Center for
Human-Computer Interaction
Department of Computer Sciences

UNIVERSITÄT SALZBURG

Reliability Displays in Building Information Modeling: A Pattern Approach

Alexander Mirnig[1], Peter Fröhlich[2], Johann Schrammel[2], Damiano Falcioni[3], Michael Gafert[2], Manfred Tscheligi[1]

[1]Center for Human-Computer Interaction, University of Salzburg, Austria

[2]Center for Technology Experience, AIT Austrian Institute of Technology GmbH, Vienna, Austria

[3]BOC Asset Management GmbH, Vienna, Austria

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Bio

Alexander Mirnig
Center for Human-Computer Interaction
University of Salzburg, Austria
alexander.mirnig@sbg.ac.at

Focus Areas

- Automated driving
  - Transitions on higher automation levels
  - Legal constraints for operation and deployment of automated vehicles
- Knowledge transfer
  - Transfer across disciplines
  - Patterns as transfer tools
- Trust
  - Trust calibration

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Current Projects

CALIBRaiTE

HADRIAN

Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

https://hadrianproject.eu

Digibus® Austria

www.digibus.at

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Reliability Displays – What are They?

Trust:

- A relation between two agents, in which one (trustor) depends on the achievement of the other agent's (trustee) goals.
- Characterized by uncertainty, vulnerability = risk

Reliability:

- A quality of consistently aiding to achieve the user's goals to a certain degree (positive or negative)

Reliability Displays – What are They?

Reliability Display:

- A display containing interface elements that serve to communicate the expected reliability (correctness) of data presented to the user.

- In addition to the "raw" output, there are additional indicators allowing the user to estimate how reliable the output s/he is working with is.

