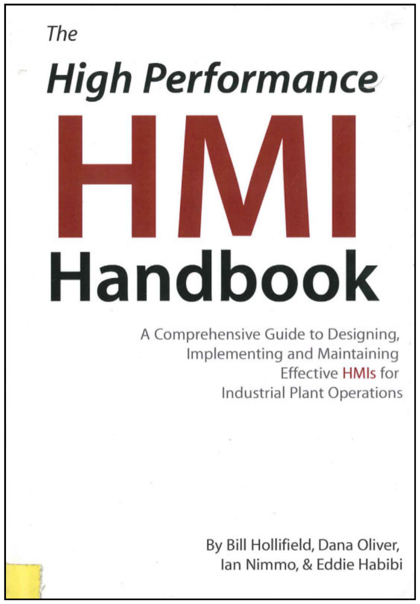
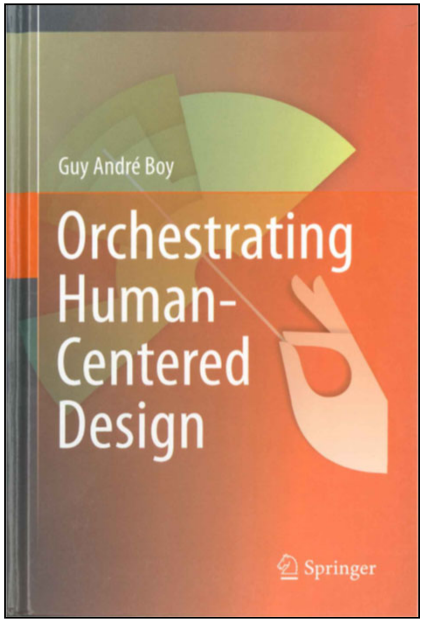
HMI

Human Machine Interaction

Litterature





(Also excerpt from Olsson, Piani book on homepage)

Overview

- HMI objectives and background
- Good HMI practice
- Alarms
- HMI tools (demo/discussion)
- Data connection (DDE, COM, OLE, OPC)

Goal

After this lecture you should:

- Understand the HMI scenario
- Know some rules of thumb for HMI design.
- Know the main features of data flow in common HMI systems

Humans and machines compensate for each other

- Power
- Speed
- Attention - alarms
- Memory
- “Intelligence”
- Rule based thinking
- Symbolic information

Humans and machines have to adjust to each other

- We can not have systems that humans can not handle
- High education and training more and more required

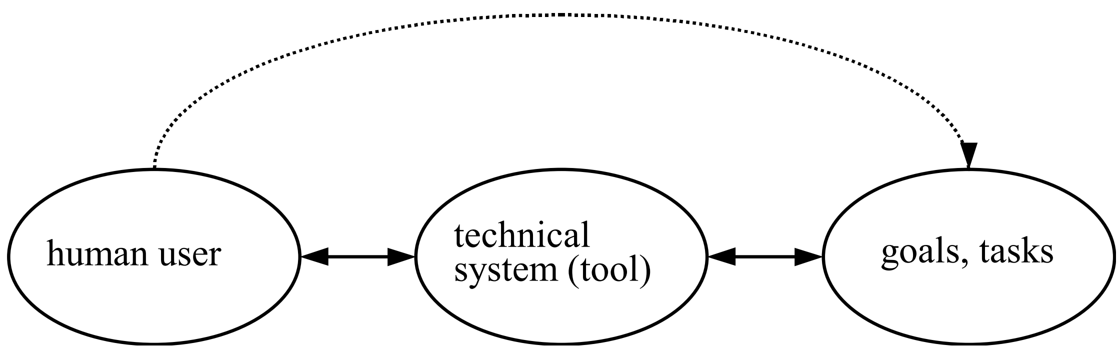
This is where it started…

(From Hollifield et al)

