Embedded Systems
INSTITUTE

ArtistDesign Workshop on Embedded Systems in Healthcare 2009

Thom van Beek

Capture User Requirements using Workflow Scenarios

Abstract

Capturing user requirements in the early phase of a systems architecting project is not a trivial task. This approach uses a flowchart model of the expected operational use of the system to explicitly capture, discuss and develop the use related requirements for the system in natural language, from very early the design process (Project Preparation Phase).

In this presentation the different shapes, characteristics and benefits of the workflow models (flow chart, Gantt chart and 3D animations) are explained and demonstrated using a case study as an example and the benefits of these models, e.g. early phase user requirements documentation, hierarchical expanding model, customer feedback facilitation, explicit intra and extra design team communication/understanding are shown. The benefits for different stakeholders are explained. With stakeholders being the development organization as a whole, system architects, project design team third parties involved and the customer/user.

After requirements specification, the next step for the system architect is to translate the user requirements into system functionality. It is demonstrated how the workflow models provide a guide to develop a functional model of the system at the start of the conceptual design. By using the operational workflow as input to the function model creation process, an explicit relation between user requirements and system properties is obtained. In the framework of the systems engineering approach, these early defined workflow-functions relations between what the user wants and what the system should do can be used in the system verification phase to evaluate the system.

