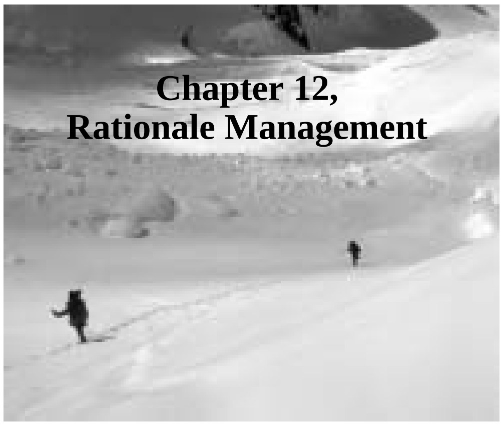
Object-Oriented Software Engineering
Using UML, Patterns, and Java



Chapter 12, Rationale Management

An aircraft example

A320
- First fly-by-wire passenger aircraft
- 150 seats, short to medium haul

A319 & A321
- Derivatives of A320
- Same handling as A320

Design rationale
- Reduce pilot training & maintenance costs
- Increase flexibility for airline

An aircraft example (2)

A330 & A340
- Long haul and ultra long haul
- 2x seats, 3x range
- Similar handling as A320 family

Design rationale
- With minimum cross training, A320 pilots can be certified to fly A330 and A340 airplanes

Consequence
- Any change in these five airplanes must maintain this similarity

Overview: rationale

- What is rationale?
- Why is it critical in software engineering?
- Centralized traffic control example
- Rationale in project management
  - **Consensus building**
  - **Consistency with goals**
  - **Rapid knowledge construction**
- Summary

What is rationale?

Rationale is the reasoning that lead to the system.

Rationale includes:
- the ***issues*** that were addressed,
- the ***alternatives*** that were considered,
- the ***decisions*** that were made to resolve the issues,
- the ***criteria*** that were used to guide decisions, and
- the ***debate*** developers went through to reach a decision.

Why is rationale important in software engineering?

Many software systems are like aircraft:

They result from a large number of decisions taken over an extended period of time.

- Evolving assumptions
- Legacy decisions
- Conflicting criteria

-> high maintenance cost
-> loss & rediscovery of information

Uses of rationale in software engineering

- Improve design support
  - **Avoid duplicate evaluation of poor alternatives**
  - **Make consistent and explicit trade-offs**
- Improve documentation support
  - **Makes it easier for non developers (e.g., managers, lawyers, technical writers) to review the design**
- Improve maintenance support
  - **Provide maintainers with design context**
- Improve learning
  - **New staff can learn the design by replaying the decisions that produced it**

Representing rationale: issue models

Argumentation is the most promising approach so far:

- More information than document: captures trade-offs and discarded alternatives that design documents do not.
- Less messy than communication records: communication records contain everything.

Issue models represent arguments in a semi-structure form:

- Nodes represent argument steps
- Links represent their relationships

ATM Example

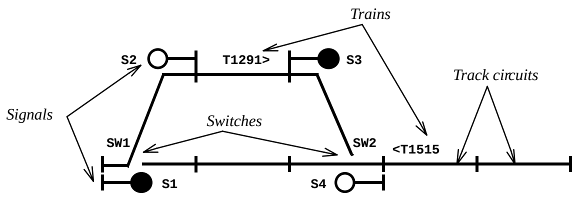
Question: Alternative Authentication Mechanisms?

References: Service: Authenticate

Decision: Smart Card + PIN

	Criteria 1: ATM Unit Cost	**Criteria 2:** Privacy
Option 1: Account number	+	–
Option 2: Finger print reader	–	+
Option 3: Smart Card + PIN	+	+

Centralized traffic control



- CTC systems enable dispatchers to monitor and control trains remotely
- CTC allows the planning of routes and replanning in case of problems

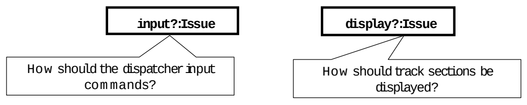
Centralized traffic control (2)

CTC systems are ideal examples of rationale capture:

- Long lived systems (some systems include relays installed last century)
  - **Extended maintenance life cycle**
- Although not life critical, downtime is expensive
  - **Low tolerance for bugs**
  - **Transition to mature technology**

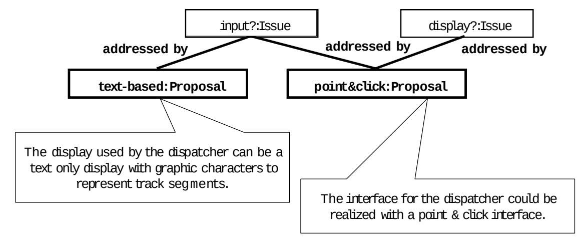
Issues

- Issues are concrete problem which usually do not have a unique, correct solution.
- Issues are phrased as questions.


input?:Issue
How should the dispatcher input commands?
display?:Issue
How should track sections be displayed?

Proposals

- Proposals are possible alternatives to issues.
- One proposal can be shared across multiple issues.

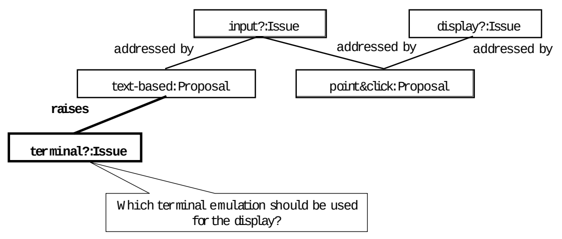


The display used by the dispatcher can be a text only display with graphic characters to represent track segments.

The interface for the dispatcher could be realized with a point & click interface.

Consequent issue

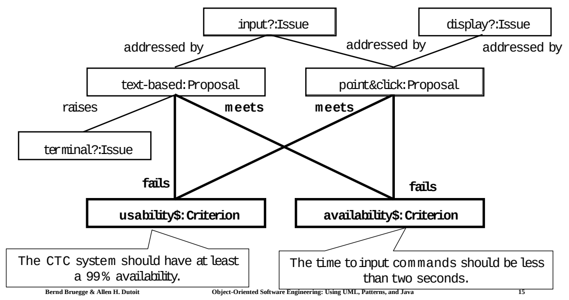
- Consequent issues are issues raised by the introduction of a proposal.



Which terminal emulation should be used for the display?

Criteria

- A criteria represent a goodness measure.
- Criteria are often design goals or nonfunctional requirements.



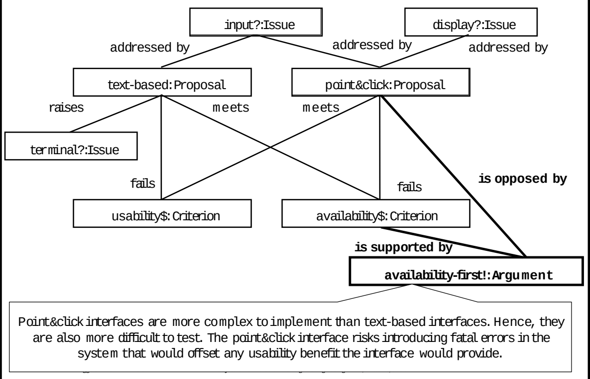
The CTC system should have at least a 99% availability.

The time to input commands should be less than two seconds.

Arguments

- Arguments represent the debate developers went through to arrive to resolve the issue.
- Arguments can support or oppose any other part of the rationale.
- Arguments constitute the most part of rationale.

Arguments (2)

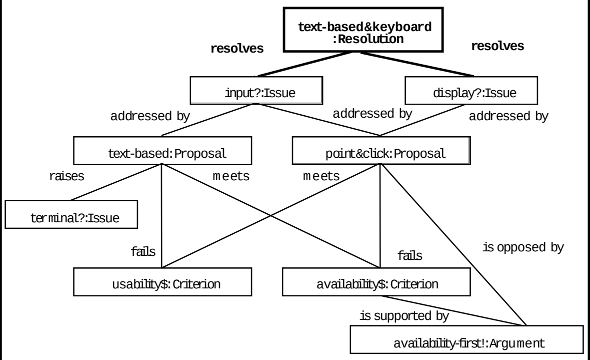


Point&click interfaces are more complex to implement than text-based interfaces. Hence, they are also more difficult to test. The point&click interface risks introducing fatal errors in the system that would offset any usability benefit the interface would provide.