- → Trust calibration

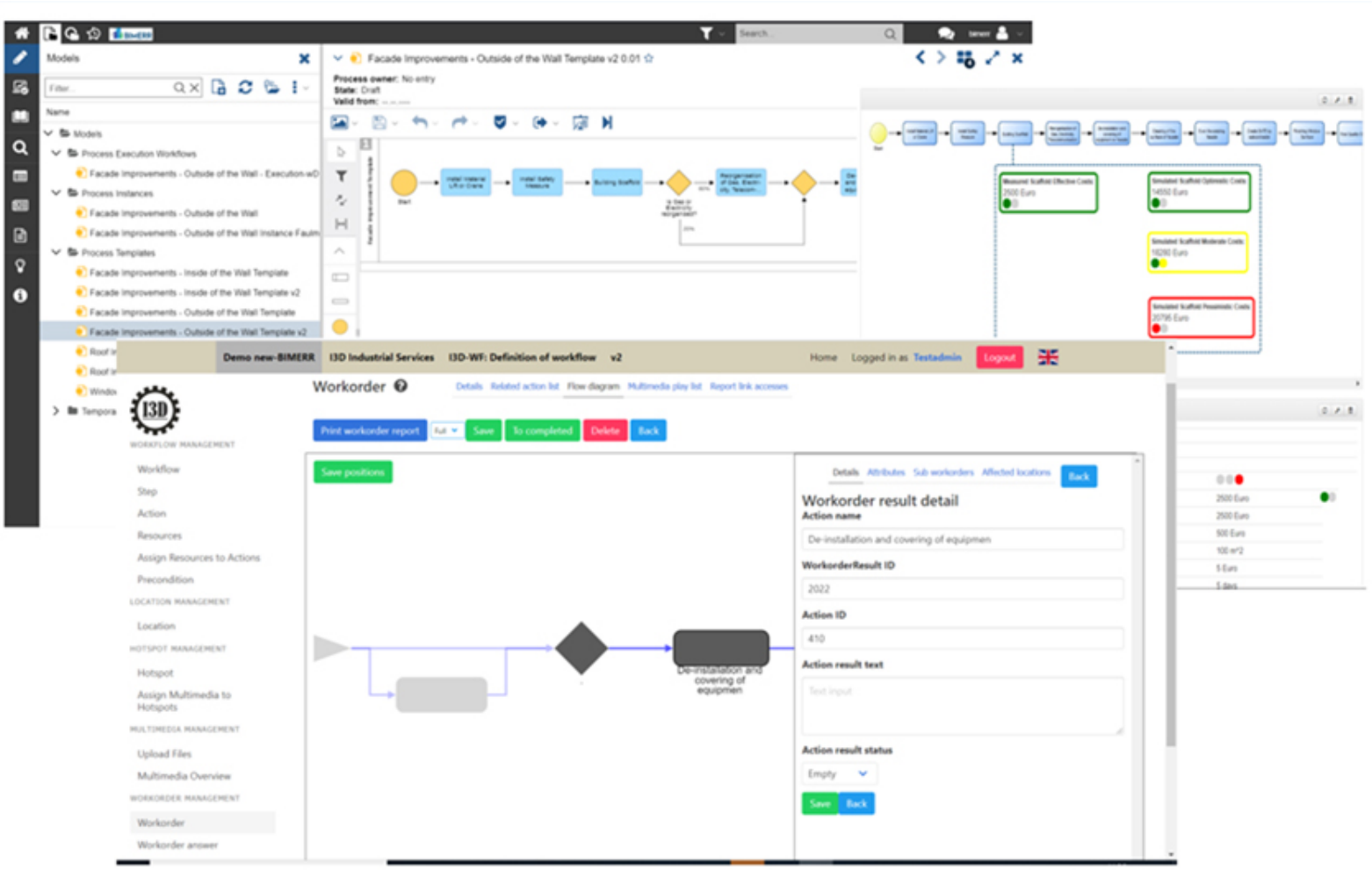
The Context: BIM

Building Information Modeling

- Digital representation of a building process

- Computer models (often 3D) supplemented with – and connected to – data relevant to the execution of the building process

The Context: BIM



Source: https://bimerr.eu/wp-content/uploads/2020/06/Bimerr-Process-Workflow-Modelling-Automation-Toolkit.jpg

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The Context: BIM

Challenges

- Requirement for entire construction value chain to use consistent BIM tools
- High learning curve on behalf of architecture and construction professionals
- Size and Processing load induced by BIM models

The Context: BIM

Perceived Benefits

- Reduction of critical mistakes and omissions
- Improving collaboration between stakeholders, thereby:
  - Enabling lower costs through less rework
  - Removal of additional documentation efforts
  - Higher quality due to closer control.

→ Reliability displays to ensure these goals can be met

The Approach

1) Expert Interviews

2) Requirements Extraction

3) Requirements Prioritization and Selection

4) Pattern Design

Requirements Analysis - Interviews

In-depth Interviews conducted with building process management experts (n=3)

Objectives

1) Which factors are most indicative of the data reliability in BIM process management?

2) How can these factors be integrated into UI designs to communicate data reliability to the user?

Requirements Analysis - Requirements

R1: The presentation of reliability displays should follow the degree of abstraction. Highlight upfront the level of detail of the model.

R2: The system should always highlight the properties and restrictions of the underlying model, including uncertainties in representing the reality.Furthermore, the nature of the analysed object with regard to the related expected uncertainty/accuracy should be shown.

R3: It should be possible to filter system output (both with regard to data protection and to usability).

R4: It should be possible to define who provided an input and the related chosen approach.

Requirements Analysis - Requirements

R5: There should be a clear indication on who provided an input, estimation or prognosis. In addition, the system should show how this input was provided, with regard to the applied method, the used system, the user role and expertise

R6: The system should provide cues and detailed information on whether the considered building model or respective estimations have undergone previous reliability checks. To make this indicator meaningful, it is necessary to also show whether the software output has been surveyed by an expert to disambiguate them and to filter for relevancy in the given context.

R7: In the case that AI is involved in the processing of the data, it would be necessary to provide an indication on which underlying data and models a respective estimation or prognosis has been made.

Requirements Analysis - Requirements

R8: The time period of data input as well as its relation to the respective billing period should be displayed. This should encompass ranges of default threshold values beyond which the provided data is deemed unreliable. The underlying assumption is that a closer match of data input with the actual billing period indicates its level of detail and correctness.

R9: The system should provide cues on which of the renovation project deliverables is subject to a contractual penalty related to quality or time delays. In case of existence of such a penalty, a higher reliability is ascribed to it.

Requirements Analysis – Prioritized Requirements

R5: Provide clear indication on who provided an input, estimation or prognosis. And how this input was provided with regard to the applied method, the used system, the user role and expertise

R8: The time period of data input as well as its relation to the respective billing period should be displayed.

R9: Provide cues on which of the renovation project deliverables is subject to a contractual penalty related to quality or time delays.

Pattern 1 – Expertise-Based User Roles (R5)

Problem

The data that feeds the system comes from a variety of sources of unequal reliability, depending on

- whether whoever entered the data held the appropriate role to do so
- a sufficient level of expertise to minimize errors or oversights

Solution

Rights management that considers these aspects in the account parameters

- User type (human or other system)
- Role
- Level of expertise

Pattern 1 – Expertise-Based User Roles (R5)