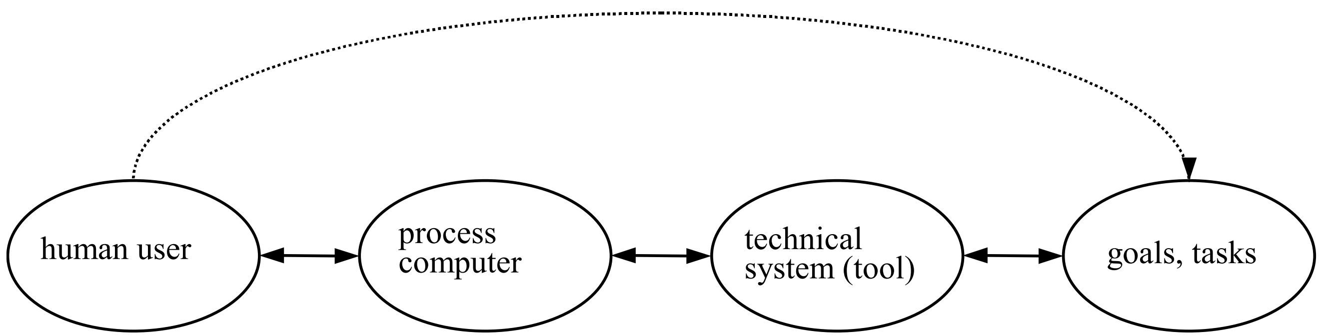
Different HMI views @ IEA

- Situation awareness
  - Dr. Lawrence Jones; Power applications
- Usability
  - Master thesis; Anders Lyddby
- Complexity reduction
  - Tech Lic; Gianguido Piani