artist

Capture User Requirements using Workflow Scenarios

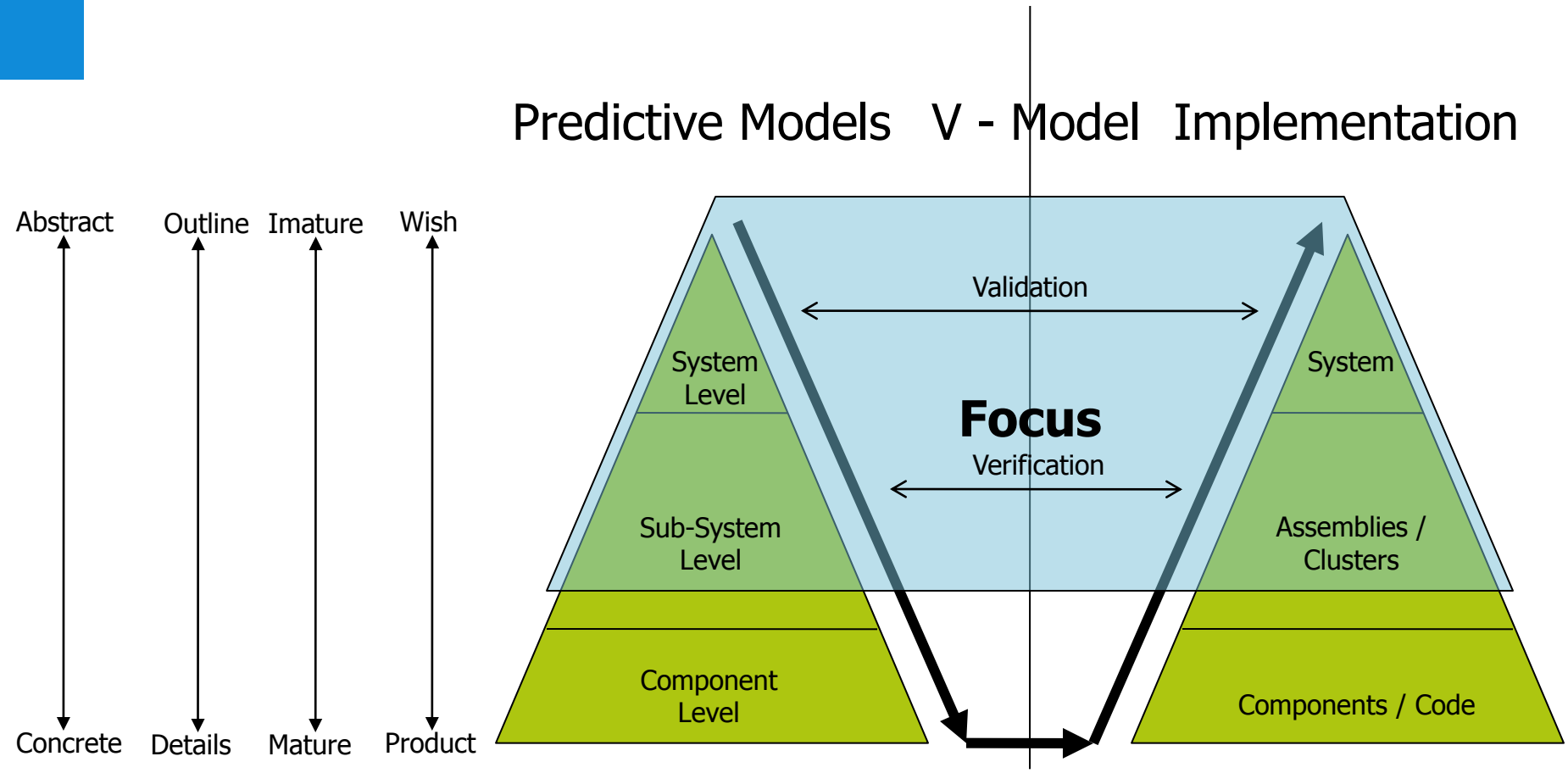
7-12-2009

WESH 2009, Eindhoven
Thom van Beek, TU Delft

Content

- Background: Complex Systems Architecting
- Motivation
- Objectives of this Research
- Approach: Scenario Based Architecting
- Introduction of the Case: MRI – Neuro Surgery suite
- Stakeholders & Models discussed
- Results
- Conclusions

Background:
Complex Systems Architecting



Motivation

Products will only be successful when they:

- Satisfy customer needs (requirements)
- Reach the market at the right time
- Are sold at the right price

[Pahl & Beitz]

To achieve Best-In-Class performance, companies must:

- Use multiple design criteria to define system architecture and add that criteria to the system requirements

- Requirements should be linked to higherlevel system functions as well as the overall customer need it meets

- Leverage a model driven design approach to overcome communication barrier and verify requirements have been met

[Boucher]

[Pahl & Beitz] *Engineering Design, A systematic approach, 3rd ed., 2007*
[Boucher] *Systems Engineering, Top four design tips to increase profit margins for mechatronic and smart products*, 2009

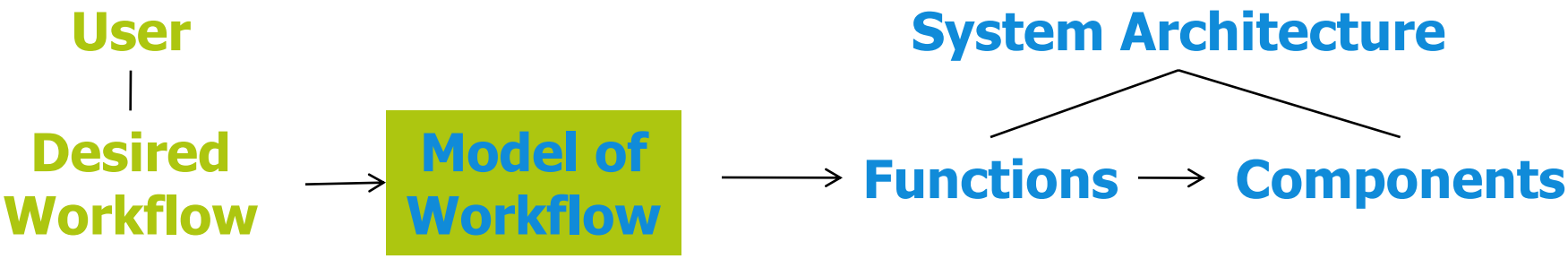
Objectives of this Research

- **How to Capture User Requirements and Effectively Translate them into a Transparent System Architecture?**

- Keywords:
  - Focus on Functional Requirements
  - Conceptual design
  - Systems engineering
  - Architecting
  - Industry as Laboratory
  - Case study
  - Medical Systems

Approach

- **How to Capture User Requirements and Effectively Translate them into a Transparent System Architecture?**
- User = All people that interact with the system during operation
- Focus on Function of System
  - Function = To Do Something



