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Informal (Behavior) Modeling for a (Medical) System

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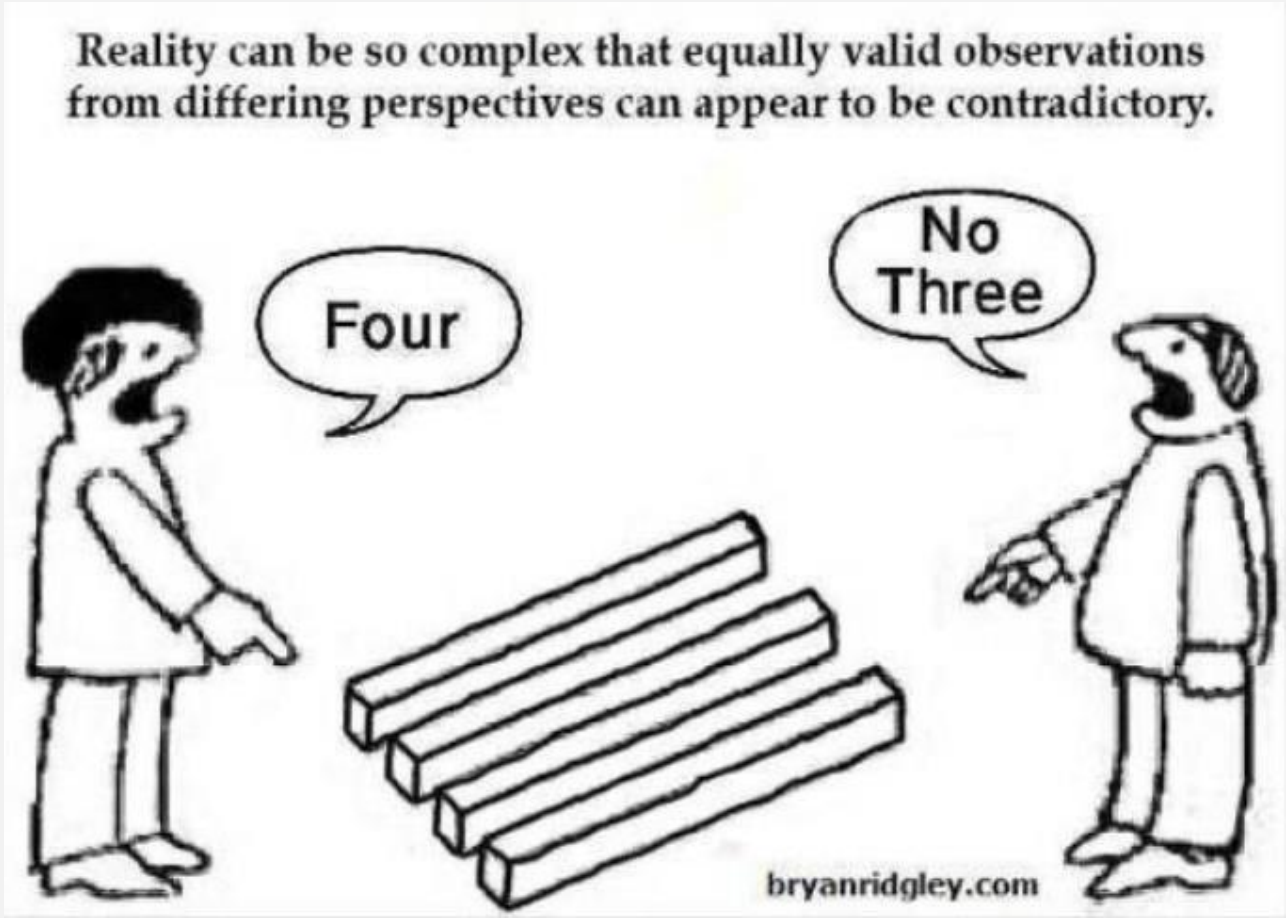


