

User Interface Design for Dependable Systems in Industrial Automation

46th IFIP WG 10.4 Meeting

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IFIP

INTERNATIONAL FEDERATION FOR INFORMATION PROCESSING

dependability.org

Content

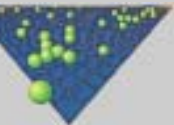
- **SIEMENS Corporate Technology – User Interface Design**
- **Introduction & History of UI in Industrial Automation**
- **The Human Operator**
 - Human Information Processing, Mental Models, etc.
- **Usability & User-centered Design**
 - From use context to evaluated systems
- **User Interface Examples**
 - Engineering portal
 - Supervisory Control
 - Mobile Devices for Service and Maintenance

SIEMENS

Corporate Technology

User Interface Design

CORPORATE TECHNOLOGY





For the user,
the user interface
is the product !



**Users „experience“ a product above all through its user interface.
Optimized user interaction plays an important role in the competitive markets**

CT IC 7 – User Interface Design Process

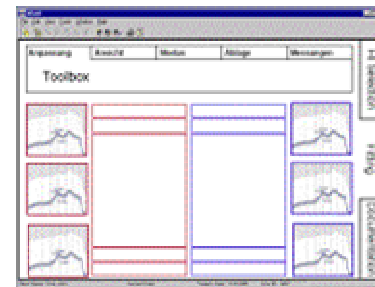
Requirements Analysis

User Profiles & Needs
 Workflows & Use Context
 UI-Trends in the Market
 Ideas for UI Solutions

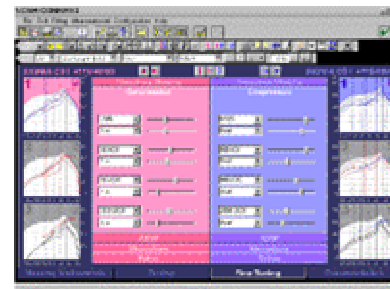


Design & Specification

Information & Functional Architectures
 UI Concepts and Solution Interaction & Visual Design
 Specifications & Styleguides



Usability & Acceptance Tests with Users
 Inspections based on Standards and Heuristics
 Data Mining of Usage Behavior and Analysis



Demos & Prototypes
 Technology Integration
 Product Solutions
 Technical Consulting

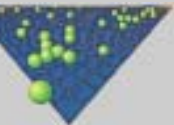
Usability Evaluation

Prototypes & Implementation

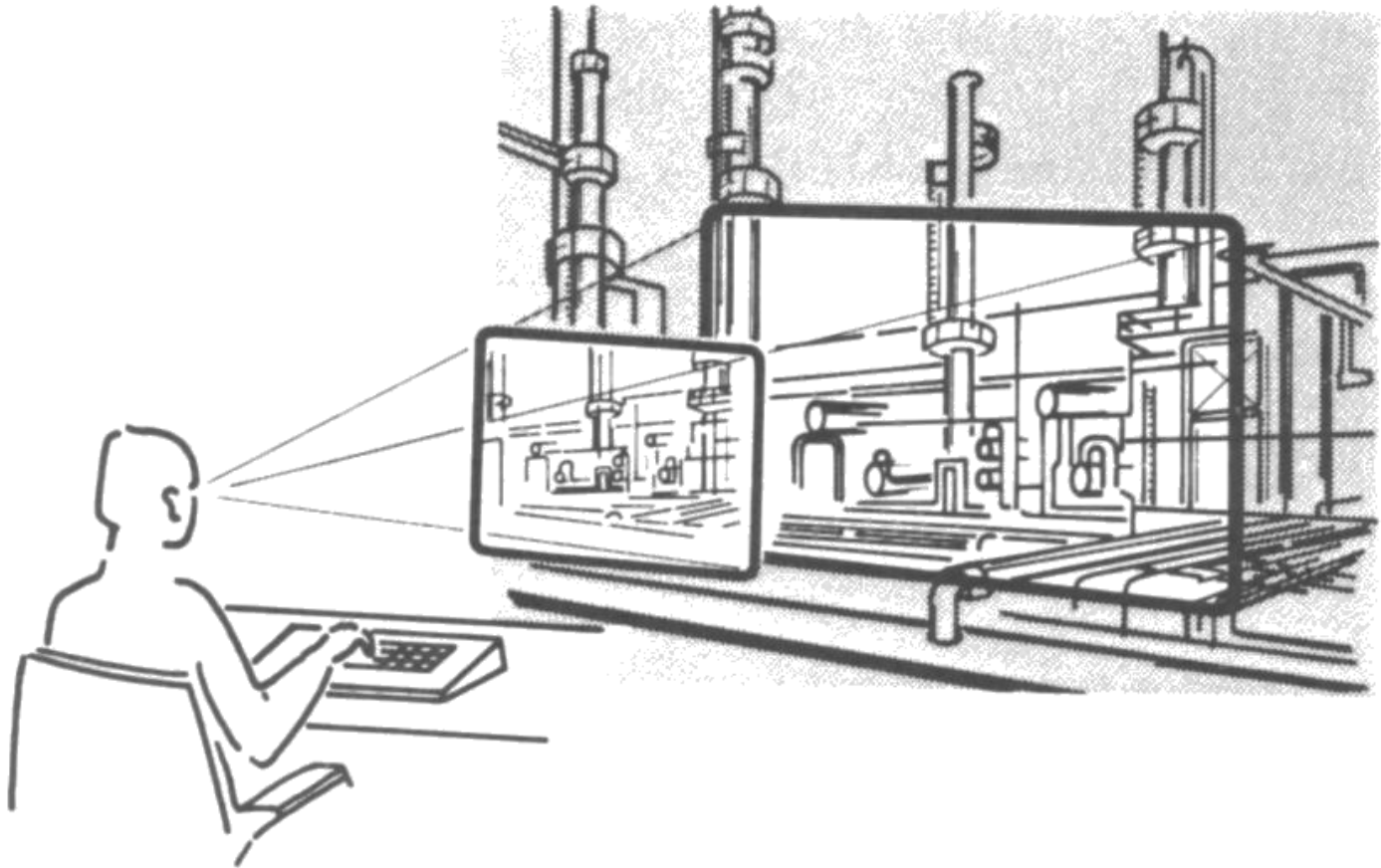
User-centered and iterative approach integrated into marketing & development

Introduction and History

From electromechanical instruments
to mobile Computer Devices



INTRODUCTION



The Window to the Process

(Charwat, 1998)

Once upon a time ...



... nowadays ...



