Abstract

Architects in the high-tech world are from origin often splendid technologists. Breadth of know-how enables them to design technically balanced systems. Unfortunately not every technically balanced system is also good and useable. Design for useability requires quite some context know-how especially application know-how.

This presentation positions the architecture discipline as a means to create good, useable and technically balanced systems. The system architect fulfils a central role. More than ever the system architect needs business and application insight to give direction to the technical design process.
Presentation flow

- Case: MRI scanner
- Follow the system architect bottom up through the MRI scanner
- "CAFCR" framework
- The role of the system architect
- How does a system architect work?
- Conclusion
Illustration case: MRI scanner
Physics view

Gradient Coil
40 mT/m/ms

Magnet
3T, ...

RF coil, Eff vol. =
Software architecture view

- Property editor
- Application
  - Session manager
  - Spool server
- Broker
  - Queue manager
- NameSpace server
- Transparant Communication
  - Resource scheduler
  - Configurable pipeline
- Event manager
- Monitor
- Compliance profile
  - Abstraction Layer
- Registry
- Plugin framework
- Device independent format
  - Plug & play
- Persistent Storage
MR imaging methods view

RF

Gz

Gx

Gy

TR

TE
Conceptual Work by the architect

- Most disciplines require multiple views, for instance circa 4 views in SW [Kruchten, Soni]
- Only a subset of disciplines has been shown (not shown are a.o. mechanics, logistics, project management)

The **system architect integrates** the **complementing disciplinary views**

However

Decisions and trade-offs in the **conceptual view** are driven by **application**, **business** and **operational** inputs
Useability and main stakeholders

The engineer creates a technological UI...

without imagining the clinical reality

Select Virtual Representation Display Mode

- Intermittent
- Adaptive
- Semi-Reflective

0.2 Fuzzle Factor

Patient Jansen has been removed

OK

"In the meantime the patient is horrified by the intimidating system, the weird cage around his body and the EKG leads attached to his breast..."
Radiology department view

MR Examination room

Control room

"MPR" room

CT Examination room

Control room

Reading Room
Cardio application drivers and related features

Application
- Look at snapshots of heart movements
- Look at anatomical details: vessels, wall motion
- Diagnosis of heart anomalies
- Patient accessibility
- Prevent claustrophobia
- Patient handling
- Duration of patient stay

Functional
- Short acquisition time (20 ms)
- Fast high contrast, imaging method (TR, TE,...)
- SNR
- Relevant contrast
- Tage-Arno like viewing

Conceptual
- Magnet homogeneity
- Gradient rise time
- Heart RF coil
- High throughput acquisition and reconstruction
- High throughput image processing and display
Cardio Market Model

- Patient
- Referring Physician
- Cardiology Department
- Siemens, GE MRI scanner
- Philips MRI scanner
- Cardiology Information System
- X-ray Ultra Sound Systems

Competition
Complementors

From Techno-nerd to Stakeholder Representative
Gerrit Muller
Cardio Business Model

Employer

Insurance company

Patient

Care

Insurance premium

Pay per ...

Government

Legislation

Cardiology department

Competing Cardio centers

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version: 0.5
14th November 2000
MRcardioBusinessModel

PHILIPS Research
IST - SWA - IA
# Cardiology business drivers

<table>
<thead>
<tr>
<th>Key Business drivers</th>
<th>Derived Application drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recuperation rate</td>
<td>Diagnosis of heart anomalies</td>
</tr>
<tr>
<td>Mortality rate</td>
<td>Patient Accessibility</td>
</tr>
<tr>
<td></td>
<td>Duration of patient stay</td>
</tr>
<tr>
<td></td>
<td>Patient emergency access</td>
</tr>
<tr>
<td>Cost/treatment</td>
<td>Patient monitoring capabilities</td>
</tr>
<tr>
<td>Attractiveness</td>
<td>Department image</td>
</tr>
<tr>
<td></td>
<td>Clinical workflow</td>
</tr>
<tr>
<td></td>
<td>Integration with information systems</td>
</tr>
</tbody>
</table>

Interventional support
Prevent claustrophobia
Patient handling
Business and application understanding by the architect

- Only a subset of required views has been shown (not shown are a.o. information model, workflow, stakeholders and stakeholder concerns)

- Marketing and application specialists are the primary owners

The system architect needs to understand the context to make a good and useable design
System Architect integrates 5 viewpoints

What does Customer need in Product and Why?