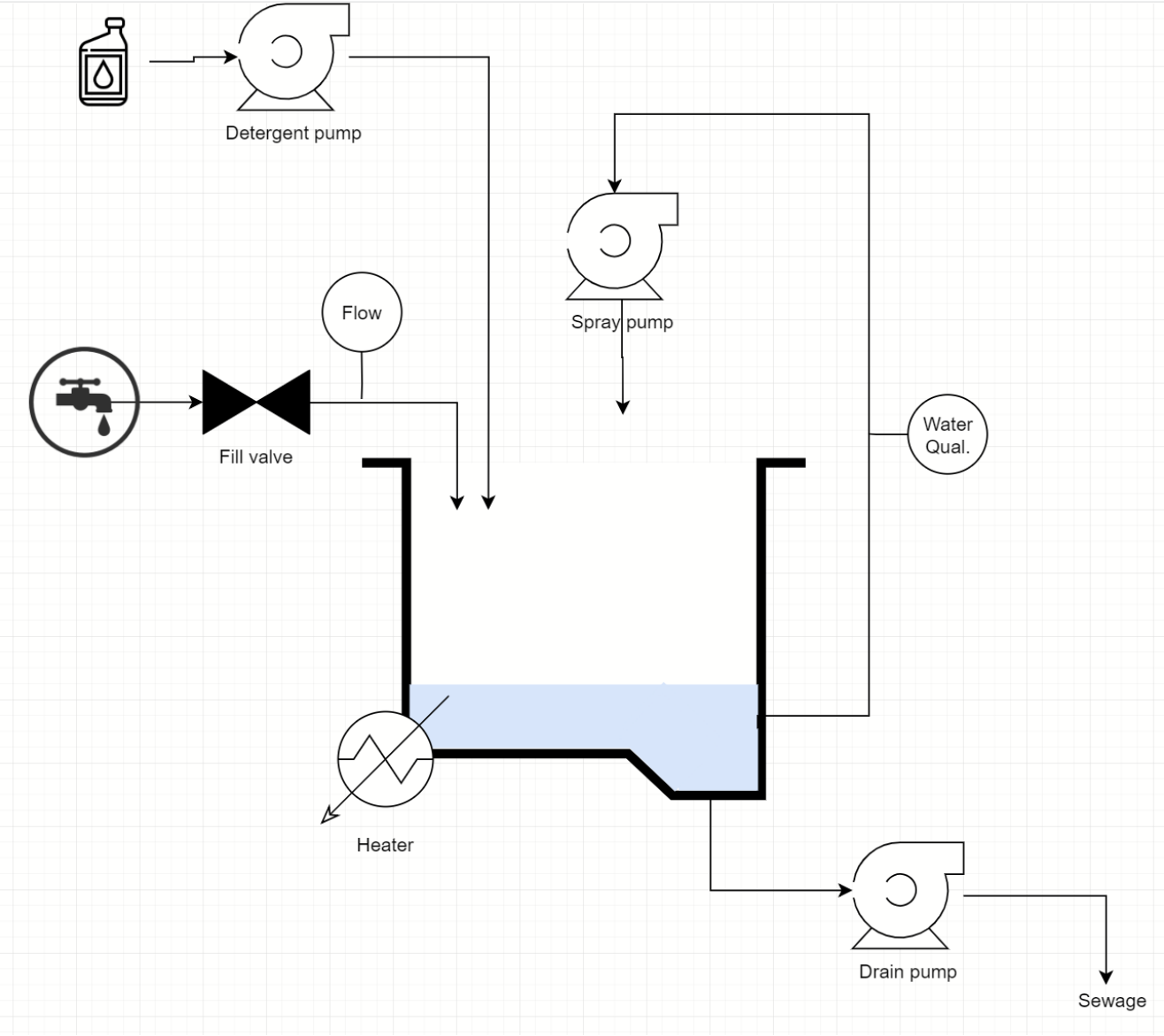
Introduction

- Context
- Anonymized example case
- Problems during project
- Gradually adding formalization (evolving tools and mindsets)
  - **Formalized text** and requirements
  - **Graphical notation** for behavior specification
  - Process **integration**, traceability, and status tracking

Context

- Sorry, details confidential ☹
- Medical cleaning system (V-model, medical standards such as IEC62304)
- Medium sized
  - Product family with international release (variability+regulations)
  - ±100 sensors/actuators
  - ± 300 software components (few thousand methods)
  - ± 300 error types