Solution

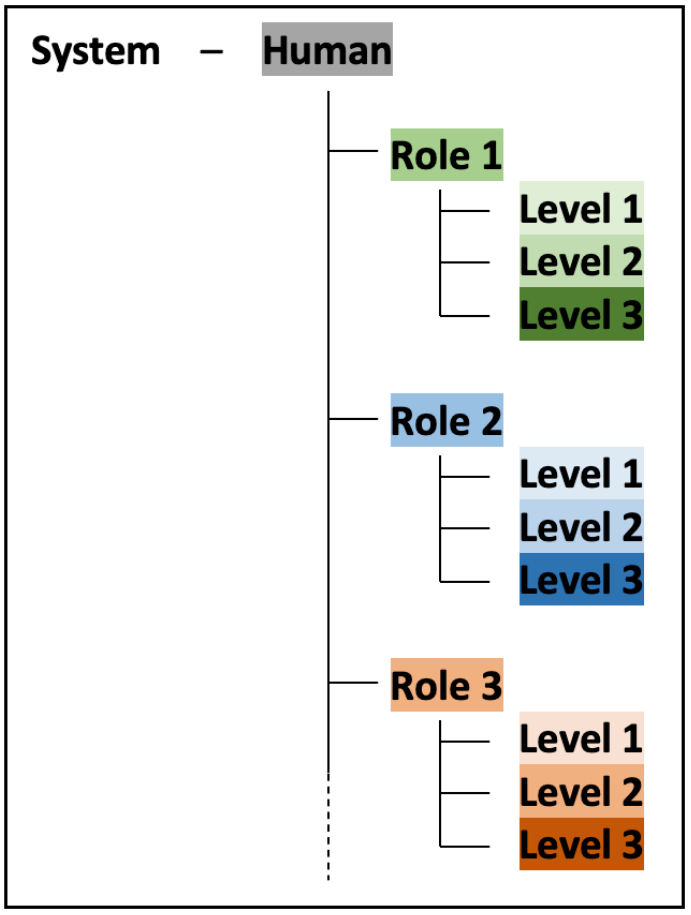
Account hierarchy with color-coded role and expertise indicators

Predefined metrics with regard to

- roles within context

  e.g., site manager, foreman, project manager, ...

- Level of expertis per role:
  - Years of experience in field
  - Volume (monetary) of previous projects
  - Valuation re. Whether neither, one or both thresholds are exceeded (= 3 Levels)



Pattern 2 – Reliability through Recency (R8)

Problem

The more distant events are, the more difficult they are to retrace for any individual who was involved with them. if the information available via documentation is incomplete, inaccurate, or otherwise insufficient, it becomes more difficult to correct such deficiencies.

Solution

Capturing and visualizing the temporal distance between data collection/availability and entry into the System.

Pattern 2 – Reliability through Recency (R8)

Solution

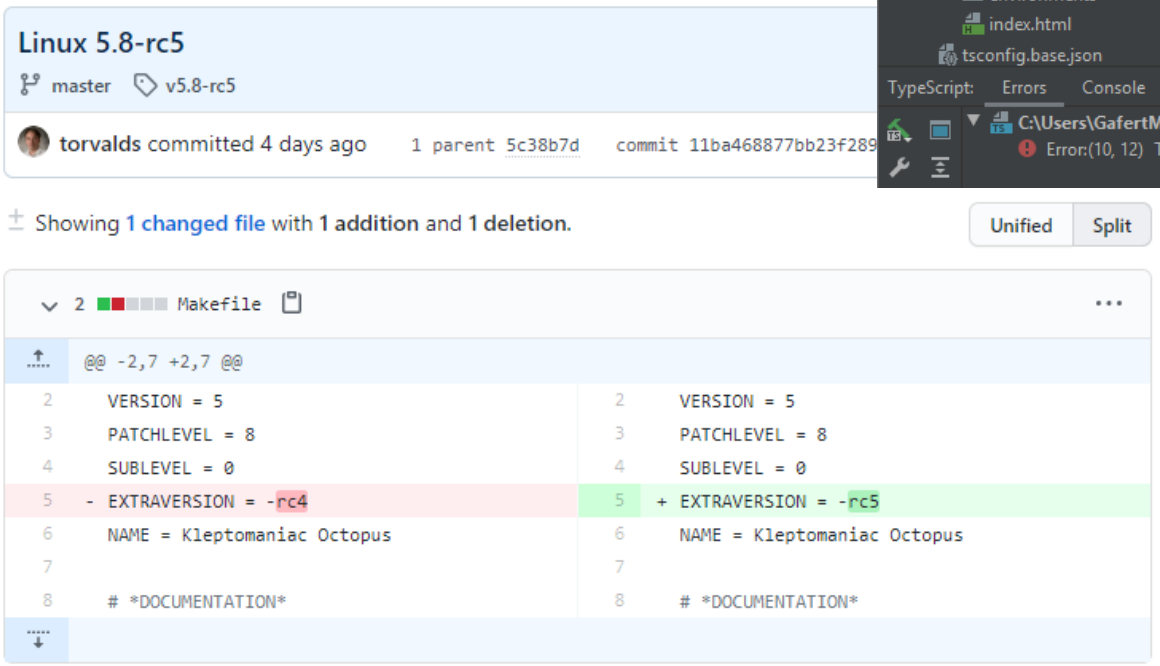
- Upon entry, each data item is flagged with the date on which it was entered.
- In addition, for each item the date of initial data collection or availability is entered.
- Define **reliability thresholds** for how close these dates match
- 3-Level system
  - Late vs. in time vs. with minor delay