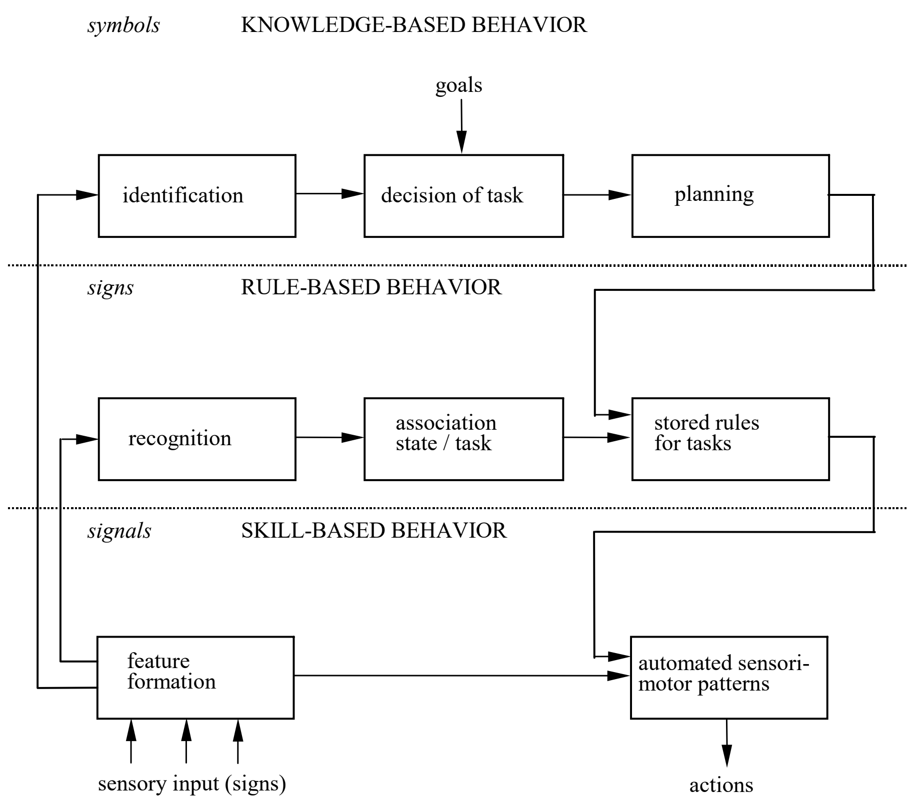
Interactions



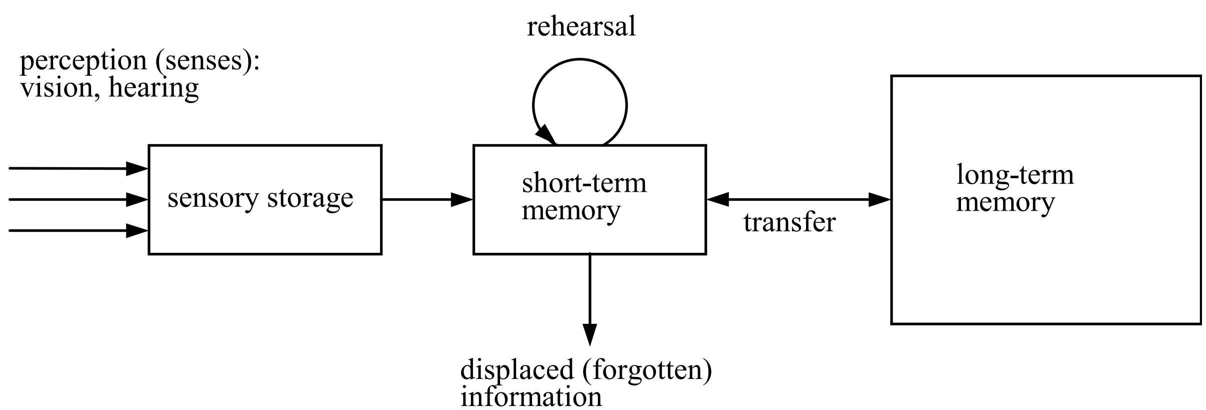
The Process Computer as a View into the Process



Levels of Human Performance



Dual Memory Model



Remember…

- Previous experience is powerful
- Social and cultural background [1]
- Educational level
- Objectives and motivation

1) Interesting reading: https://www.huffpost.com/entry/cross-cultural-gestures_b_3437653 (2022-05-05)

Some Experiences of the Operator Role (1)

- The user HAS to be part of the design
- The system has to be able to grow according to the demands
- Easy interpretation of the man-machine interface
- Don't forget control room environment

Some Experiences of the Operator Role (2)

- Mental models have to be pictured
- TIME is a difficult variable to show!
- The system has to **help** the operator, not to be another burden!
- Competence development!
- Different users need different presentations

Seven Steps to High Performace HMI

(From Hollifield et al)

1. Adopt a High Performance HMI Philosophy and Style Guide

2. Assess and benchmark existing graphics against the HMI Philosophy

3. Determine specific performance and goal objectives for the control of the process, for all modes of operation

Seven Steps to High Performace HMI

(From Hollifield et al)

4. Perform task analysis to determine the control manipulations needed to achieve the performance and goal objectives

5. Design and build high performance graphics, using the design principles in the HMI Philosophy and elements from the style guide

Seven Steps to High Performace HMI

(From Hollifield et al)

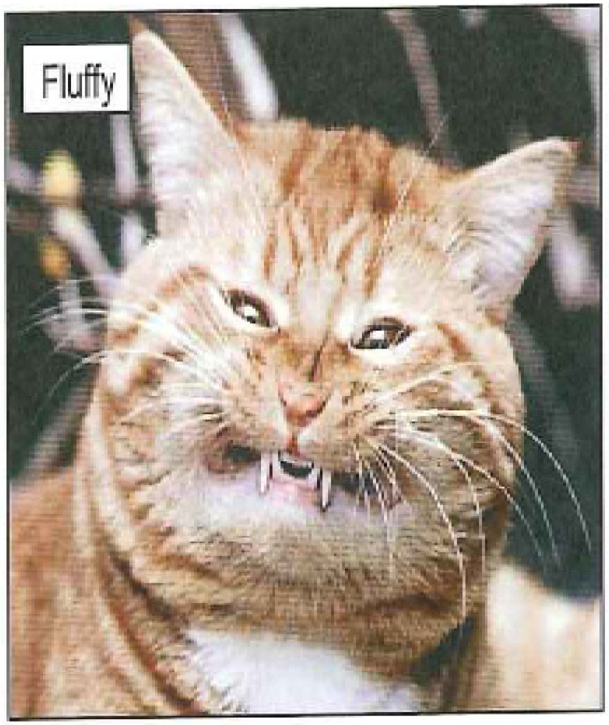
6. Install, comission, and provide training on the new HMI