Example case : Parts

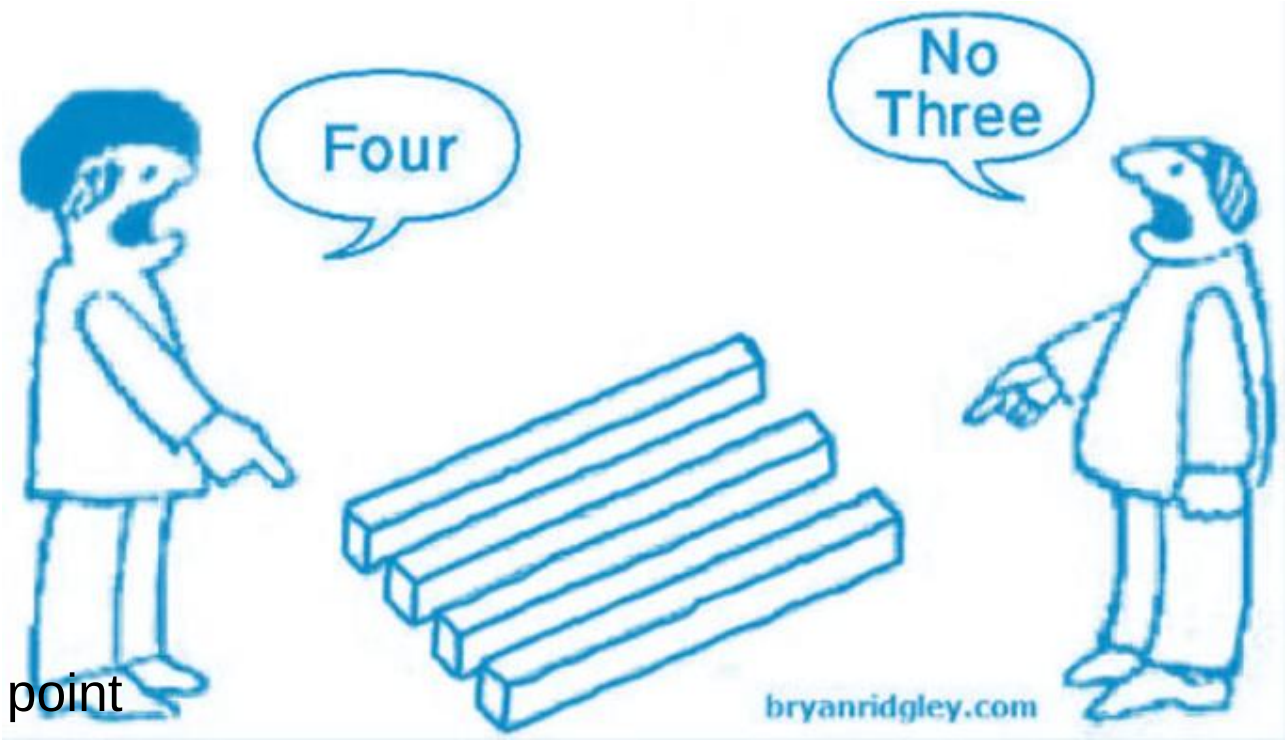


Example case: Program

Program:

- Rinse (hot)
- Wash
- Rinse (cold)

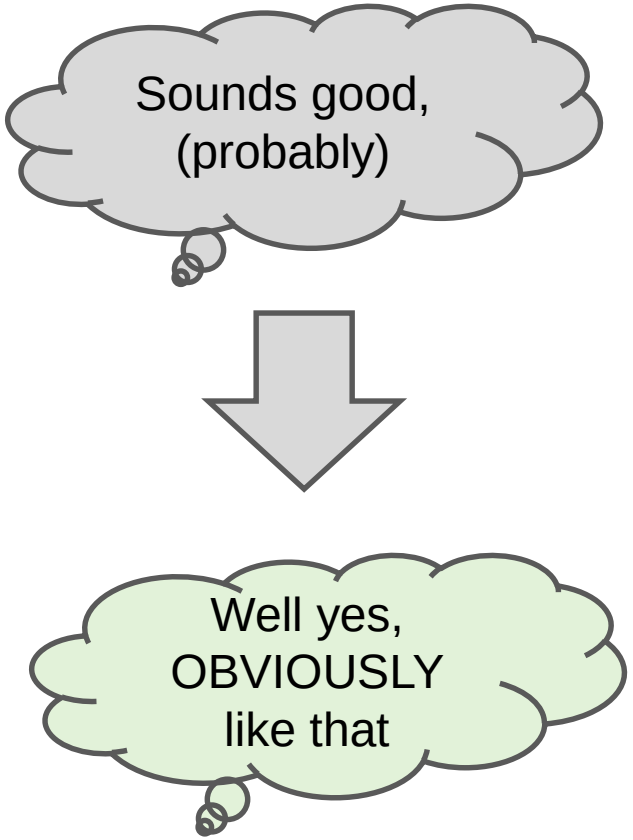
Problem – part 1



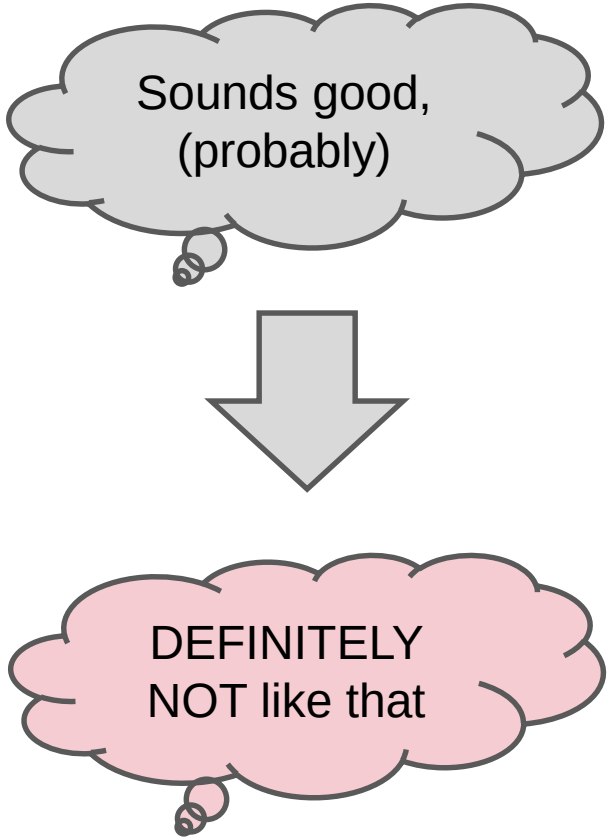
- Conflicting & changing statements
- Specs too high level
  - The system should clean
  - The system should have a unique selling point
- Ambiguous terminology
  - Clean: wash? rinse? spray?
  - Not qualified with critical parameters
- Focus on individual component design instead of system behavior