Resolutions

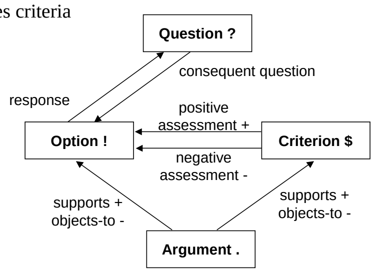
- Resolutions represent decisions.
- A resolution summarizes the chosen alternative and the argument supporting it.
- A resolved issue is said to be closed.
- A resolved issue can be re-opened if necessary, in which case the resolution is demoted.

Resolutions (2)

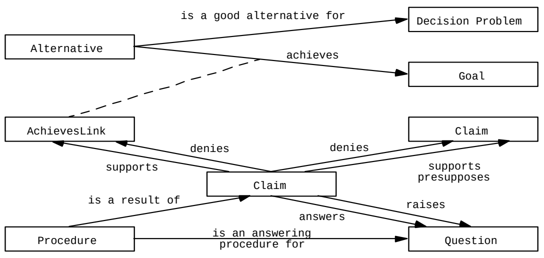


Questions, Options, Criteria

- Designed for capturing rationale after the fact (e.g., quality assessment).
- QOC emphasizes criteria



Other issue models: Decision Representation Language



Overview: rationale

- What is rationale?
- Why is it critical in software engineering?
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- Rationale in project management
  - Consensus building (WinWin)
  - Consistency with goals (NFR Framework)
  - Rapid knowledge construction (Compendium)
- Summary

Consensus building

Problem

- Any realistic project suffers the tension of conflicting goals
  - **Stakeholders come from different background**
  - **Stakeholders have different criteria**

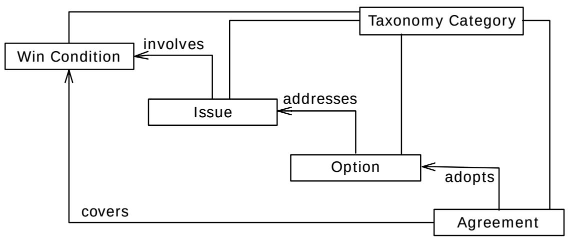
Example

- Requirements engineering
  - **Client: business process (cost and schedule)**
  - **User: functionality**
  - **Developer: architecture**
  - **Manager: development process (cost and schedule)**

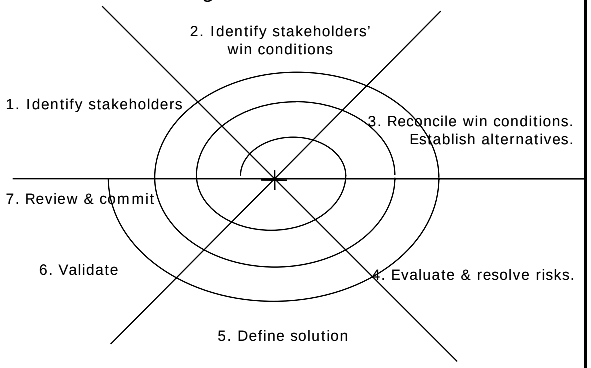
Consensus building: WinWin

- Incremental, risk-driven spiral process
  - **Identification of stakeholders**
  - **Identification of win conditions**
  - **Conflict resolution**
- Asynchronous groupware tool
  - **Stakeholders post win conditions**
  - **Facilitator detects conflict**
  - **Stakeholders discuss alternatives**
  - **Stakeholders make agreements**