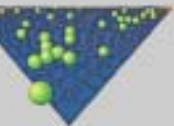
© SIEMENS AG

... and tomorrow



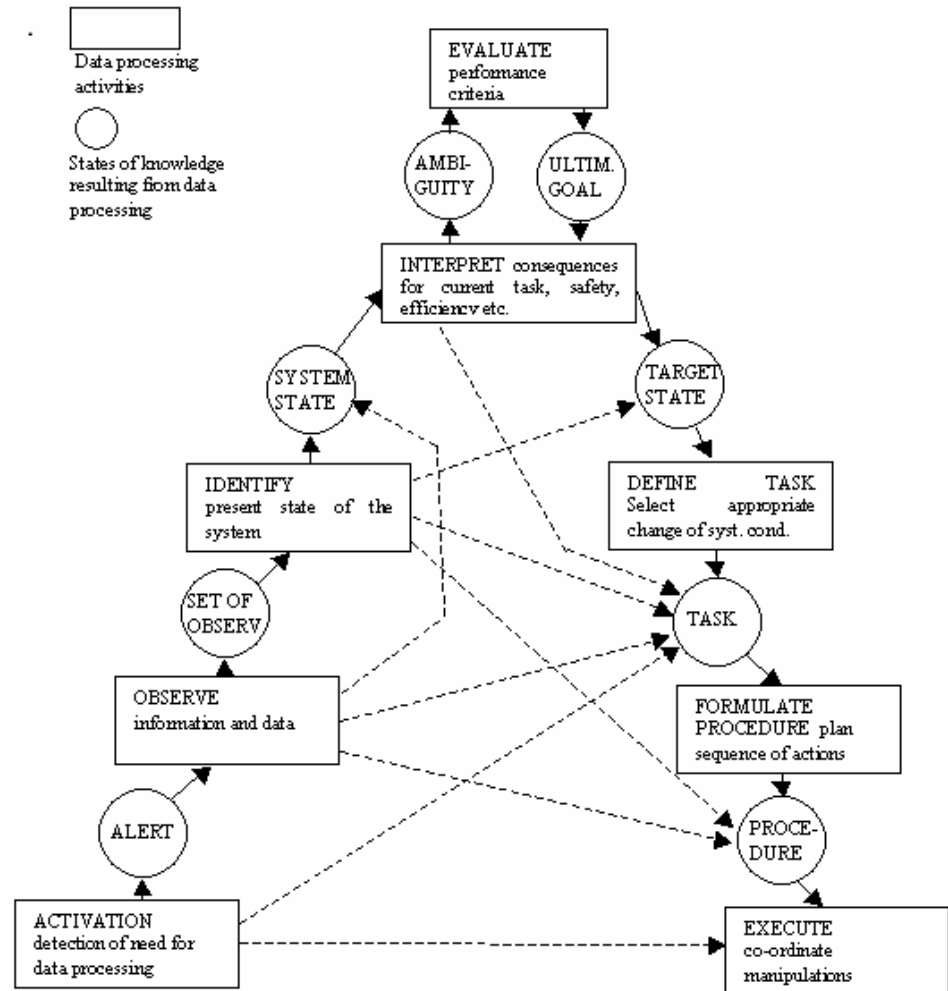
© SIEMENS AG

The Human operator



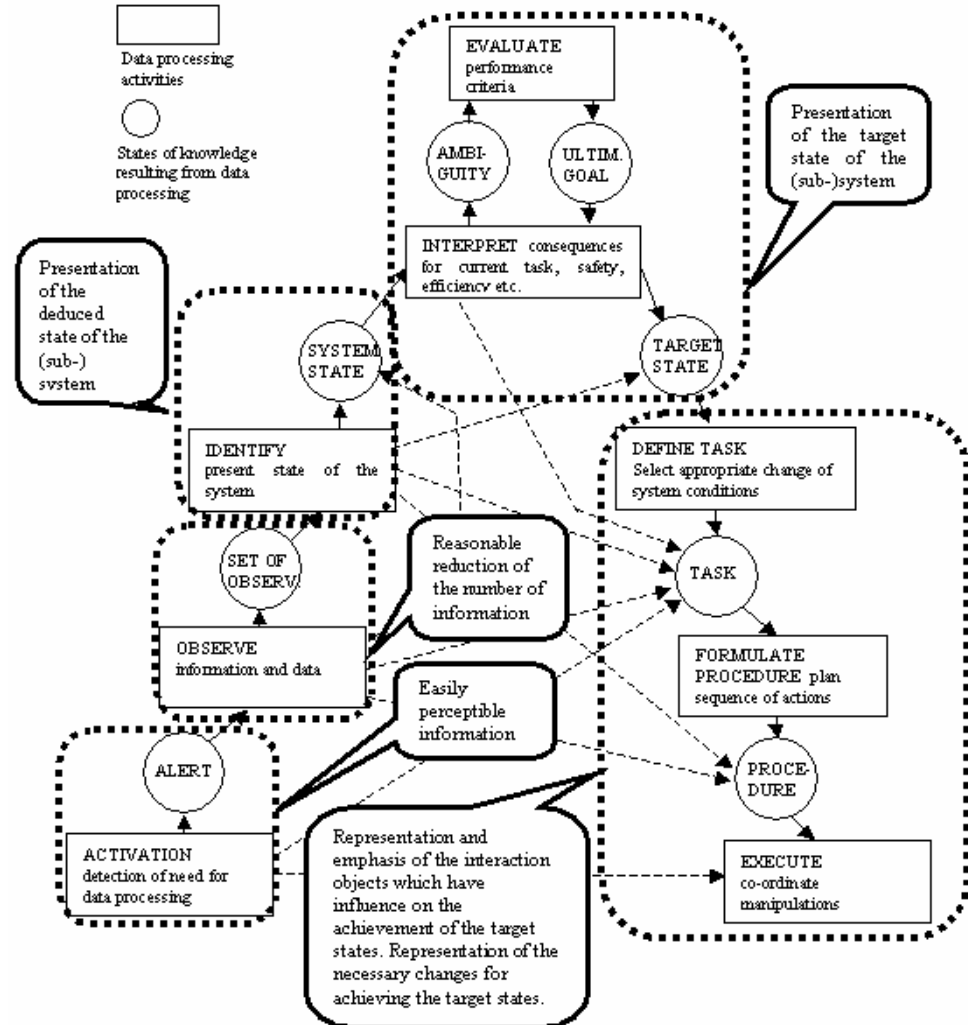
Human Information Processing

- Rasmussen's model of human decision:



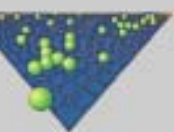
Human Information Processing

- Rasmussen's model of human decision: Support of the human operator by the User Interface

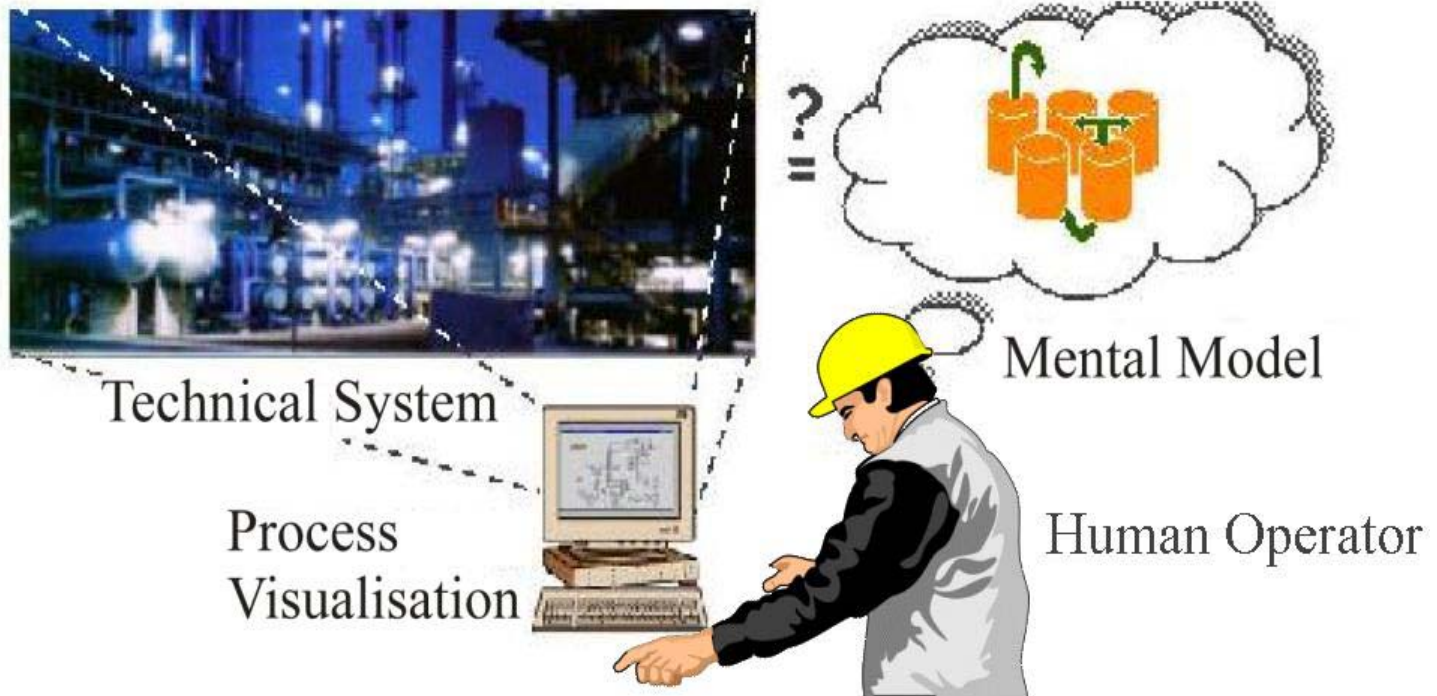


Rule-based behavior

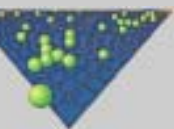
- **rules about the interaction with the technical system**
- **rules are corresponding with well-known situations**
- **fails in rare fault situations - knowledge-based behavior is necessary**



Mental Models

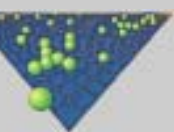


- Based on the system knowledge the operator forms a mental model of the system.
- A mental model contains the conceptions, which the operator formed regarding the functionality of the technical system.
- The quality of the interventions in the technical system by the operator depends on the correctness and quality of this mental model



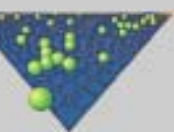
Mental Models

- **Characteristics of Mental Models (Dutke, 1994):**
 - Mental models have basically functional structure.
 - Mental models have strong pictorial-descriptive character
 - and can be promoted by pictorial means. (Dutke, 1994)
- **Influences on mental models (Bainbridge, 1992):**
 - Knowledge about task und goal, tools, system, training and experience
- **Problem solving and action planning (Dutke, 1994):**
 - Simulation with different initial values (possible actions) and state information
 - Optimization by changing the initial values

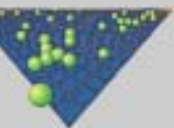


Mental Models

- **Necessary compatibility (Charwat, 1992):**
 1. between the real technical system und the presentation (UI)
 2. between the presentation and the mental model
 3. between the presentation and the interaction
 4. between different interaction devices
 5. between different presentation types of the technical system



Usability and User-centered Design



Definition of Usability

“Extend to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” (ISO 9241-11)