Problem – part 2 (feedback of domain experts)

When the spec is correct



When the spec is wrong



Text Formalization – part 1 (glossary in word processor)

Glossary Glossary

load:

Dishes in the dishwasher to be cleaned.

cleaning program:

A program designed to clean a load.

detergent:

water:

Move liquid at high speeds along the load to provide

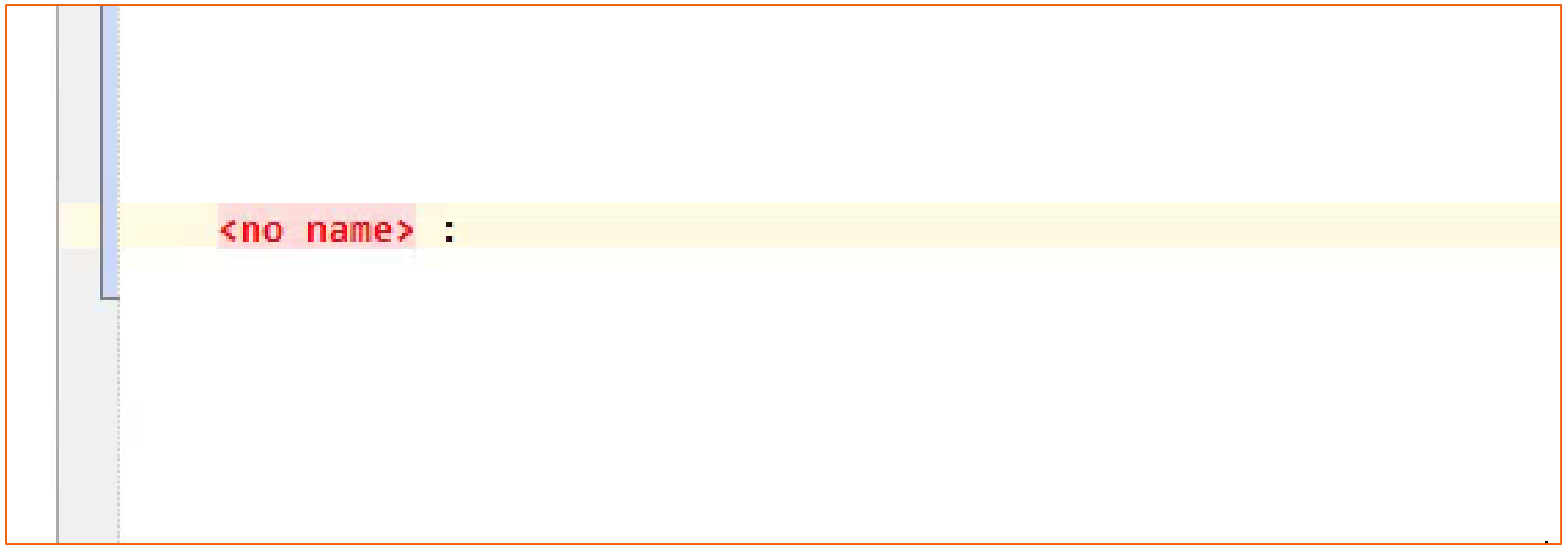
water:

Water provided by the public water supply system.

- Duplicate terms
- Not sorted
- …
- Maintenance hell

Text Formalization– part 2 (interaction)

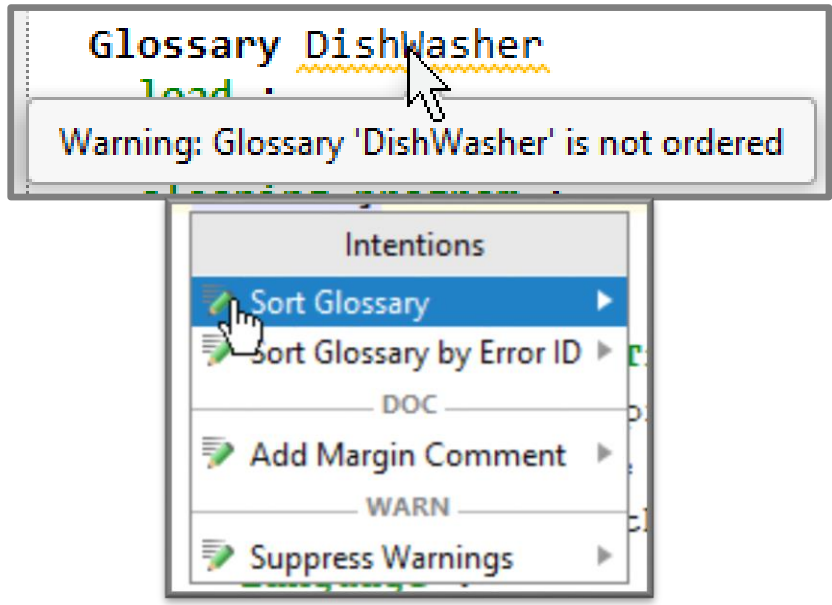
- Formalize a document (e.g. glossary) in modeling environment (MPS)
- Look&Feel: IDE with “Code completion” and “checks as you type”