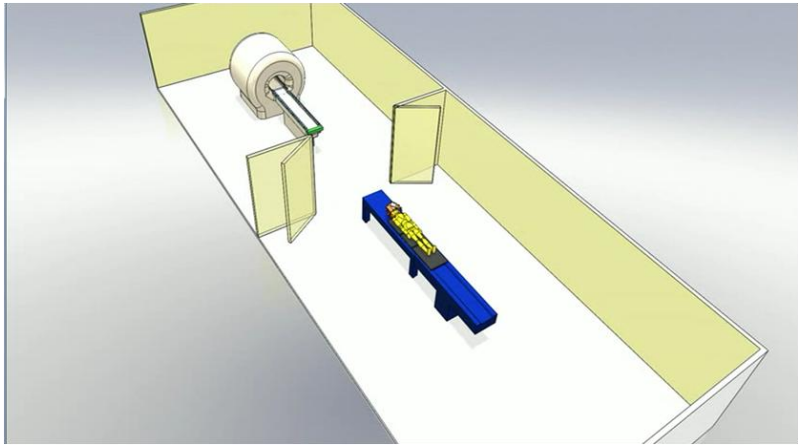
Approach:
Scenario Based Architecting

- Explicitly Model the Intended/Expected Use of the System
- Connect Use to Functions of the System
  - Makes Functions Traceable to User Needs
  - Transparancy
- Makes Verification/Validation Easier

- Is Applied in Software
  - e.g. UML Use Cases, Business Process Modeling
  - Not that detailed
  - To Generate Code
  - What about Hardware & Software?
- **Case Study**

Introduction Industrial Case (1)
MRI – Neuro Surgery

- Industrial partner: Philips Healthcare, MRI
- Case: **Philips MRI – Neuro Surgery Transfer**
- Brief Animation

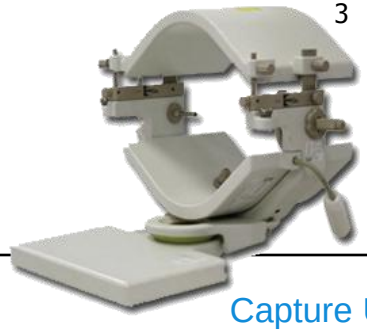


Introduction Industrial Case (2)
MRI – Neuro Surgery

- Project conditions:
  - Minimal budget and resources
  - First step in life cycle only (two pilot customers)
- Project characteristics:
  - Multidisciplinary multisite project team
  - Integrating multi modalities (integral application and patient centric solution)
  - Based on partnerships (capturing value of leading vendors in neuro domain)
  - Based on minimal changes system components (Sense & Simplicity)
- Project Timeline:
  - Project Preparation: November 2008
  - Formal Project start: April 2009
  - Product release: September 2009 – November 2009

Introduction Industrial Case (3)
MRI – Neuro Surgery

- Pre-Conditions:
  - Re-Use of Existing (3rd parties) Systems:
    - Surgery Table and Trolley
    - Infrared Markers Navigation System
    - Head Fixture and Coil
    - Philips Achieva MRI