7. Control, maintain, and periodically reassess the HMI

”It is impossible to design a system so perfect that no one needs to be good”

(T.S. Eliot)

Fluffy's Blood Test



Blood Tests for Fluffy -1	
Test	Results
HCT	31.7%
HGB	10.2 g/dl
MCHC	32.2 6/dl
WBC	9.2 x10^9 /L
GRANS	6.5 x10^9 /L
L/M	2.7 x10^9 /L
PLT	310 x10^9 /L

(From Hollifield et al)

Fluffy continued…

Blood Tests for Fluffy - 2		
Test	Results	Range
HCT	31.7%	24.0 – 45.0
HGB	10.2 g/dl	8.0 – 15.0
MCHC	32.2 6/dl	30.0 - 36.9
WBC	9.2 x10^9 /L	5.0 - 18.9
GRANS	6.5 x10^9 /L	2.5 - 12.5
L/M	2.7 x10^9 /L	1.5 - 7.8
PLT	310 x10^9 /L	175 - 500

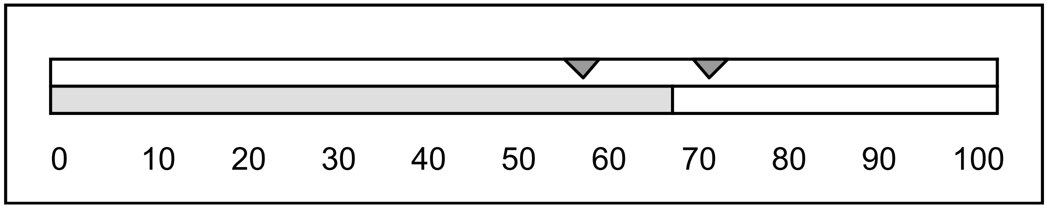
(From Hollifield et al)

Fluffy continued…

Blood Tests for Fluffy - 3			
Test	Results	Range	Indicator Low – Normal – High
HCT	31.7%	24.0 – 45.0	
HGB	10.2 g/dl	8.0 – 15.0	
MCHC	32.2 6/dl	30.0 – 36.9	
WBC	9.2 x10^9 /L	5.0 – 18.9	
GRANS	6.5 x10^9 /L	2.5 – 12.5	
L/M	2.7 x10^9 /L	1.5 – 7.8	
PLT	310 x10^9 /L	175 – 500	

(From Hollifield et al)

Intuitive Presentation

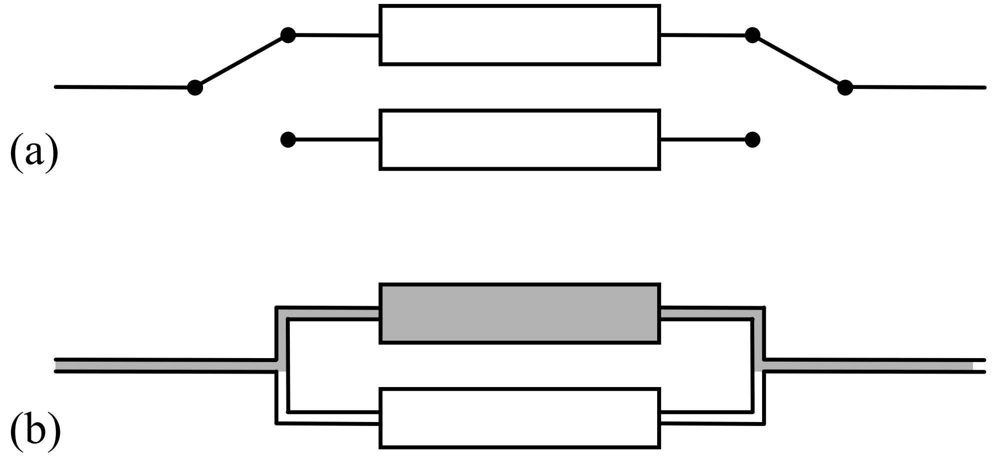


Message (1)

A502 POWERED: YES/NO

A502 POWER: ON/OFF

Graphical Representation



How to Remember?