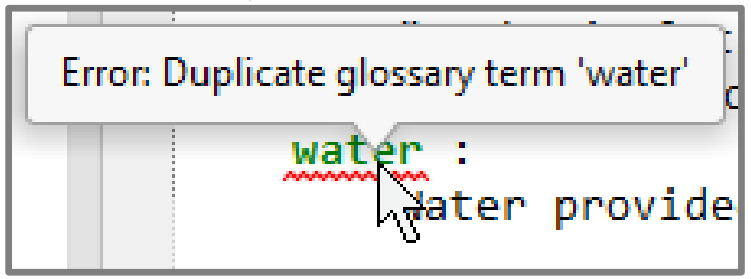


Text Formalization– part 3 (some features)

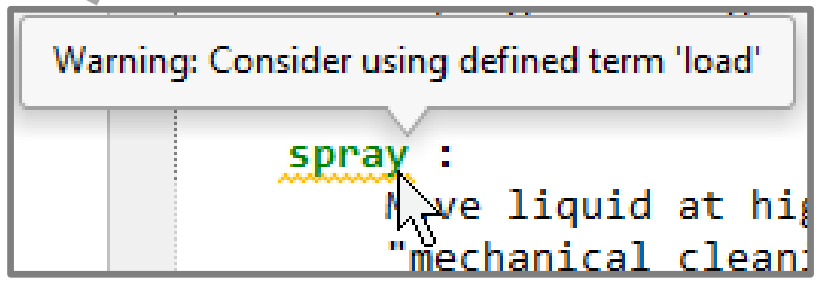
```
Glossary DishWasher
    load :
        Dishes in the dishwasher to be cleaned.
    cleaning program :
        A program designed to clean a load.
    detergent :

    spray :
        Move liquid at high speeds along the load to provide
        "mechanical cleaning" and bring the liquid
        (water with or without detergent) in contact with the load.
    water :
        Water provided by the public water supply system.
```

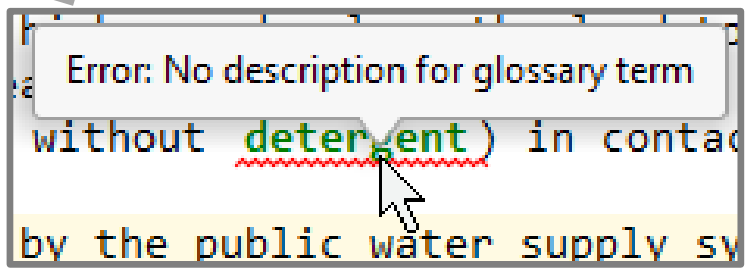




Not globally unique



Not formalized



Not described

Text Formalization – part 4

- We defined a vocabulary
- **Any text we write** (and review), uses that vocabulary
- A “compiler” to your document
- Details are “a hyperlink away”
- Use engineering practices on text:
  - change impact (usage) analysis
  - refactoring

Custom Formalization – (example: sensors/actuators)

- Required fields
- Additional specific checks

  (e.g. naming conventions)

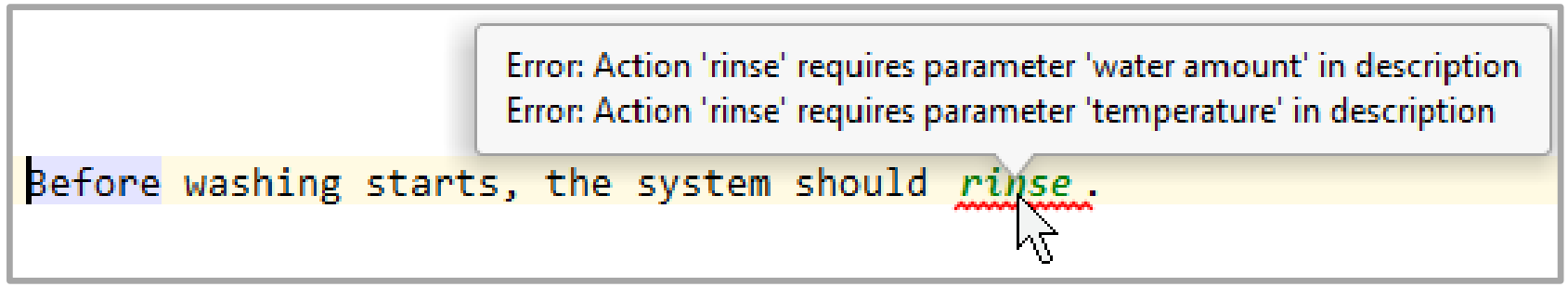
```
Glossary SensorsActuators
  actuator
    name:       Spray Pump
    hw name:    sprayer01
    connector:  CONN_A12
    pin:        DO34
  actuator
    name:       Drain Pump
    hw name:    sewagepump01
    connector:  CONN_A12
    pin:        DO35
  actuator
    name:       <no name>
    hw name:    <no hardwareName>
    connector:  <no pAndIName>
    pin:        <no pinName>
```

