CHANGE IMPACT ANALYSIS ON COMPONENT BASED DESIGN USING FEATURE MODELS

Software Architecture Evolvability

Nicolas Dintzner, Martin Pinzger
SERG, Delft University of Technology
Context

- Product Line
- Re-engineering of major components
- Known upcoming changes
- Changes in the system’s environment
Question

Can we design today our system in such a way that integration of future external components will be simple?
Feature models to describe change

System under study

System features

- Table Movements
  - Table Translation
    - Longitudinal
  - Table Rotation
    - Lateral
    - Rotate X
    - Rotate Y

External system(s)

External features

- Tables
  - TABLE_1
  - TABLE_2
  - NEW TABLE

Composition rules

- "TABLE_2" implies "Rotate X" and "Rotate Y"
- "TABLE_1" implies "Rotate X"
- "NEW TABLE" implies "Lateral"
Linking feature models and design

System features
- Table Movements
  - Table Translation
  - Table Rotation
    - Longitudinal
    - Lateral
    - Rotate X
    - Rotate Y

External features
- Tables
  - TABLE_1
  - TABLE_2
  - NEW TABLE

Realizes

System design

Designed for
Input: component design annotations

Movement controller

Translation controller

*Table translation*

*TABLES*

Table 1 Controller
*Longitudinal – Lateral*

*TABLE_1*

Table 2 Controller
*Longitudinal – Lateral*

*TABLE_2*

Rotation controller

*Table rotation*

*TABLES*

Rotation X
*Rotate X*

*TABLE_1, TABLE_2*

Rotation Y
*Rotate Y*

*TABLE_2*
Input: product configurations

- Existing product configurations

<table>
<thead>
<tr>
<th>CONFIGURATION 1:</th>
<th>CONFIGURATION 2</th>
<th>CONFIGURATION 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Movements</td>
<td>Table Movements</td>
<td>Table Movements</td>
</tr>
<tr>
<td>Table Translation</td>
<td>Table Translation</td>
<td>Table Translation</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>Longitudinal</td>
<td>Longitudinal</td>
</tr>
<tr>
<td>Table Rotation</td>
<td>Lateral</td>
<td>Table Rotation</td>
</tr>
<tr>
<td>Rotate X</td>
<td>Table Rotation</td>
<td>Rotate X</td>
</tr>
<tr>
<td>TABLES</td>
<td>Rotate Y</td>
<td>Rotate Y</td>
</tr>
<tr>
<td>TABLE_1</td>
<td>TABLES</td>
<td>TABLES</td>
</tr>
</tbody>
</table>

- “New” configurations

<table>
<thead>
<tr>
<th>CONFIGURATION 4: NEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Movements</td>
</tr>
<tr>
<td>Table Translation</td>
</tr>
<tr>
<td>Longitudinal</td>
</tr>
<tr>
<td>Table Rotation</td>
</tr>
<tr>
<td>Rotate X</td>
</tr>
<tr>
<td>Rotate Y</td>
</tr>
<tr>
<td>TABLES</td>
</tr>
<tr>
<td>NEW TABLE</td>
</tr>
</tbody>
</table>
Impact computation process

1. Feature model, configurations, design
2. Compute all feature interactions
3. Filter irrelevant interactions
4. Locate interactions in design
5. Impact Report
Initial set: all interactions

 repeater for all system features (28 interactions in total)
Impact computation process

1. Feature model, configurations, design
2. Compute all feature interactions
3. Filter irrelevant interactions
4. Locate interactions in design
5. Impact Report
Filtering interactions

- Configuration filtering
  - pairs that do not appear together in at least one configuration file
    → *features not packaged together do not interact*

- Implementation filtering
  - pairs that are not implemented by at least one component
    → *features separate by design do not interact*

- Relevance filtering
  - system features that do not interact with the new feature
    → *irrelevant to the analysis*
Impact computation process

1. Feature model, configurations, design
2. Compute all feature interactions
3. Filter irrelevant interactions
4. Locate interactions in design
5. Impact Report
Locating the impacts on design

• Based on
  • the remaining interactions
  • distribution of features on components (parent, siblings and subs)

• Impacts:
  • None
  • Introduce variability
  • Extend variability
  • Potential impact depending on abstraction stability
Locating the impact: example

[longitudinal]-[NEW TABLE]  [longitudinal]-[MAGNUS]  [longitudinal]-[AD7]

Table 1 Controller
Longitudinal – Lateral
TABLE_1
[longitudinal]-[TABLE_1]

Table 2 Controller
Longitudinal – Lateral
TABLE_2
[longitudinal]-[TABLE_2]

NEW COMPONENT
Longitudinal – Lateral
NEW TABLE
[longitudinal]-[NEW TABLE]
Impacted components

Movement controller

Translation controller

Table_1 Controller

Table_2 Controller

Rotation controller

Rotation X

Rotation Y

[rotate x]-[TABLE_1]

[rotate x]-[TABLE_2]
Extend variability

[rotate y]-[TABLE_2]
Introduce variability

[table rotation]-[TABLES]
Potentially impacted

[rotate x]-[TABLES]
Extend variability
Change impact analysis on component based design using Feature Models

Can we design today our system in such a way that integration of future external components will be simple?

Impact Report

Contact:
Nicolas Dintzner
N.J.R.Dintzner@tudelft.nl