4687834000

or

46 - 8 - 783 4000

- Remember the 7 +/- 2 rule!

About Color

- Powerful but dangerous
- 4-5 possible to understand. (Abs max: 7)
- Consistent use
- Redundancy needed (color blindness)
- Blink attribute on symbols - **not on text**

Poor Structuring

Water Treatment Plant **[24] Chemical Precipitation Section** 14:18:04

PUMP 105 PROCESS WATER STATE=ON ALARM=NO OVERHEAT=NO
PUMP 118 WASHWATER STATE=ON ALARM=NO OVERHEAT=NO
PUMP 127 REACTION VESSEL OUTPUT STATE=ON ALARM=YES OVERHEAT=NO
PUMP 132 SLUDGE SILO FEED STATE=ON ALARM=NO OVERHEAT=NO
PUMP 138 SLUDGE SILO OUTPUT STATE=ON ALARM=NO OVERHEAT=YES
PUMP 139 SLUDGE FINAL OUTPUT STATE=OFF ALARM=NO OVERHEAT=NO
PUMP 143 VACUUM FILTERING STATE=ON ALARM=NO OVERHEAT=NO
PUMP 154 LIQUID WASTE STATE=ON ALARM=NO OVERHEAT=NO
PUMP 166 LIQUID FILTRATION STATE=ON ALARM=NO OVERHEAT=NO
PUMP 221 ALKALI INLET STATE=ON ALARM=NO OVERHEAT=NO
PUMP 226 NA-SULPHIDE INLET STATE=ON ALARM=NO OVERHEAT=NO
PUMP 232 POLYMER PROC.A INLET STATE=ON ALARM=NO OVERHEAT=NO
PUMP 237 POLYMER PROC.B INLET STATE=OFF ALARM=NO OVERHEAT=NO
PUMP 242 POLYMER PROC.C INLET STATE=ON ALARM=NO OVERHEAT=NO

REACTION VESSEL OUTPUT /127/ (m3/h) = 53
SLUDGE SILO FEED /132/ (m3/h) = 92
SLUDGE SILO OUTPUT /138/ (m3/h) = 74
NA-SULPHIDE INLET FLOW /226/ (m3/h) = 68

Input Command >>

Better Structuring

Water Treatment Plant **[24] Chemical Precipitation Section** 14:18:04

Main reaction	Operation	Function	Overheat	Flow Rate
PUMP 105 PROCESS WATER	ON	OK	OK	
PUMP 118 WASHWATER	ON	OK	OK	
PUMP 127 REACTION VESSEL OUTPUT	ON	**ALARM**	OK	53 m3/h
PUMP 132 SLUDGE SILO FEED	ON	OK	OK	92 m3/h
Main reaction	**Operation**	**Function**	**Overheat**	**Flow Rate**
PUMP 138 SLUDGE SILO OUTPUT	ON	OK	**ALARM**	74 m3/h
PUMP 139 SLUDGE FINAL OUTPUT	OFF	OK	OK	
PUMP 143 VACUUM FILTERING	ON	OK	OK	
PUMP 154 LIQUID WASTE	ON	OK	OK	
PUMP 166 LIQUID FILTRATION	ON	OK	OK	
Main reaction	**Operation**	**Function**	**Overheat**	**Flow Rate**
PUMP 221 ALKALI INLET	ON	OK	OK	
PUMP 226 NA-SULPHIDE INLET	ON	OK	OK	68 m3/h
PUMP 232 POLYMER PROC. A INLET	ON	OK	OK	
PUMP 237 POLYMER PROC. B INLET	OFF	OK	OK	
PUMP 242 POLYMER PROC. C INLET	ON	OK	OK	

Input Command >>

Alarms (1)

(The Gottröra crash Dec 27 1991)

Q.

"*Stefan, this crash was not your first emergency. As you told me before, you have been confronted with engine failure in a DC3 during an Atlantic flight, with 'contaminated oxygen' on a T38 and again with engine failure on a F27. What was the most stressful situation in all these emergencies, including the Arlanda crash?*"

A. "*The uncertainty! The confusion and the loss of faith that were caused because of the nature of the electronic instruments that in this situation could not provide any relevant information. The system panel turned into crazy, senseless colour play*."