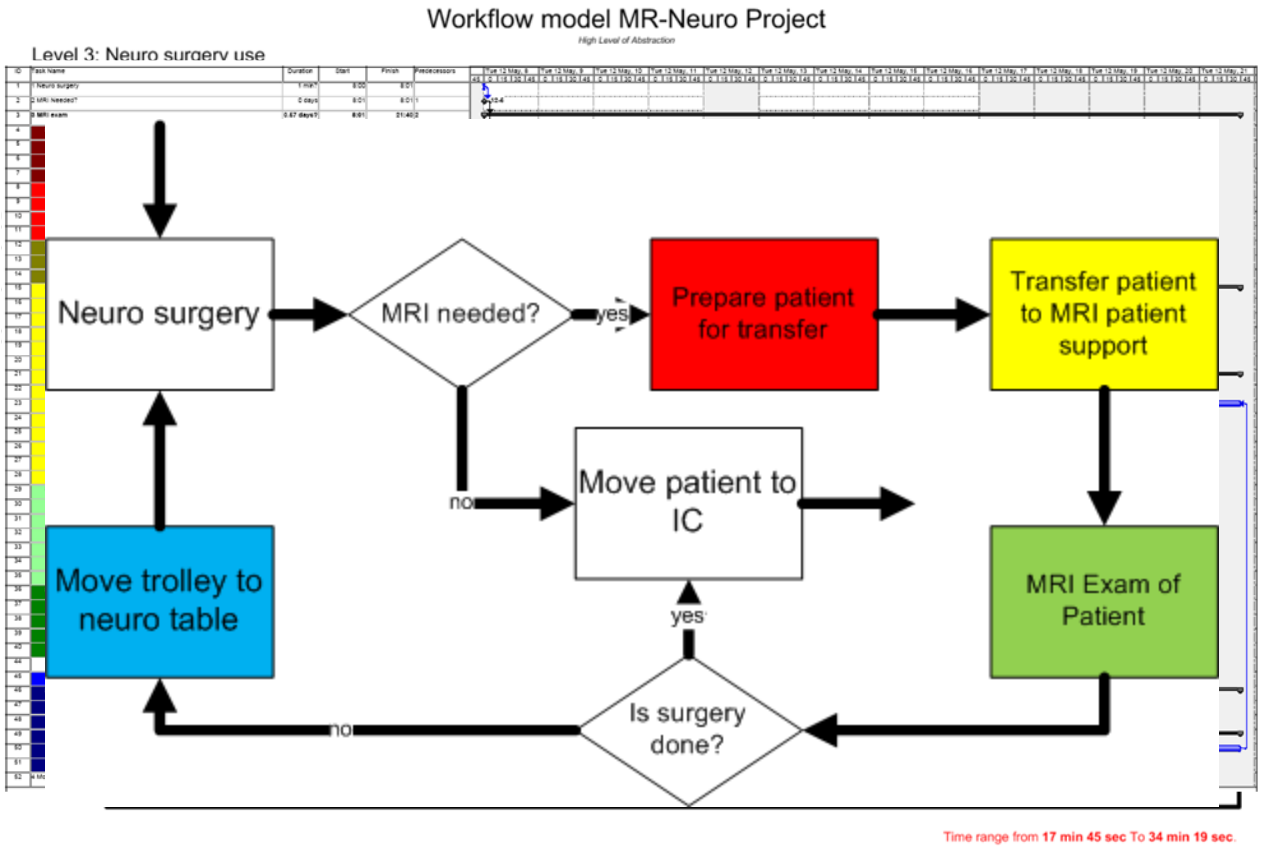


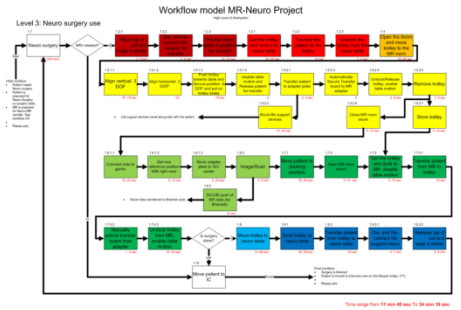
1.) www.maquet.com
2.) www.brainlab.com
3.) www.noras.de
4.) www.philips.com

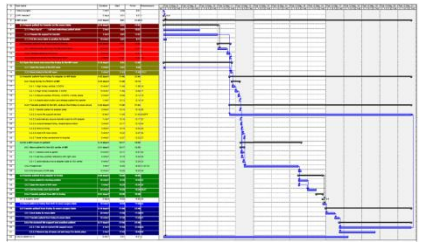
Stakeholders Involved

- MRI Development Organization
  - Project team
    - 3rd Parties
    - System Architects ← Focus
- Customer / User

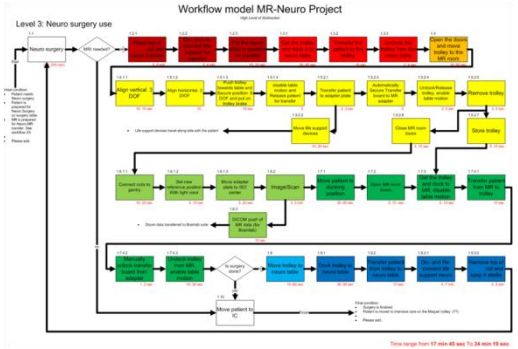
Workflow Models







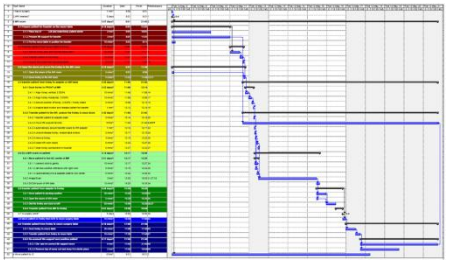
Workflow Model I



- Make intended use of system explicit before implementation
- Natural language is used
- Used to clarify task and communication in Project Team
  - Send to application, marketing and customer for review
  - Facilitate design team workshops/communication
  - Proposed as starting point ARS and CRS
  - Ended up in Documents, No extra work needed
- Easy to iterate with pen and paper
- Input from interviews and workshops