Context of Use

- Users
- Tasks
- Equipment
- Physical and social environment

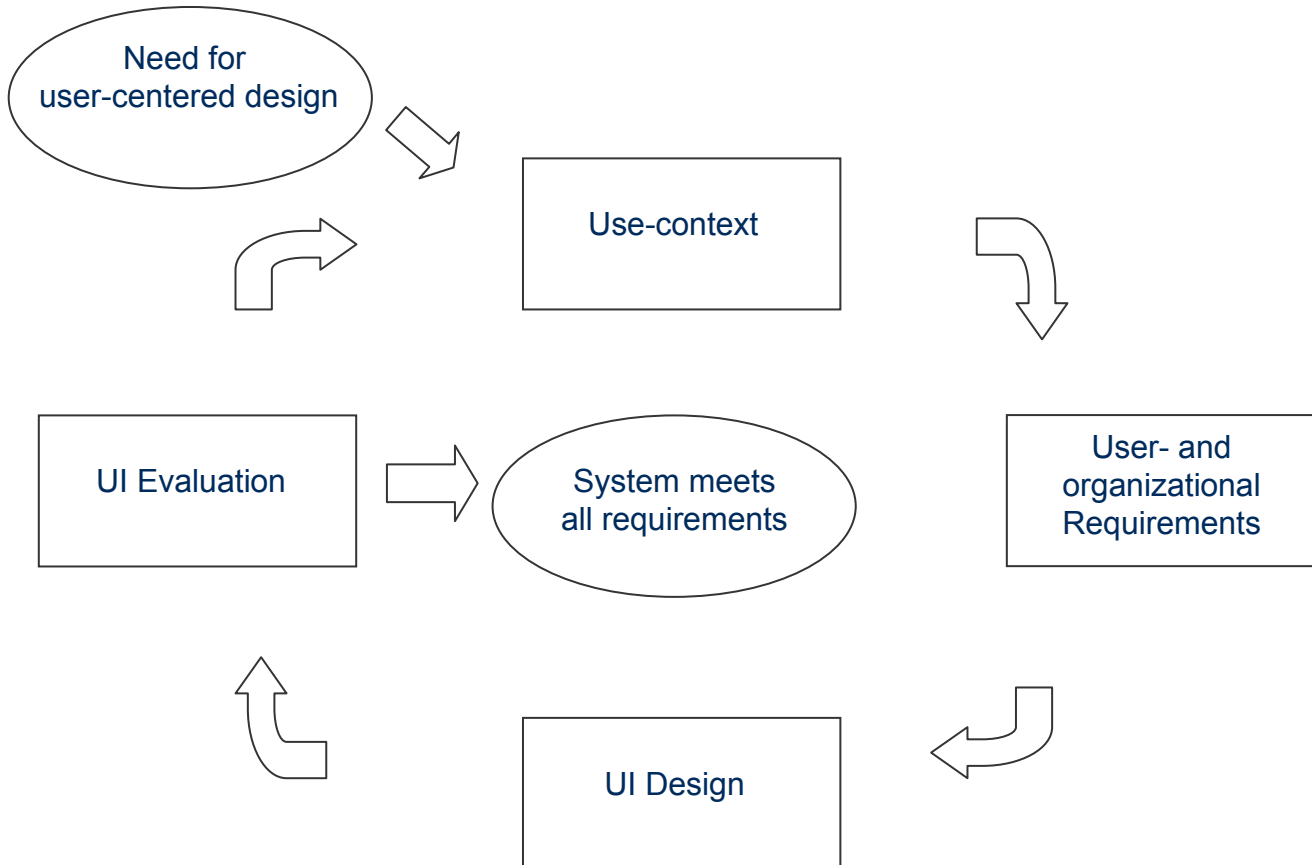
(ISO 9241-11)

Dialogue Principles

- Suitability for the task
- Self-descriptiveness
- Controllability
- Conformity with user expectations
- Error tolerance
- Suitability for individualization
- Suitability for learning

(ISO 9241-10)

ISO 13407



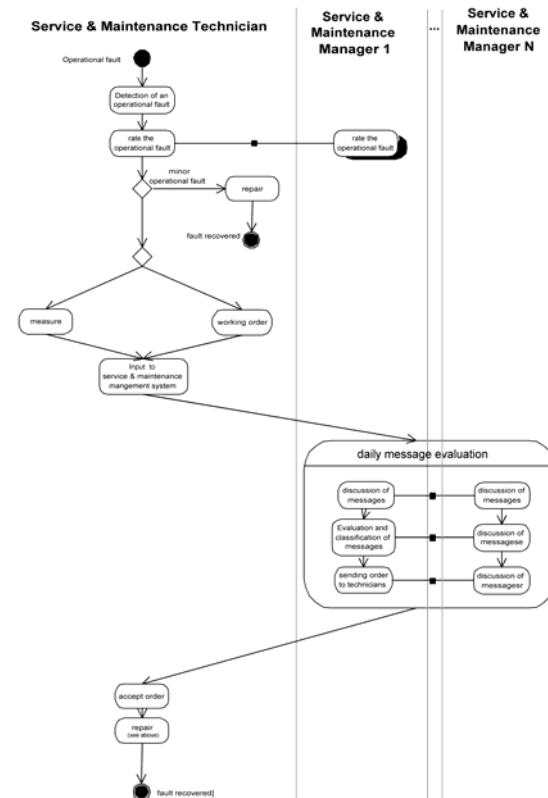
Use-context

- **user characteristics**
 - skills
 - experiences
 - mental models
 - etc.
- **tasks**
 - goal
 - frequency and duration
 - etc.
- **organizational & physical environment**
 - software
 - hardware
 - etc.



User- and Organizational Requirements

- satisfy laws & regulations
- support of workflows
- task performance
- interfaces between user roles etc.
- feasibility of service & maintenance
- etc.



User Interface Design

- use of knowledge from previous steps
- concretize design solutions from paper to functional prototypes
- check design solutions with end users
- etc.

Handwritten annotations on the screenshot:

- Guten Tag ATE!** and **STARTSEITE** (highlighted in yellow)
- Drop Down** (pointing to the navigation menu)
- Suchmaschine** (pointing to the search bar)
- Wartungshandbücher** (pointing to the main content area)

The screenshot shows the following interface elements:

- Navigation:** aktuelles Über, Liste, Liste, Wochen-, Jahres-
- SIEMENS Logo**
- CT IC 7 User Interface Design**
- Navigation Icons:** Aufgaben, Dokumente, Störungen, Ersatzteile, Kommunikation
- Search Bar:** Begriff eingeben, Suchen
- Help/Logout:** Hilfe, Logout
- Left Sidebar:** Dokumentation, Auftrags, Freischaltwesen
- Main Content:**
 - Dokumentation >**
 - Wartungshandbücher
 - Bedienungsanleitungen
 - Stromaufpläne
 - Funktionspläne
 - Explosionszeichnungen
- Wartungshandbücher Section:**

Wartungsbuch 1.0	Download/Öffnen
Stichworte: Wartung, Arbeit, Störungen	
Dateiname: wartungsbuch.pdf / .doc	
Download Größe: 200kB	
Datum der Veröffentlichung: 1/12/2002	
Wartungsbuch 2.0	Download/Öffnen
Stichworte: Wartung, Arbeit, Störungen	
Dateiname: wartungsbuch.pdf / .doc	
Download Größe: 200kB	
Datum der Veröffentlichung: 1/12/2002	
Wartungsbuch 3.0	Download/Öffnen
Stichworte: Wartung, Arbeit, Störungen	
Dateiname: wartungsbuch.pdf / .doc	
Download Größe: 200kB	
Datum der Veröffentlichung: 1/12/2002	
Wartungsbuch 4.0	Download/Öffnen
Stichworte: Wartung, Arbeit, Störungen	
Dateiname: wartungsbuch.pdf / .doc	
Download Größe: 200kB	
Datum der Veröffentlichung: 1/12/2002	