Alarms (2)

- Alarm limits are crucial
- Alarm groups
- Priority
- Summary/History
- Alarm sequences – one cause many alarms – find the root (Ex: https://www.goalart.com)
- Included in the datastructure

DDE –Dynamic Data Exchange

- Available in Windows for a long time
- Net DDE also early (Win 3.11)
- Simple addressing:
  - Application
  - Topic
  - Item
- Single access or subscription

DDE drawbacks

- Slow when the number of connections increase – becomes a bottleneck
- Difficult with timing control
- Limited number of message formats

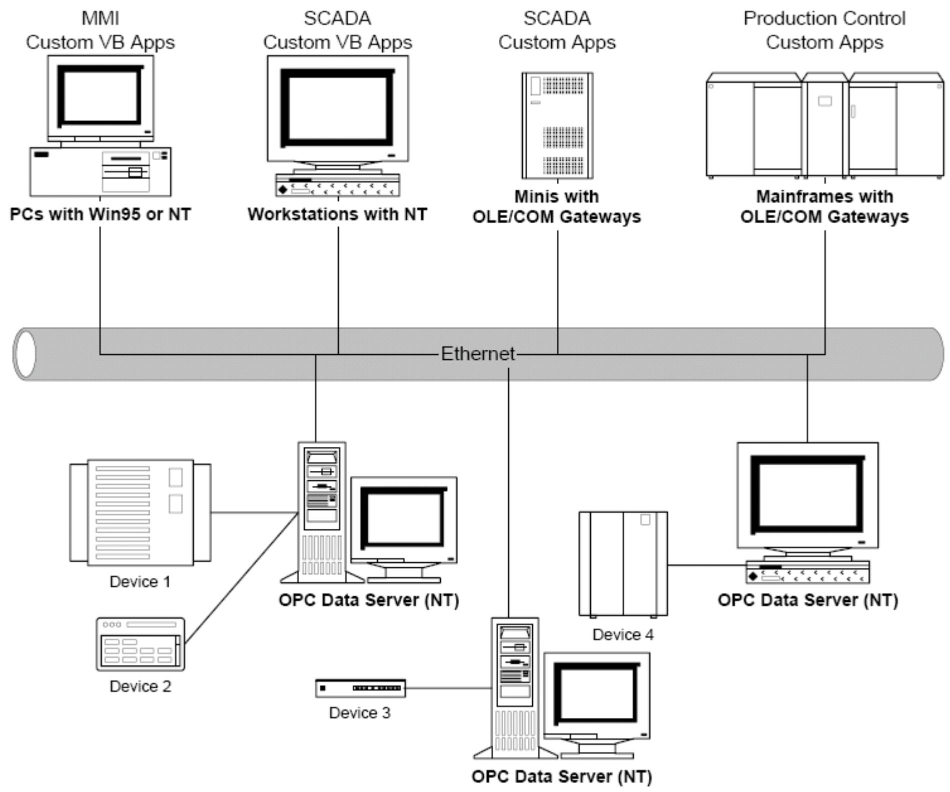
Microsoft Component Object Model (COM)

- Distributed COM – DCOM
- No language definition, no implementation details, a platform independent standard for COM objects to interact.
- The foundation technology for OLE and ActiveX

OPC

- OLE for Process Control (Old def.)
- OLE Object Linking and Embedding (based on DCOM)
- Event and Alarmhandling included
- http://www.opcfoundation.org/

OPC implementation structure



.NET (2002)

- An even more improved framework
- Replaces COM and DCOM
- From Windows Vista (2006)
  COM is not included!

One of the reasons why Win XP (2001) reached EOL 2014

OPC today…

- Problems for the automation business when COM/DCOM was removed
- OPC UA : *Unified Architecture* is preferred today.
- Based on SOA: *Service Oriented Architecture* rather than OS functions.
- ***OPC=Open Platform Communication***

OPC today

- Data Access (DA)
- Alarm and Event (AE)
- Historical Data Access (HDA)
- XML Data Access (XML DA)
- Data Exchange (DX)