Custom Formalization – (example: actions with parameters)

```
action  rinse
  water amount :
      Amount of water for the rinse.
  temperature :
      Temperature to rinse on.
```

Introduce a “verb/action” with “parameters” in a glossary

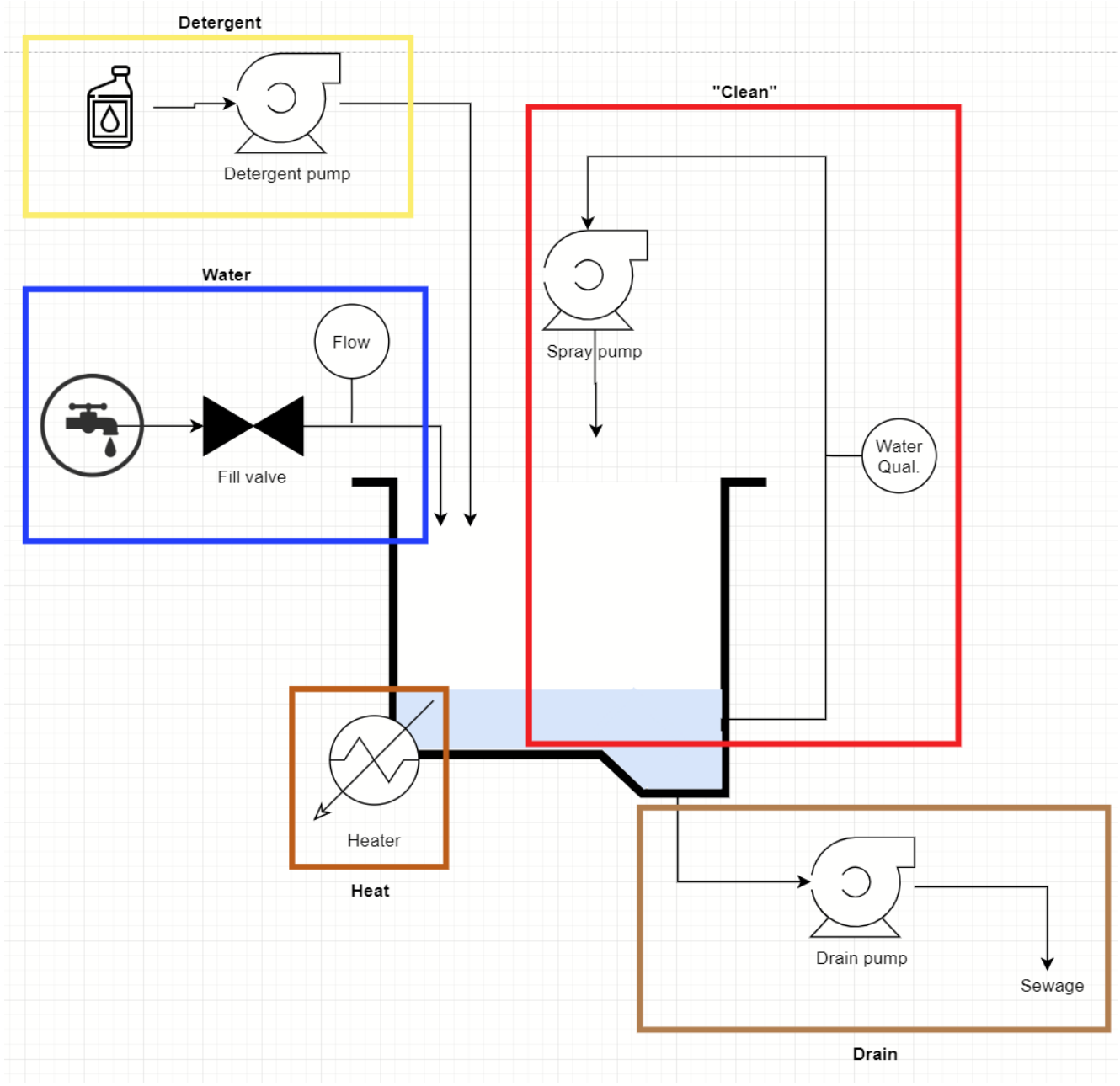
Informal parameters: “mention” of parmeter is enough




```
Before washing starts, the system should rinse .
The water amount (rinse) should always be more than 1 liter
and the temperature (rinse) should be high enough to dissolve fat.
```