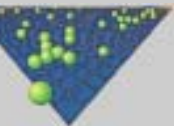
User Interface Evaluation

- e.g. Usability tests
- typical end users
- typical task scenarios



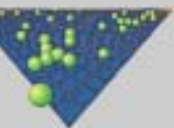
User Interface examples

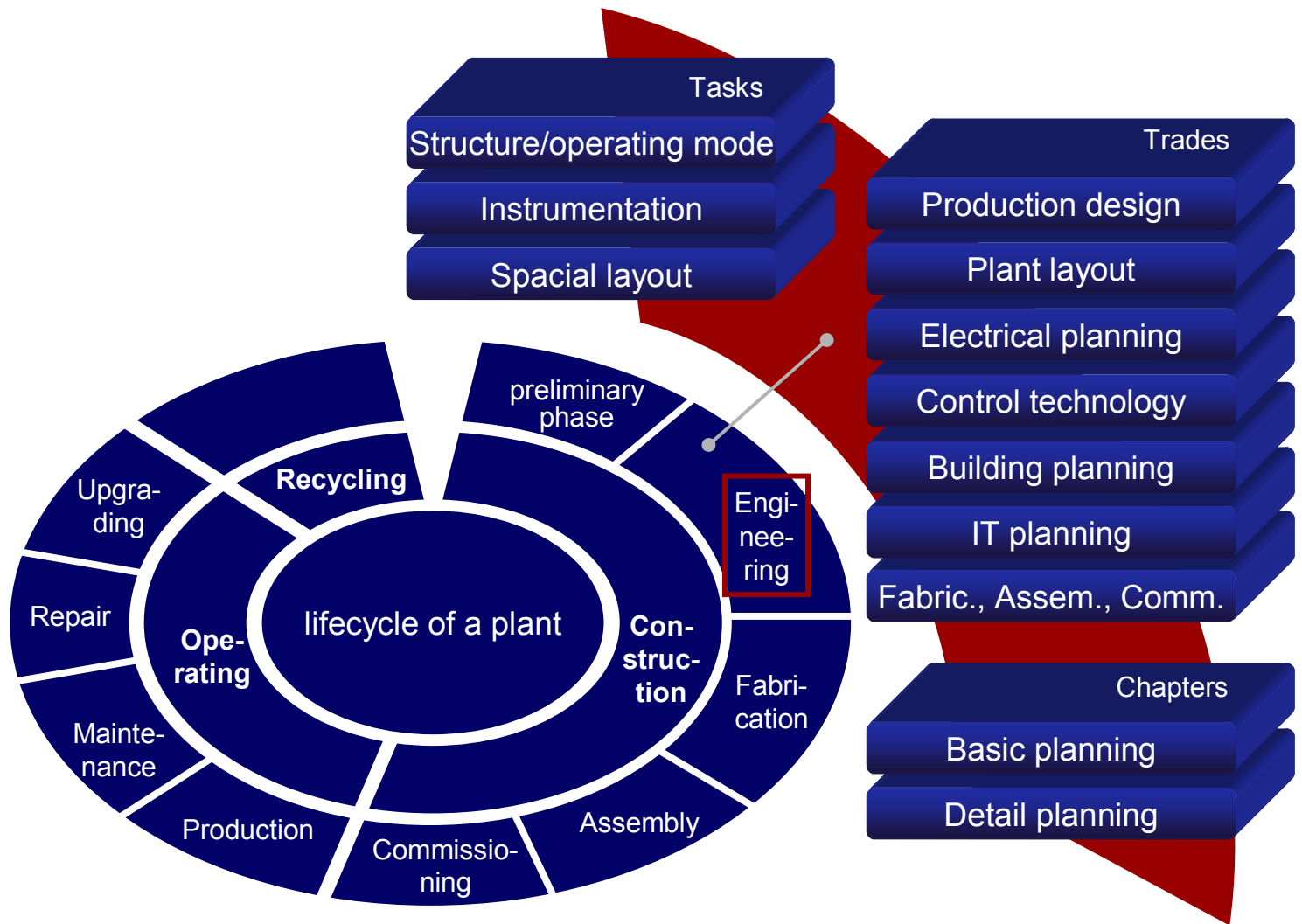
Research work



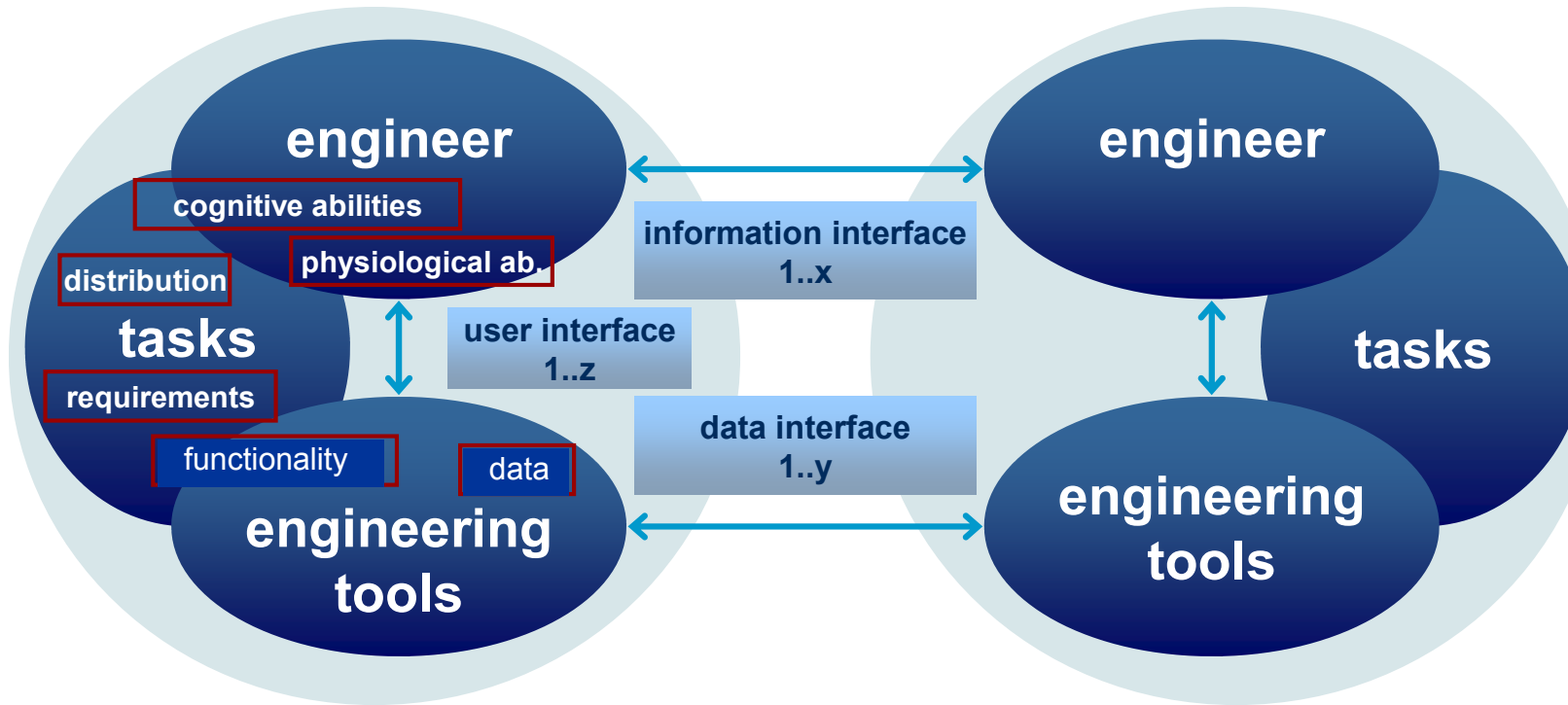
Example: Engineering portal

- **During, A., T. Komischke, C. Wittenberg, U. Berger (2004): A vision for an information management tool for plant engineering – functionality and user interface. In: Horváth, Xirouchakis (Eds.): Proceedings of the TMCE 2004, April 12-16, 2004, Lausanne, Switzerland, Rotterdam: Millpress.**

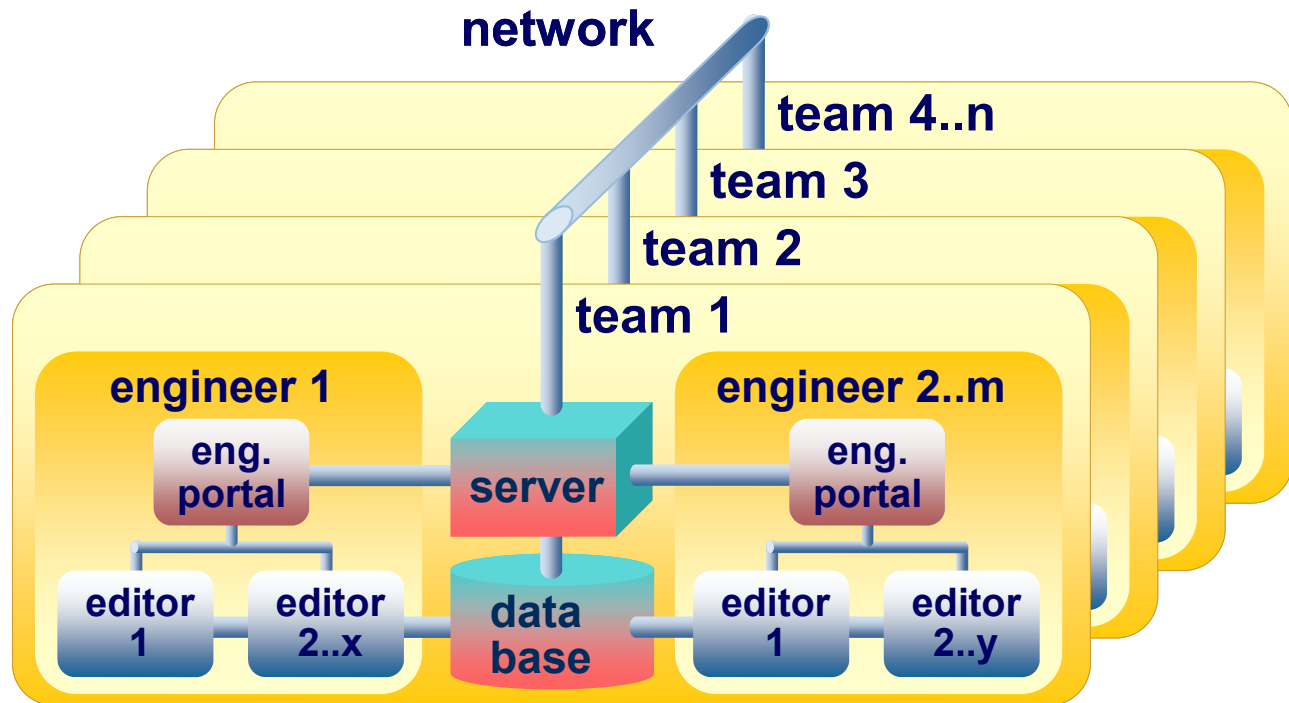




Model of the environment of an engineer



Assumed Working Structure



Projektgruppe1: Übersicht

Aktuelle Projekte

Dringende				
Normale				
BTU Cottbus				
Bearbeitungszentrum	v0.5	Festmodell	11.4.2004	Projekttemplate Kleinanlage
Pneumatikanlage	v0.7	Ausbildung	08.4.2004	Projekttemplate Kleinanlage
Siemens - ICN				
Fertigungslinie	v1.1	Mobiltelefone	12.3.2004	Projekttemplate Grossanlage
Ruhende				

Neue Projekte

Akquise			
Kraftwerk Isar 1	Angebot	12.3.2004	Erweiterung um einen Block
Siemens - I&S			
Logistikzentrum	Angebot	12.3.2004	Neubau für Post in Neufahrn
Brauerei	Vorbereitung	10.5.2004	Neubau in Erding
Flughafen	Vertragsverh...	01.3.2004	Erweiterung des Terminals 1
Kommende			

Projektarchiv

2004					
Warmwalzwerk	v1.9	05.1.2004	Servicevertrag	Eco Stahl AG	offen
Verpackungsanlage	v2.2	19.3.2004	abgeschlossen	Deutsche Post	archiviert
2003					
2002					
2001					

Teamintern1: Übersicht

Projekte

Projektsteckbriefe	
Kleinprojekte	2 / 13
Grossprojekte	0 / 4
Forschungsprojekte	
Steckbriefe	1 / 7
Veröffentlichungen	1 / 1
Projektvorschläge	0 / 1
Templates	
Projektvorlagen	0 / 6
Formatvorlagen	2 / 15
Prozesse	0 / 8
Abwesenheitsliste	0 / 1