- Created in approx. 4 hours. Update in hours

Workflow Model II

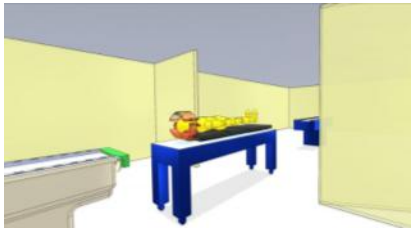


- Hierarchical workflow view
- ‘Cleaner’ representation than model I
- Time distribution made explicit

- Tools: Microsoft Project
- Input from workflow model I
- Open Issue: How to visualize iterations?

- Created in approx. 1 day. Update in 4 hours
- Bases for combined model to reveal relations

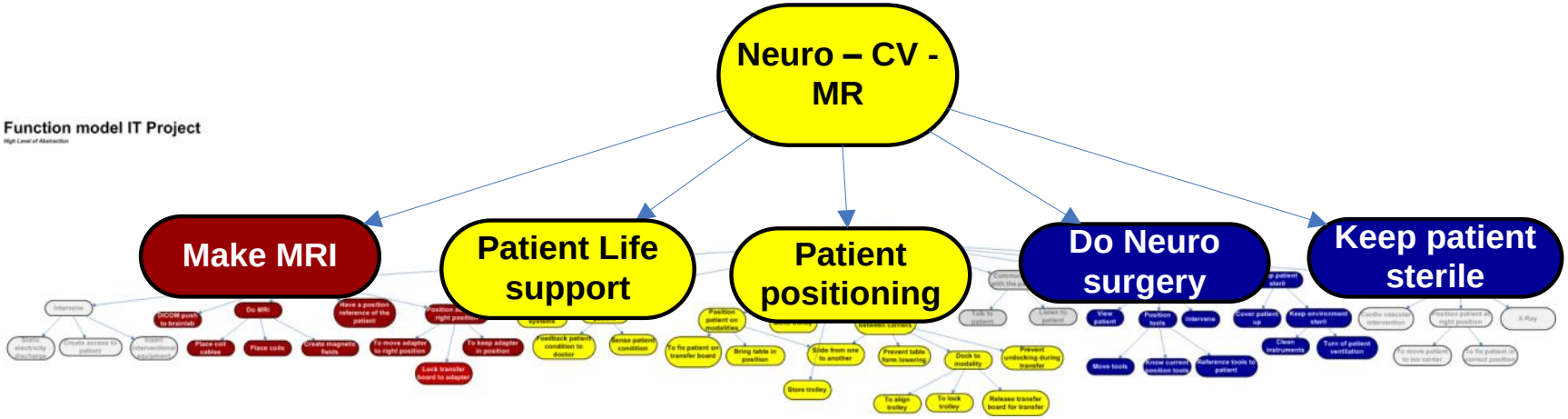
Workflow Model III



- Simplified Animation of IT workflow very early in process
- Re-Use of existing 3D CAD models and tools
- Shows hospital context / Layout explicitly
- Used to communicate
  - Facilitate design team workshops/communication
  - PPP status presentations
  - Presented to customer on visit

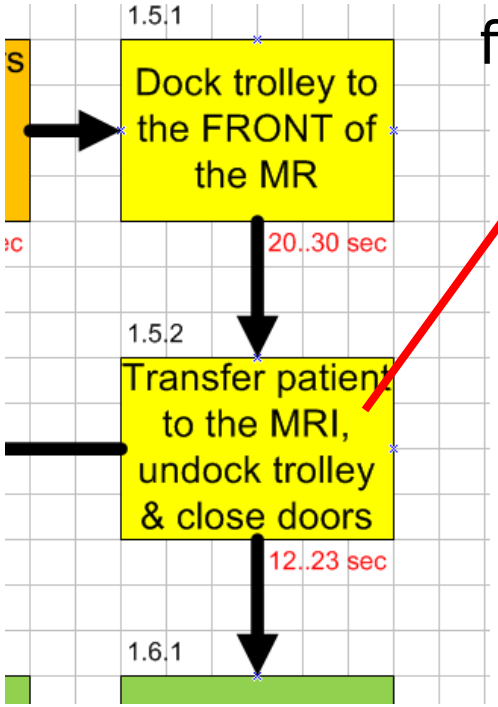
- Triggers early feedback on intended use
- Appealing
- Facilitates pre-prototype workflow communication
- Created in approx. 3 days. Iterations approx. 1 day