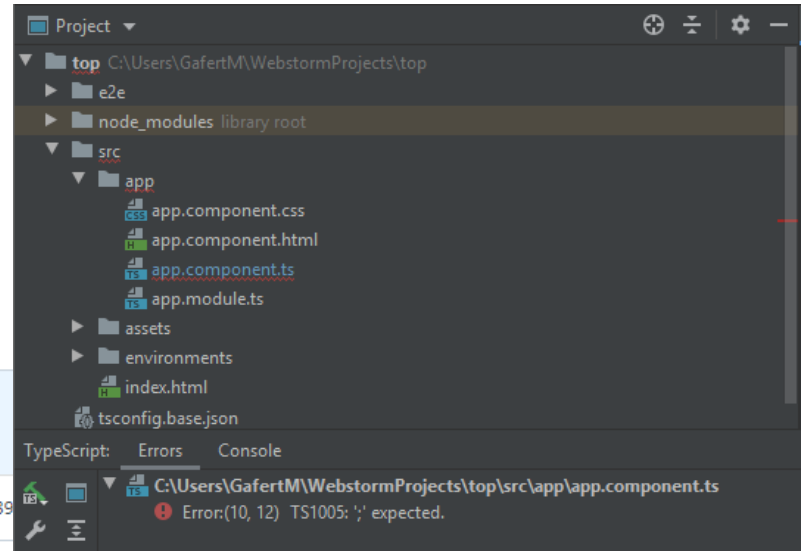
Pattern 2 – Reliability through Recency (R8)

Examples

Version history and version control

GitHub





WebStorm

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Pattern 3 – Reliability through Penalties (R9)

Problem

- Especially in larger projects, the care taken when capturing data can vary greatly between different stakeholder organizations as well as individuals within these organizations, with low data quality consistency as a result.
- Depending on how close an individual's or organization's goal match the goals of the overall project, the more reliable their input can assumed to be.

Solution

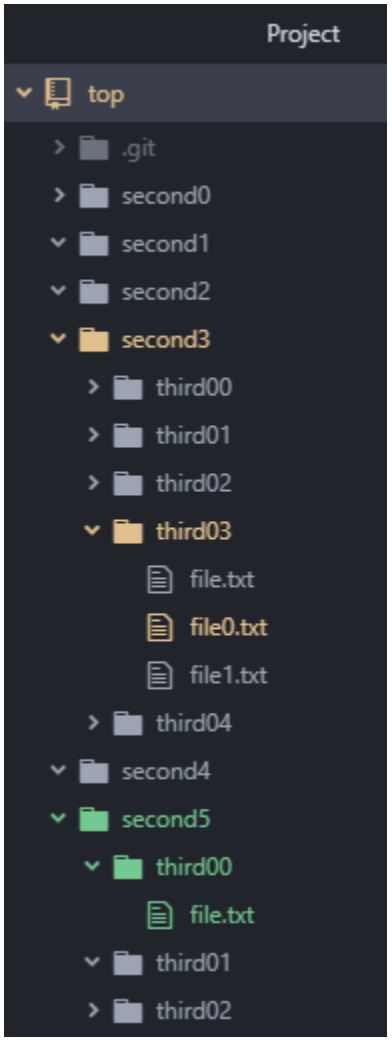
Capturing contractually stipulated monetary penalties and associating them with data items in the system

Pattern 3 – Reliability through Penalties (R9)

Solution

- Capturing contractually stipulated monetary penalties and associating them with data items in the system
- Hierarchical tree views to
  - Show presence of penalties at the top levels
  - Identify tasks or parts of projects *with and without* penalites
  - Identify items or partners/contractors associated with penalties at the lower levels

Important: even if presence of penalties can be used to indicate reliability, the inverse cannot be assumed.



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Wrap-Up

Visualize Reliability in the BIM-Context via:

- Rights management system with expertise-based user roles
- Indication of recency with regards to when data was entered
- Indicators for (contractually stipulated) penalties associated to roles, data sets, or items

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Contact

Alexander G. Mirnig
Center for Human-Computer Interaction
University of Salzburg

Jakob-Haringer-Straße 8 / Techno 5
5020 Salzburg

+43 662 8044/4834
alexander.mirnig@sbg.ac.at