Informal, but complete

Example case: “functions”

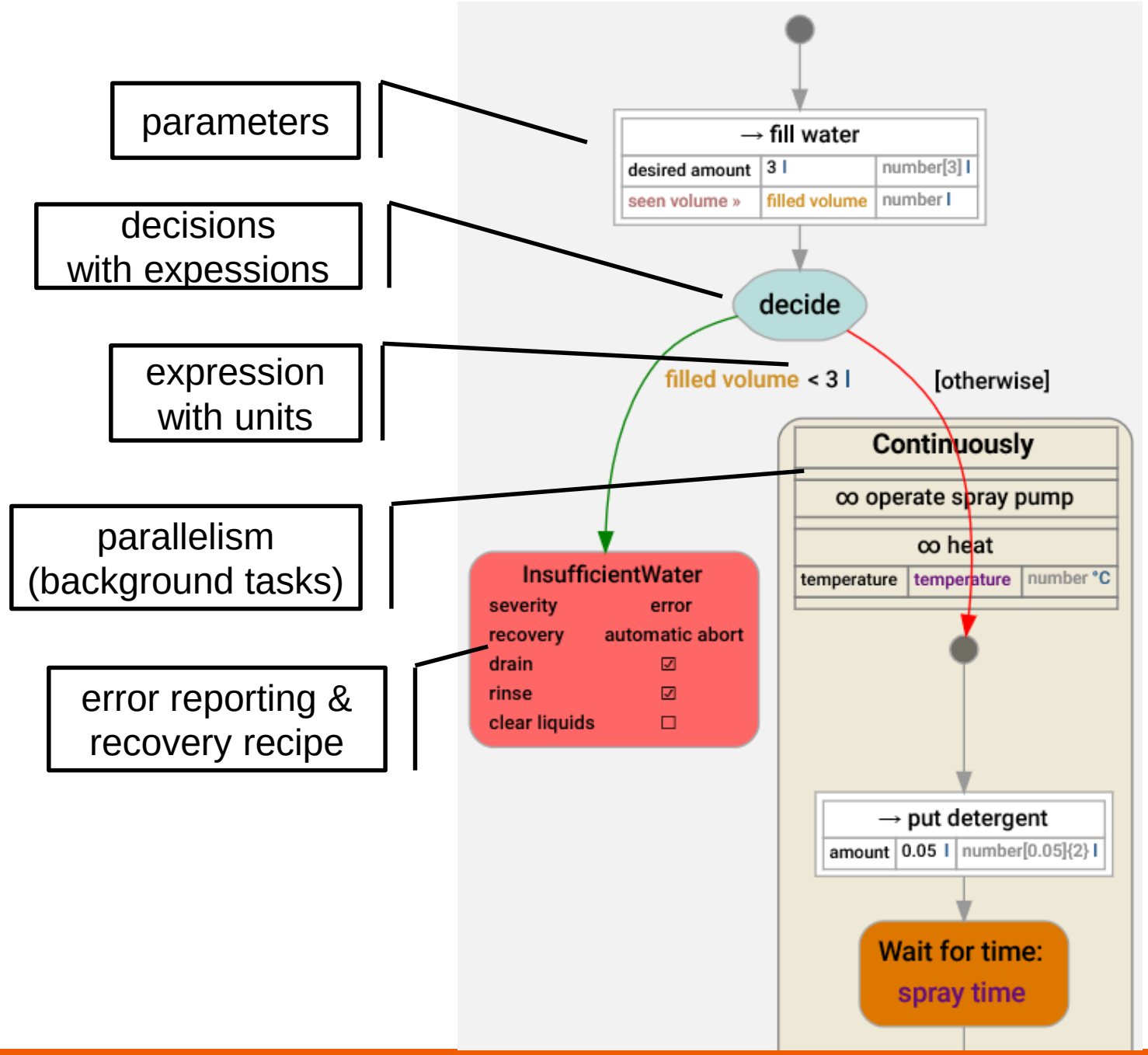


Graphical behavior modeling

- Look&Feel: Flowcharts (acceptable to domain experts)
- Flowchart extensions
  - reuse & parameters
  - nested contexts (background tasks/parallelism, “for each”, “controlled loops”)
  - errors & recovery recipes
- More formal expressions instead of text found in classical flowcharts

  (type-checked, units, decision tables, math, timed)
- Trick your experts into “almost programming” (but it doesn’t have to compile)