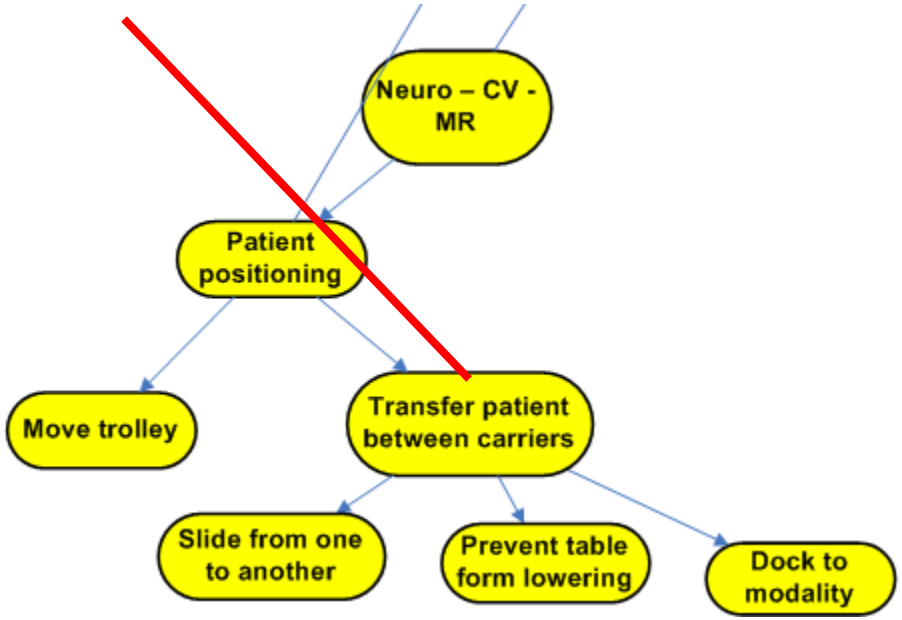
Function Model



Workflow – Function connection example

Workflow naturally described as function! Checklist.





Function Model

- Model system functions explicit
- Hierarchical view / System decomposition
- Intuitive language is used
- Helps structure design process. Checklist like
- Captures design decisions / Line of reasoning
- Starting point for behavioral and structural models
- Proposed use: System Requirement Spec. System Design Spec.

- Easy to iterate with pen and paper
- Input from project workshops and workflow models

- Created in approx. 2 hours. Update in hours

Stakeholders Costs & Benefits

- Cost:

Stakeholder: / Model:	Philips	System Architect	Project team	Third parties	Customer/ User
Workflow 	• Microsoft office Tools	• 4 days work in total • 2 hours fast iterations • 1 day longterm iterations • Learn to animate (plugin ProE)	• Deliver 3D models • Workflow interviews • Attend project workshops	• Deliver 3D models of products	• 2 hours interview about requirements • Time to Review models • Information about operators
Function 	• MS office Tools	• 2 hours work • Update in 1 hour per iteration	• Project workshops		

Stakeholders Costs & Benefits

- Benefits:

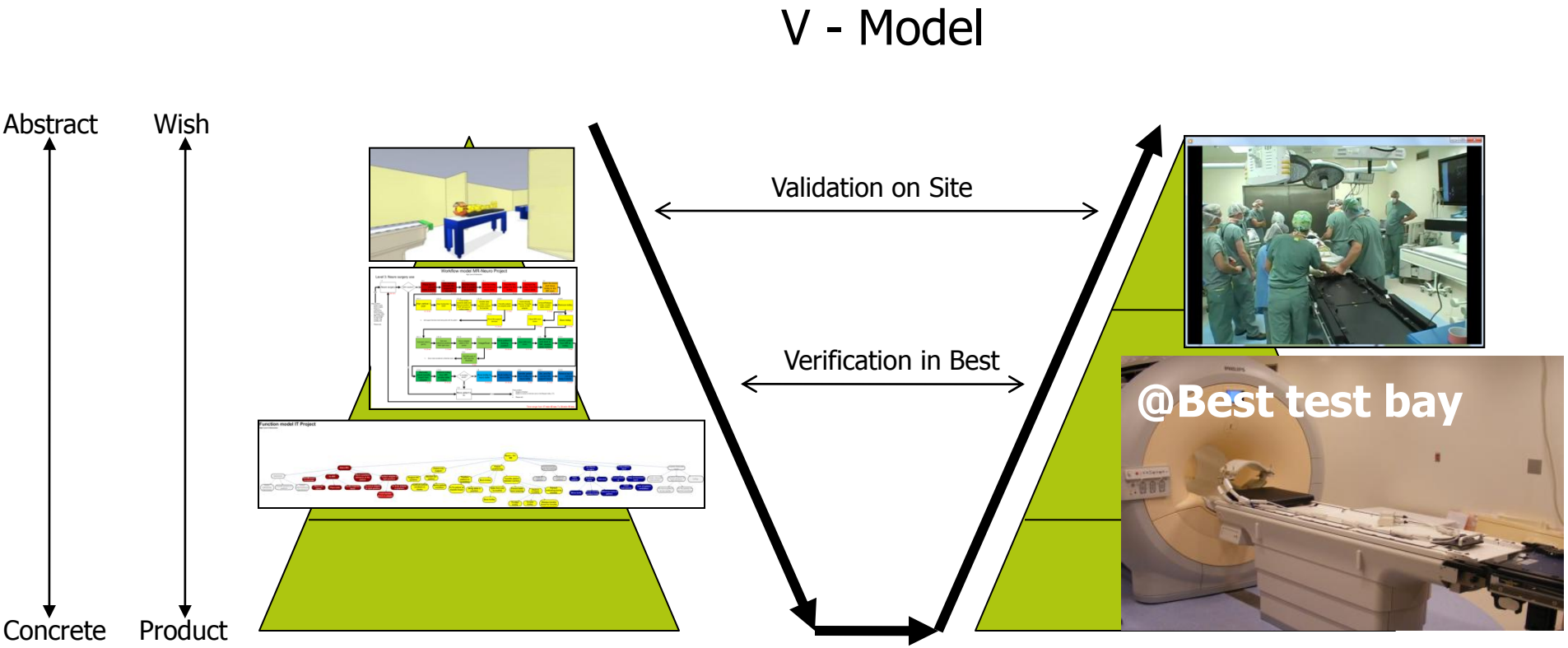
Stakeholder: / Model:	Philips	System Architect	Project team	Third parties	Customer/ User
Workflow 	• System understanding in simple words • Express Legal accountability	• Completeness check • Explicit model of use • Can be put up for review to customer • Denote responsibilities of stakeholders	• Explain concept • Communication catalyst between engineers and other disciplines • Reveal timing issues • Verification and Validation	• System understanding • See part for which they are responsible	• Something to agree or disagree with • Can be reviewed • Input to design process • System understanding • Validation
Function 	• Shows system in context to other Philips projects	• Abstract, decomposable system model • Implementation independant layers • Intuitive language • Complete overview of design task	• Reveals design decisions and line of reasoning • Decomposition • Capture design decisions		

Results

- Workflow models used in Philips Project Documentation and Presentations
- Satisfied Customer
  - Involved early
  - Validation
  - First Surgeries Succes and Immediate Added Value of patient transfer → Residual Tumor tissue discovered with aid of MRI
- Transparant Solution
  - “Sense and Simplicity”

Result

Recapitulation



Discussion

- Workflow modeling was just a small contribution to the succes of the MRI – Neuro Surgery project
- Focus on functional requirements, not the only requirements
- Function modeling was not yet fully integrated in the architecting process
- Medical Systems are well suited to describe using workflow, other systems might be less suited.

Conclusions

- Workflow models are potential bridges between the user workflow requirements and the system architecture
- The workflow models have been succesfully applied in the MR-Neuro project and will be applied in the next project

Thank you!

7-12-2009

Thom van Beek