Customer What

Customer Application

Product Functional

Product Conceptual

Product Realization
Context of the context

- Consumer
  - Drives
  - Enables
  - Value Chain
    - larger scope has smaller influence on architecture

- Customer's Business
  - Drives
  - Enables

- Customer Business
  - Drives
  - Enables

- System (producer)
Integration of 5 views

Customer business
Application
Functional
Conceptual
Realization

Integrating Views

High margin Cardiology market
Cost per examination model
Patient throughput features
System throughput model
Budget in seconds
Organizational questions w.r.t. the System Architect

- Who is this system architect?
- What is his task?
- What are his responsibilities?
- What is his role?
- Where does he fit in the organization?
The System Architect is the generalist of the team
Deliverables of a System Architect
Responsibilities of a System Architect

- Balance
- Consistency

Overview

Requirement Spec Design Realization

Decomposition Integration

Module Subsystem System

Quality Function

Overview

Elegance Simple

Integrity

KISS

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RoleSAresponsibilities
### Examples of Secondary Responsibilities

<table>
<thead>
<tr>
<th>responsibility</th>
<th>primary owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>business plan, profit</td>
<td>business manager</td>
</tr>
<tr>
<td>schedule, resources</td>
<td>project leader</td>
</tr>
<tr>
<td>market, salability</td>
<td>marketing manager</td>
</tr>
<tr>
<td>technology</td>
<td>technology manager</td>
</tr>
<tr>
<td>process, people</td>
<td>line manager</td>
</tr>
<tr>
<td>detailed designs</td>
<td>engineers</td>
</tr>
<tr>
<td>useability</td>
<td>application manager</td>
</tr>
</tbody>
</table>
What does the System Architect do?

- Think, analyse
- Listen, talk, walk around
- Design, brainstorm, explain
- Assist project leader with work breakdown, schedule, risks
- Present, meet, teach, discuss
- Write, consolidate, browse
- Read, review
- Test, integrate
- Travel to customer, supplier, conference

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Visible output versus invisible work

From Manager perspective

Decreasing Visibility

Deliverables

Responsibilities

Activities

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RoleSApyramid

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## Bottom-up elicitation of system characteristics

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity (order of magnitude)</th>
<th>architect time per item</th>
</tr>
</thead>
<tbody>
<tr>
<td>consolidation in deliverables</td>
<td>10</td>
<td>100 hrs</td>
</tr>
<tr>
<td>meetings</td>
<td>$10^2$</td>
<td>1 hr</td>
</tr>
<tr>
<td>touched details</td>
<td>$10^4$</td>
<td>0.5..10 min</td>
</tr>
<tr>
<td>seen details</td>
<td>$10^5..10^6$</td>
<td>0.1..1 sec</td>
</tr>
<tr>
<td>product details</td>
<td>$10^7..10^{10}$</td>
<td></td>
</tr>
<tr>
<td>real world facts</td>
<td>infinite</td>
<td></td>
</tr>
</tbody>
</table>
From scenario to budget

<table>
<thead>
<tr>
<th>Customer business</th>
<th>Application</th>
<th>Functional</th>
<th>Conceptual</th>
<th>Realization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario:</td>
<td></td>
<td>Typical Case:</td>
<td>Models</td>
<td>Technical estimates</td>
</tr>
<tr>
<td>Easy accessible</td>
<td></td>
<td>Functions and Quantification of</td>
<td>Functional and Performance</td>
<td></td>
</tr>
<tr>
<td>story, clearly outlining a frequently occurring situation with a valuable, but challenging solution</td>
<td></td>
<td>frequently occurring important and critical case</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Several iterations are required. In later iterations worst cases and exceptional cases are taken into account. The technical estimates are then transformed in budgets.
Architects must increase customer side contribution

- Current Architects
- Required Architects

customer, business, application, functional, conceptual, realization
Acknowledgements

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www.it4humans.org