Organisation

Räumlichkeiten	
Raumbelegung	0 / 1
Raumreservierung	2 / 7
Rechnerliste	1 / 1
Equipment	
Beschreibung	0 / 1
Anleitungen	0 / 13
Reservierung / Ausleihe	0 / 1
Abteilungsinfos	
Flyer	0 / 5
Foliensätze	1 / 10
Texte	0 / 17
Sonstiges	
Organisationsforum	3 / 32

Methoden

Projektman
Steuerungs
Implementier
Inbetriebna
Prozesse
Neue Metho
Methodenfor

Datenaustausch	4/13	Bearbeitungszentrum				Quittieren
Suchergebnisse	1/3	Variablenliste	MLiske	11.05.04	Kennzeichnungssystemänderung	Vergleichen
Selektionsliste	0/7	Dokumentation	QA	03.05.04	neue Version	Auswirkung
Aktionsliste	1/32	Pneumatikanlage				Annehmen
Komm.versuche	5/5	Fertigungslinie				Verwerfen
Regeln	1/4					Löschen

Prozessvisualisierung 0/1

Universalmenü

- Funktionen
- Kontextfunktionen
- Objekte
- Links
- Sonstiges
- Suchen
- Vergleichen
- Massendaten
- Querverweise
- Makros
- Metadatenuche
- Inhaltliche Suche
- Suchmaske 1
- Suchmaske 2
- Suchparameter

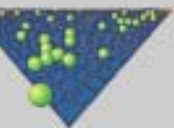
Start Save Strg+S

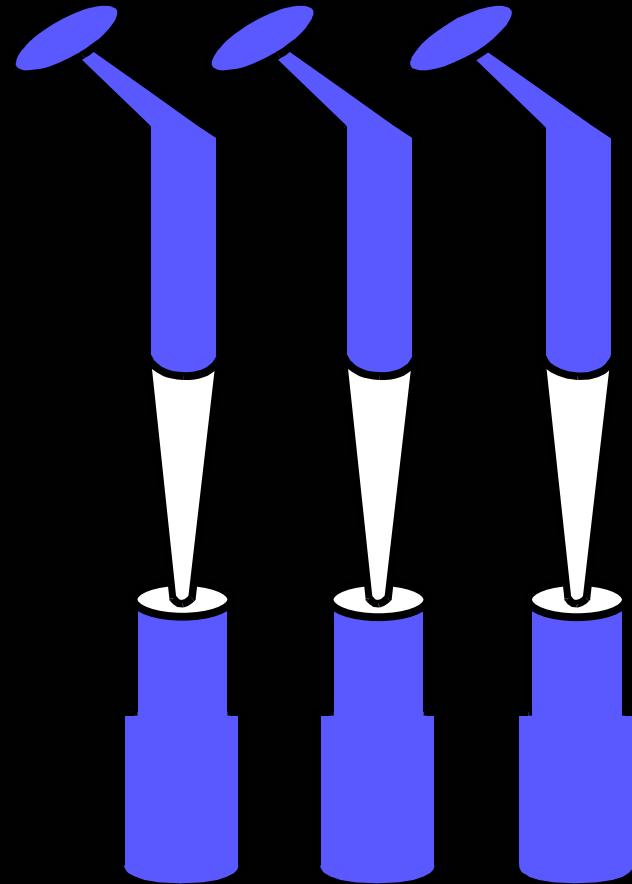
Eigenschaften Kommunikation Vorschau Informationen

Example:

Process Visualization for supervisory control

- Epstein, A., A. Beu (2000): *Design of a graphical User Interface for Process Control based on the example of a paper recycling plant*. International journal of Human-Computer Interaction Vol. 12 No 3&4, pp. 387-400.

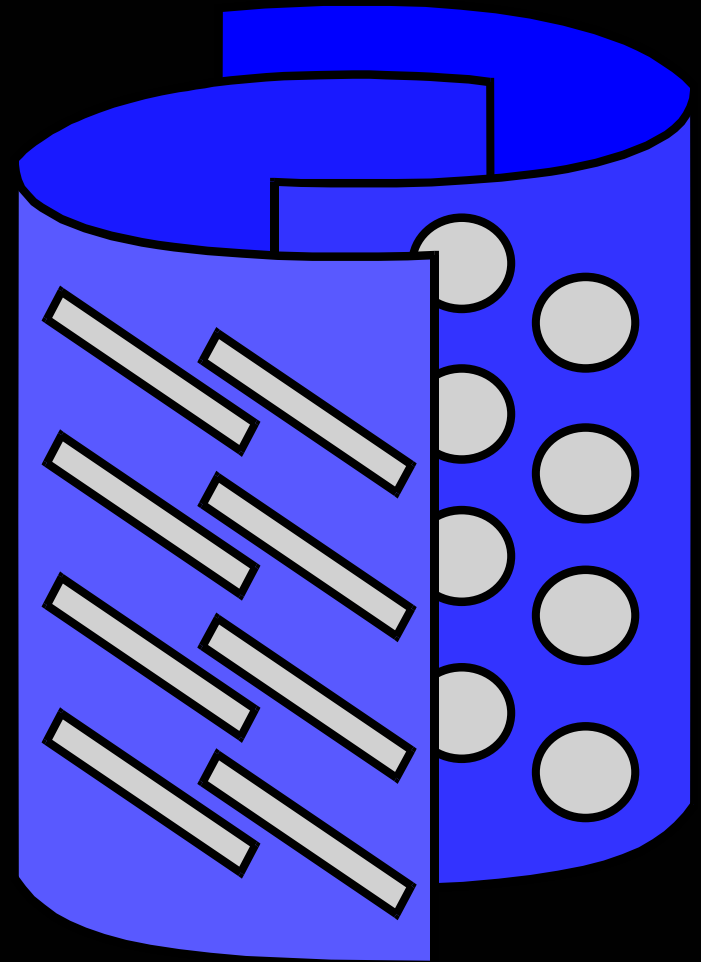




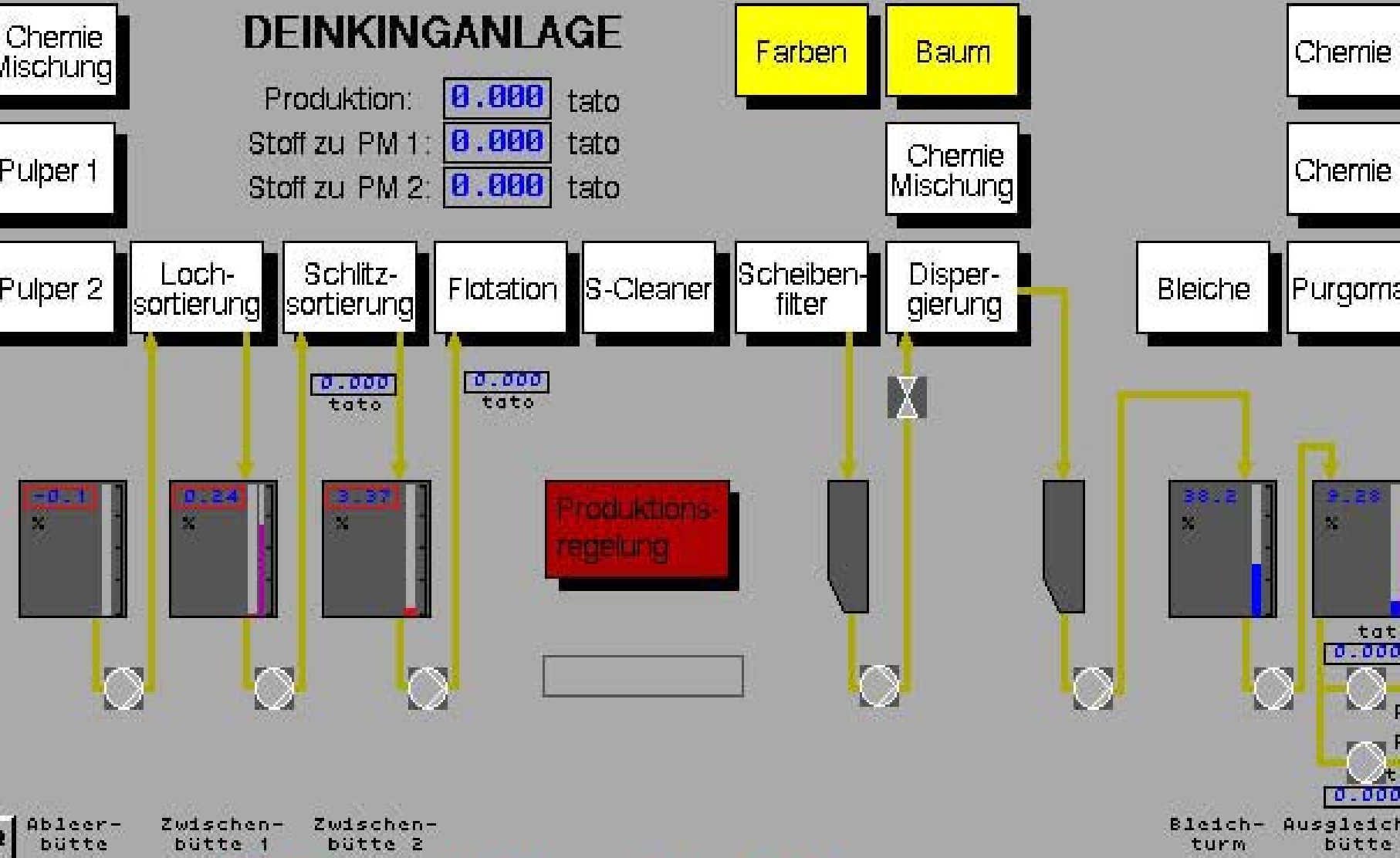
Design: Visualization of plant element

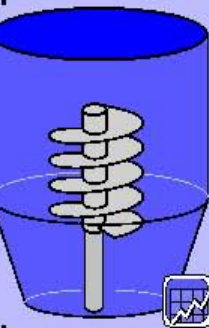
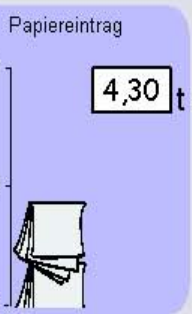
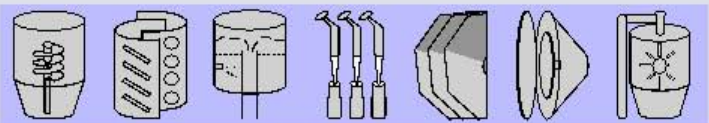
Operators' description:

- „The sorter sifts out coarse fabrics.“
- „The sieves are baskets, like cans.“
- „working with holes or with slits“

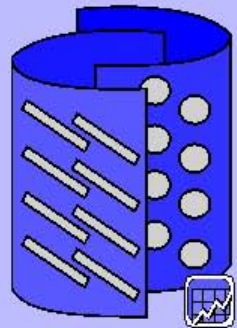
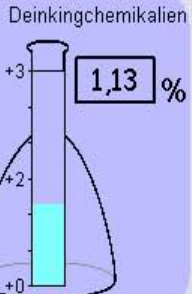


Design: Visualization of plant element

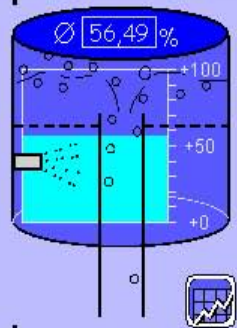




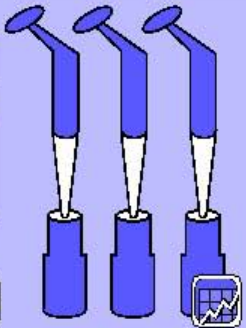
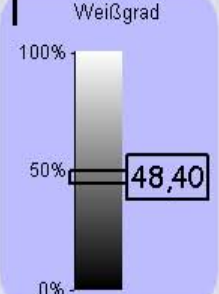
Pulper



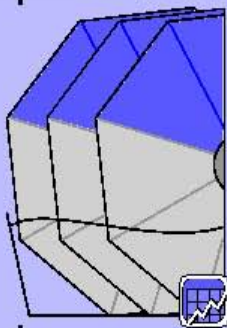
Sortierung



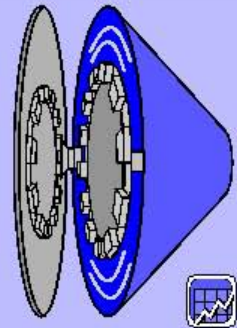
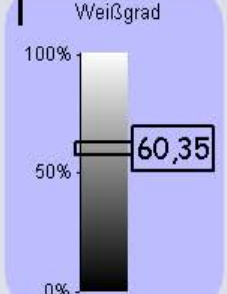
Flotation



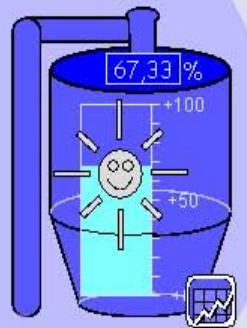
Cleaner



Eindickung



Disperger

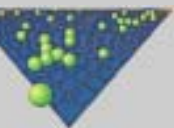


Bleiche

Example:

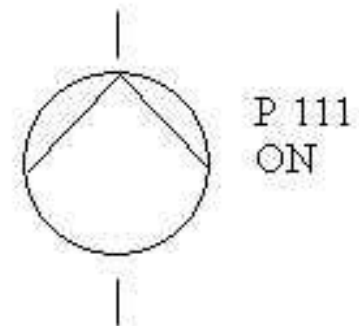
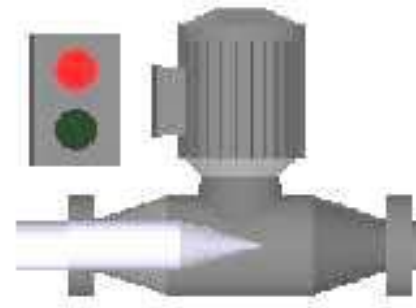
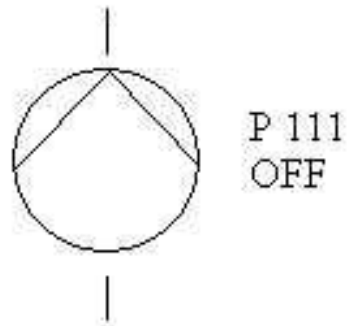
Process Visualization for supervisory control

- **Wittenberg, C (2004): *A Pictorial Human-Computer Interface for Supervisory Control*. Control Engineering Practice, Special issue: PC-B02-Process Control IFAC 2002 - Edited by P. Daoutidis and C. Scali, Amsterdam: Elsevier Science, Vol. 12 (2004) No 7, pp 865-878.**
<http://authors.elsevier.com/sd/article/S0967066103002466>.



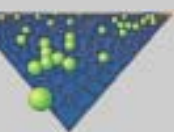
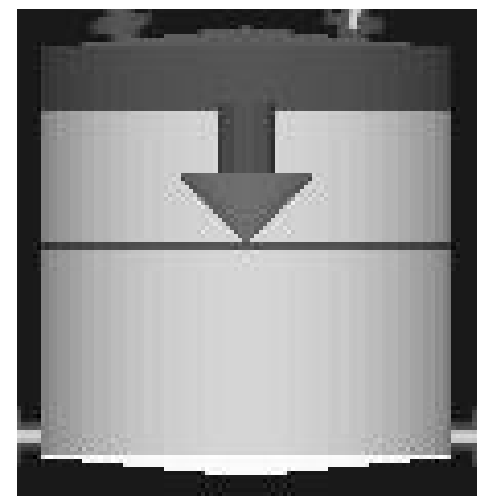
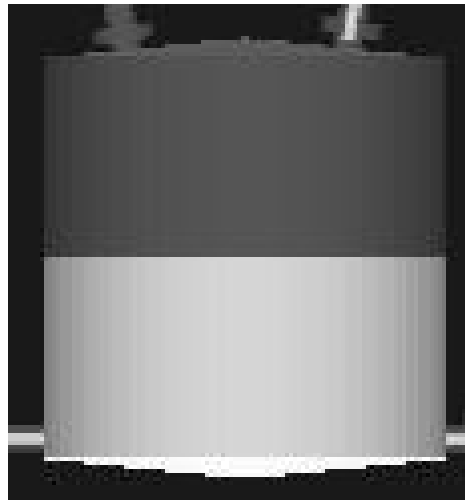
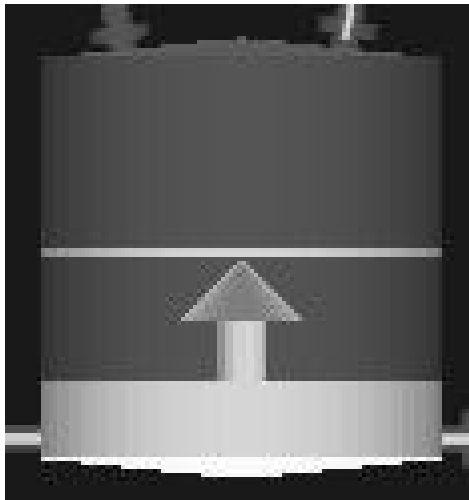
VIRTUAL PROCESS ELEMENTS