Graphical behavior modeling – example



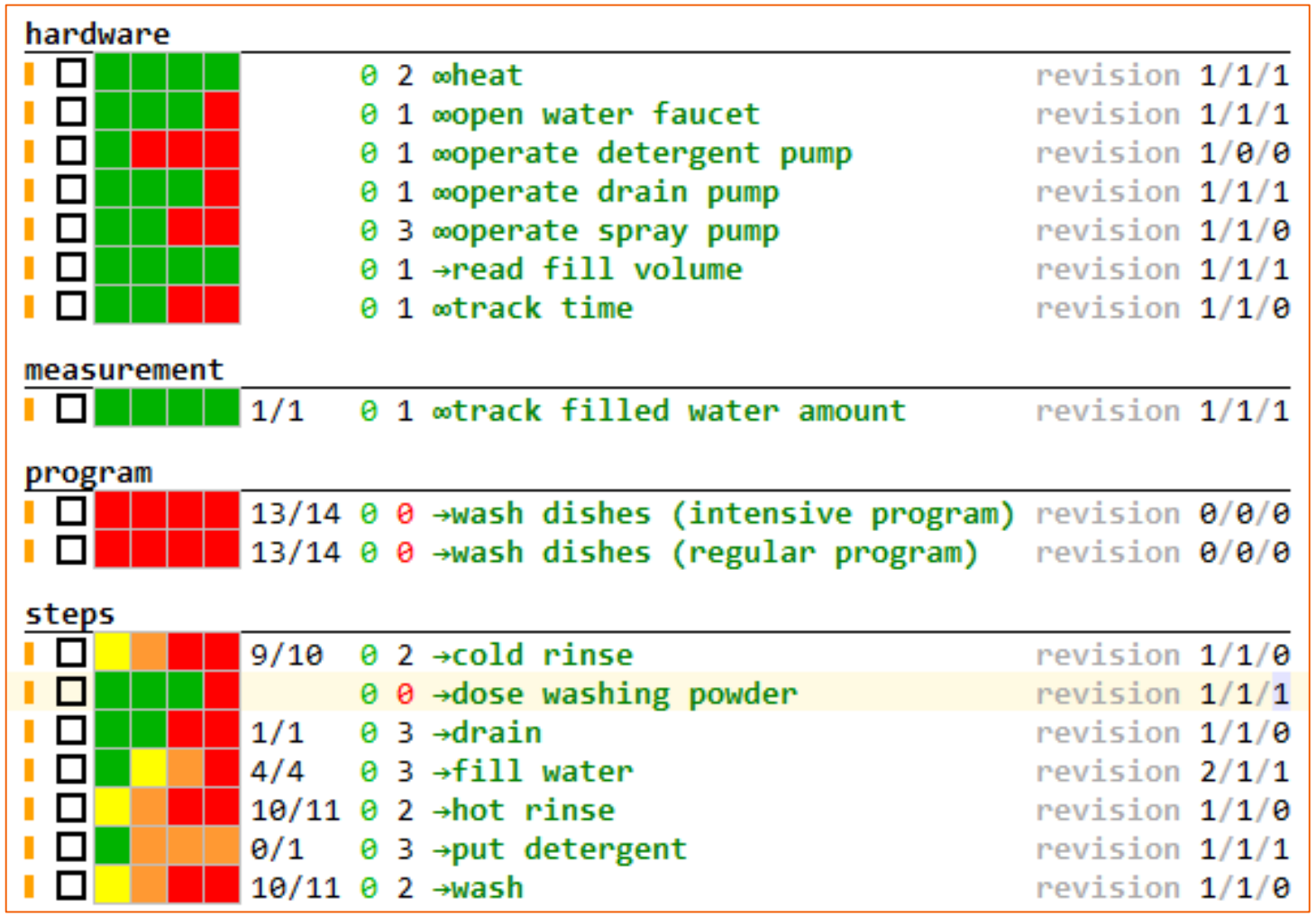
What to model

Explicitly model crucial things for “realistic/implementable” behavior such as:

- HAL (concrete sensors/actuators)
- Core data structures for process
- Critical “detail functions” (e.g. measurements)
- The most important decision tables
- Conditions and time
- Whatever is crucial for your specific case

Status tracking

- “Signatures”
  - Defined/Proposed
  - Agreed
  - Implemented
  - Tested
- Dependencies (+impact)
- Unresolved issues
- Revisions



Conclusion

- Informal models help much with concreteness, consistency and nuance
- Not a one-size fits all (adapt until you get useful feedback)
- Integration into the existing is key (mindsets, processes and infrastructure)
- Making tools is not a multi-month investment

  Reap benefits during development, even if you intend to throw away the tool
- Even though the context is different, standard practices from software development and documentation writing apply

Further resources

- Modeling environment: JetBrains MPS
- Example of glossaries and formalized text:
  - https://github.com/DSLFoundry/mps-richtext-glossaries
- Contact me on linkedin

Source of your technology