Usability & Human Factors Engineering

Benefit areas Usability & HF Engineering
(reference EMIS.PMQ.07)

<table>
<thead>
<tr>
<th>Relation to stakeholders</th>
<th>Operability</th>
<th>Safety</th>
<th>Health</th>
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<td>Maintenance</td>
<td></td>
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<tr>
<td>Reliability</td>
<td></td>
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Quantify and/or rank

share holders & clients

personnel
society
government

Legislation
Labour turnover
Economical benefits User Centered Design
Based on historical data so far

- Reduction CAPEX: 0.25% - 5%
- Reduction engineering hrs.: 1% - 10%
- Reduction rework: 1% - 5%
  - less rework, less late changes
- Reduction project duration time: up to 40%
- Reduced approval cycles
- 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!”