Pump



STATE AND GOAL VISUALIZATION

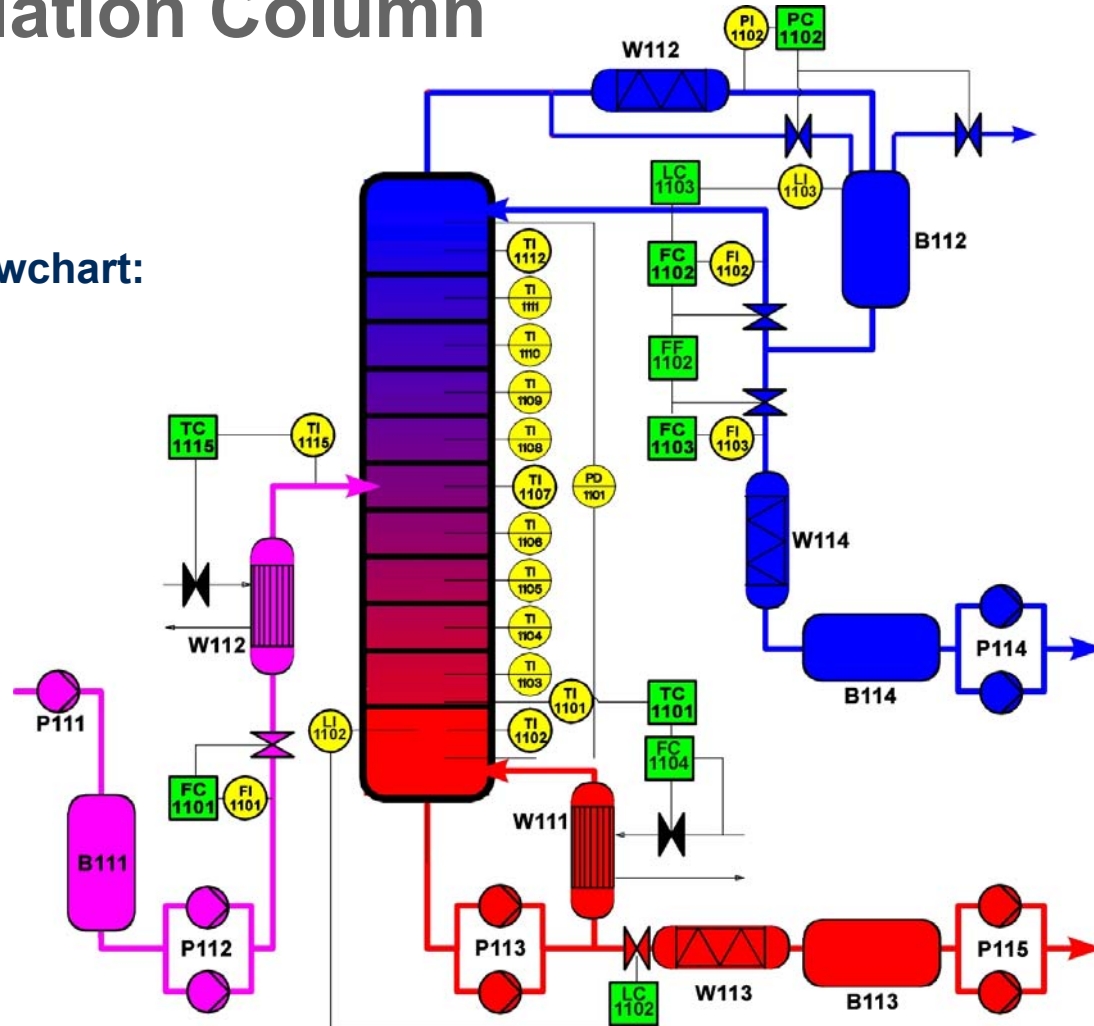
Fill-up Level

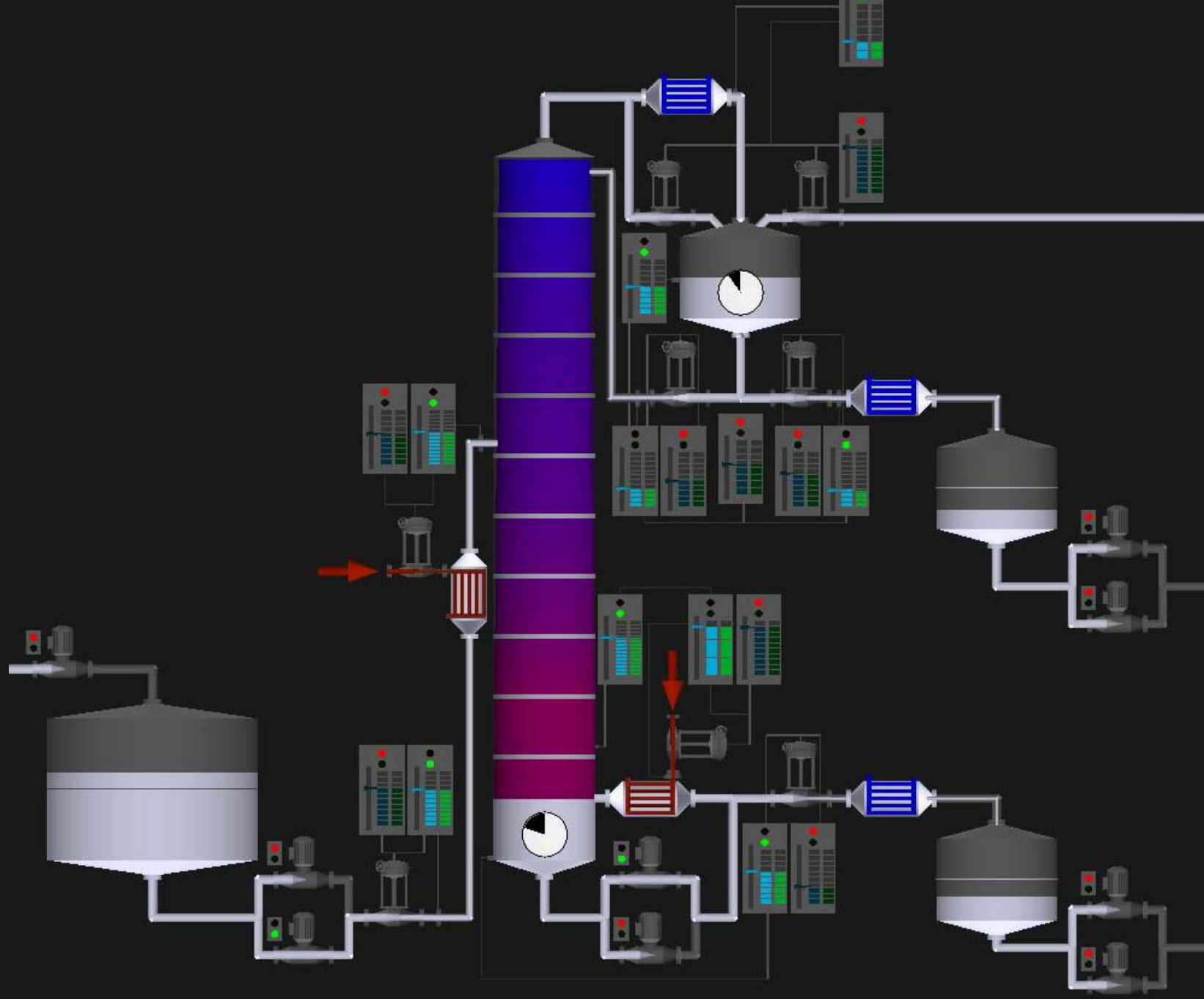


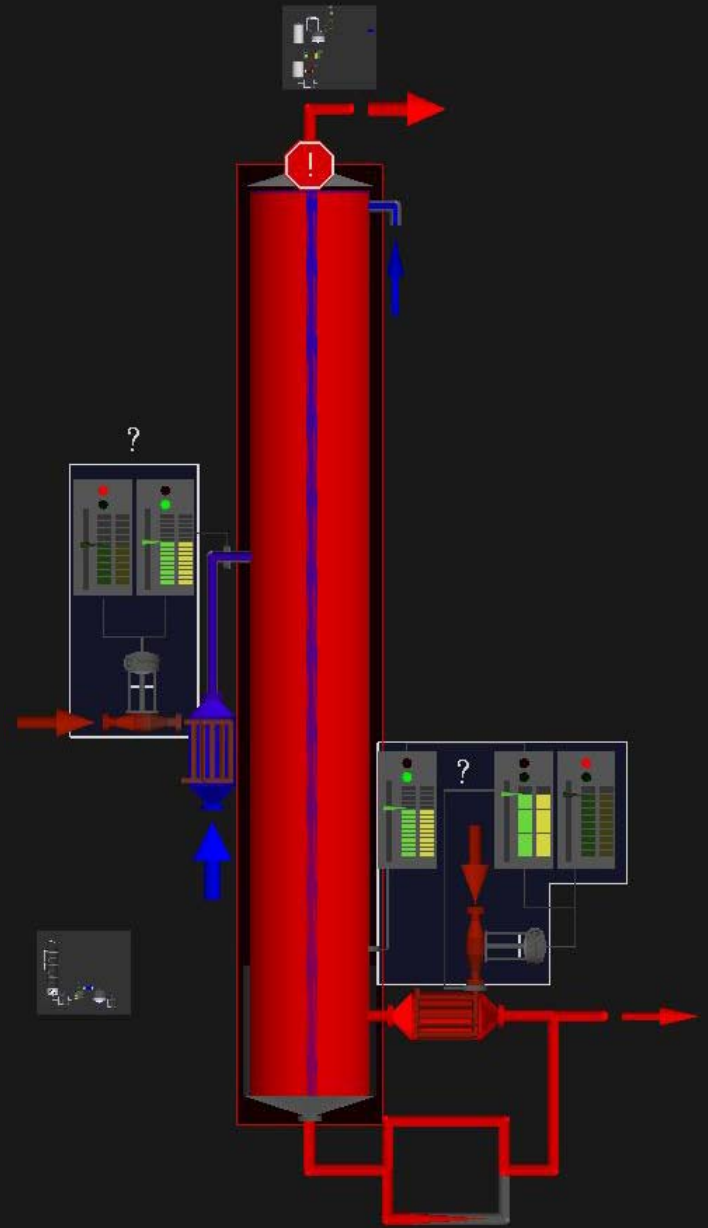
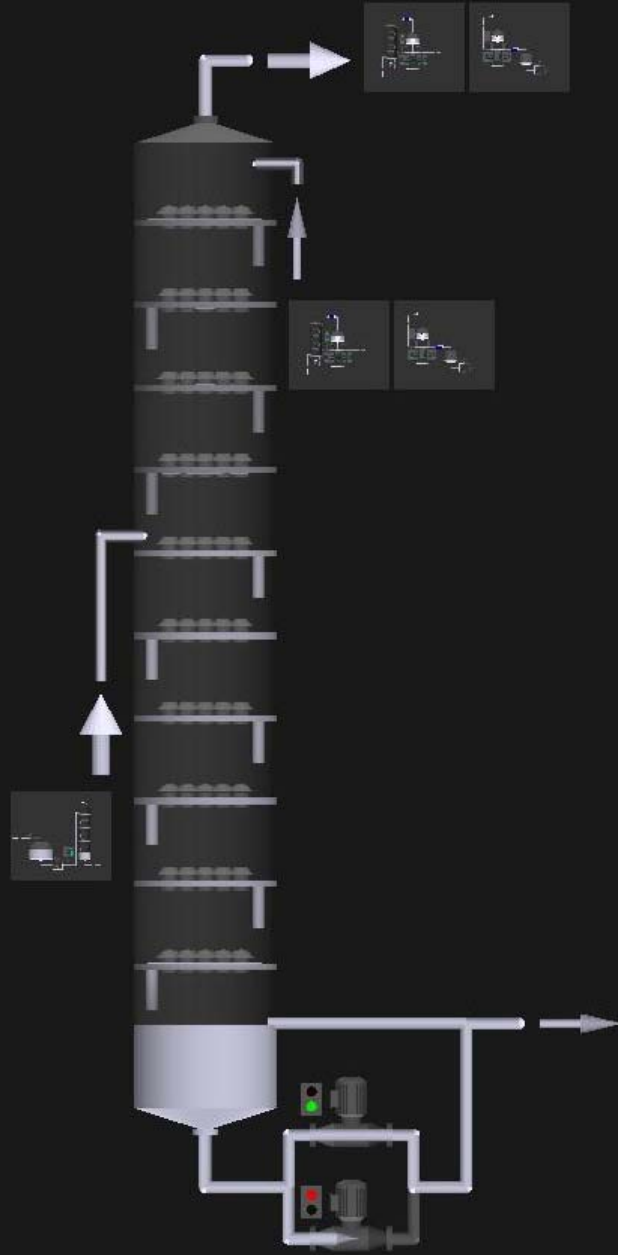
SAMPLE APPLICATION

