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.
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

[Bahl & 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]

[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

```
User
| Desired Workflow

Model of Workflow

System Architecture
→ Functions → Components
```
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
  - Transparency
- 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 MR-Neuro Project

Level 3: Neuro surgery use

- Neuro surgery
- MRI needed?
  - yes: Prepare patient for transfer
  - no: Move patient to IC
    - yes: MRI Exam of Patient
    - no: Is surgery done?

- Move trolley to neuro table

- Transfer patient to MRI patient support

Time range from 17 min 45 sec to 34 min 19 sec.
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
Workflow – Function connection example

Workflow naturally described as function! Checklist.

Dock trolley to the FRONT of the MR

Transfer patient to the MRI, undock trolley & close doors

Move trolley

Transfer patient between carriers

Slide from one to another

Prevent table form lowering

Dock to modality
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:

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

- 2 hours interview about requirements
- Time to Review models
- Information about operators

### Attend project workshops

- Deliver 3D models of products
- Information about operators

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## Stakeholders Costs & Benefits

### Benefits:

<table>
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<tr>
<th>Workflow</th>
<th>Function</th>
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<tr>
<td>Model:</td>
<td>Stakeholder: Philips</td>
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<tr>
<td>Stakeholder: Philips</td>
<td>- System understanding in simple words</td>
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<td>- Express Legal accountability</td>
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<td>- Can be put up for review to customer</td>
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<td>- Denote responsibilities of stakeholders</td>
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<td>- Shows system in context to other Philips projects</td>
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<td>- Implementation independant layers</td>
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<td>- Intuitive language</td>
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<td>- Complete overview of design task</td>
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Capture User Requirements using Workflow Scenarios
Results

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

V - Model

Validation on Site

Verification in Best

@Best test bay
Discussion

- Workflow modeling was just a small contribution to the success 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 successfully applied in the MR-Neuro project and will be applied in the next project
Thank you!

7-12-2009

Thom van Beek