Distillation Column

Flowchart:

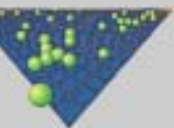




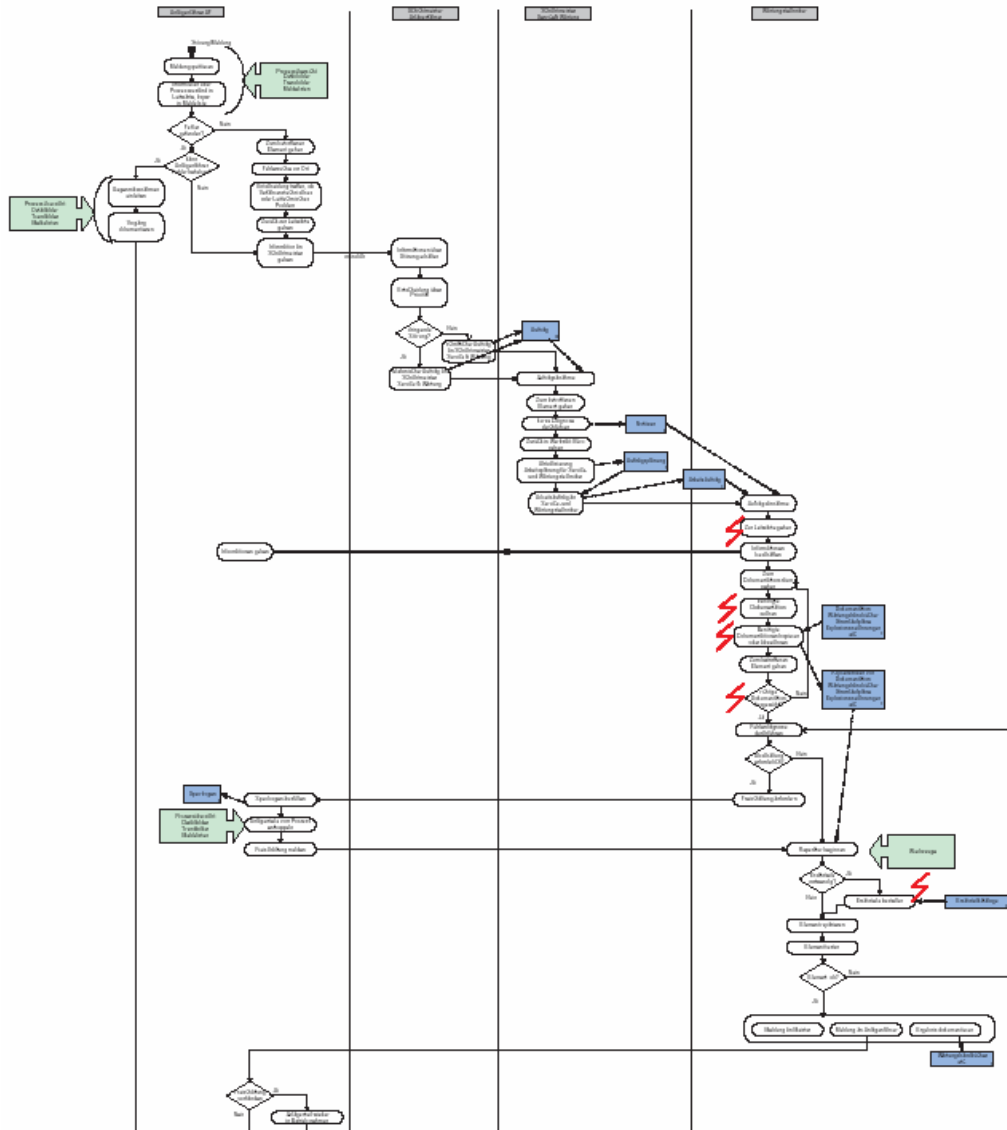


Example: Service & Maintenance

- **Wittenberg, C. & B. Otto: A Human-Computer-Interface Concept for Mobile Devices to support Service & Maintenance Staff in Industrial Domains. In: C. Stephanidis, J. Jacko (Eds.): *Human-Computer Interaction: Theory and Practice (Part II)*. Mahwah, New Jersey: Lawrence Erlbaum, ISBN 0-8058-4931-9, pp. 328-332.**



Actual Workflow of a Service Technician

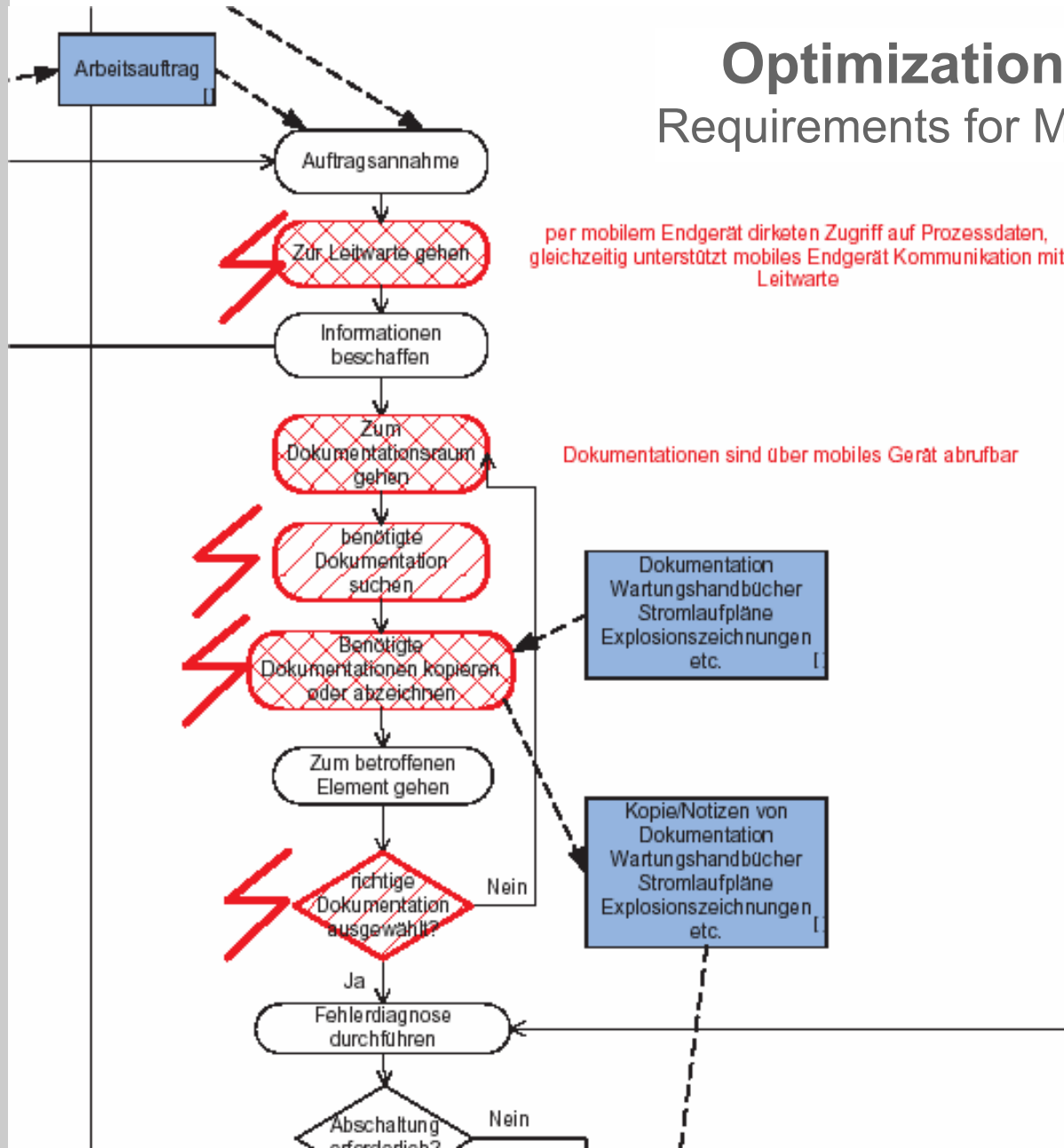


CORPORATE TECHNOLOGY



Optimization Potentials

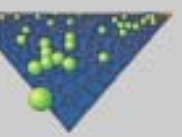
Requirements for Mobile Application



UI concept for mobile devices



COGNITIVE TECHNOLOGIES



**Thank you
for your attention!**

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