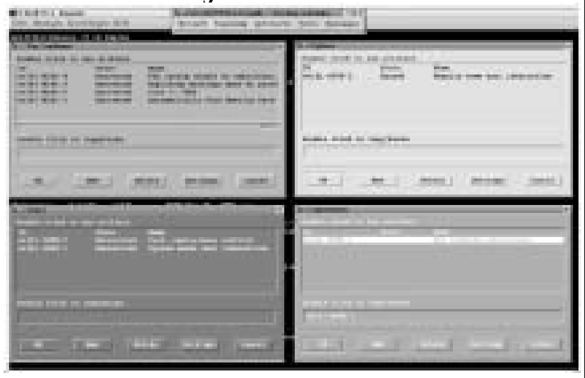
Consensus building: Model



Consensus building: Process


2. Identify stakeholders' win conditions
1. Identify stakeholders
3. Reconcile win conditions. Establish alternatives.
7. Review & commit
6. Validate
4. Evaluate & resolve risks.
5. Define solution

Consensus building: WinWin tool



Consensus building: Experiences

Context
- Initial case studies used project courses with real customers
- Used in industry

Results
- + Risk management focus
- + Trust building between developers and clients
- + Discipline
- – Inadequate tool support

Consistency with goals

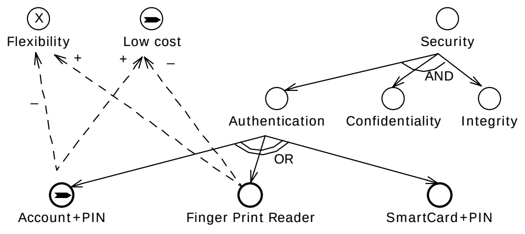
Problem
- Once multiple criteria have been acknowledged
  - **Find solutions that satisfy all of them**
  - **Document the trade-offs that were made**

Example
- Authentication should be ***secure***, ***flexible*** for the user, and ***low cost***.

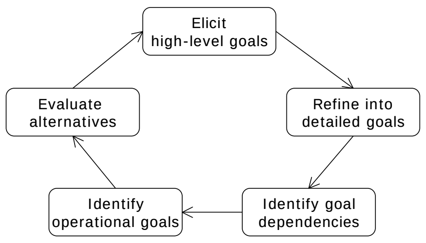
Consistency with goals: NFR Framework

- NFR goal refinement
  - **NFRs are represented as goals in a graph**
  - **Leaf nodes of the graph are operational requirements**
  - **Relationships represent “help” “hurt” relationships**
  - **One graph can represent many alternatives**
- NFR evaluation
  - **Make and break values are propagated through the graph automatically**
  - **Developer can evaluate different alternatives and compare them**

Consistency with goals: Model



Consistency with goals: Process


Elicit high-level goals
Refine into detailed goals
Identify goal dependencies
Identify operational goals
Evaluate alternatives

Consistency with goals: Experiences

+ Case studies on existing systems lead to clearer trade-offs
+ Research into integrating NFR framework and design patterns
  - **Match NFRs to design pattern "Forces"**
  - **Link NFRs, design patterns, and functional requirements**

– Tool support important

Rapid knowledge construction

Problem
- When a company is large enough, it doesn't know what it does.
  - **Knowledge rarely crosses organizational boundaries**
  - **Knowledge rarely crosses physical boundaries**

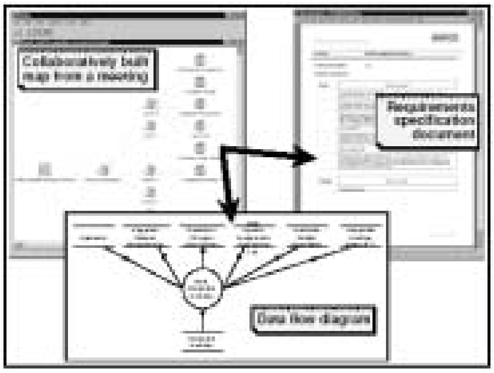
Example
- Identify resources at risk for Y2K and prioritize responses.

Rapid knowledge construction: Compendium

- Meeting facilitation
  - **Stakeholders from different business units**
  - **External facilitator**
- Real-time construction of knowledge maps
  - **The focus of the meeting is a concept map under construction**
  - **Map includes the issue model nodes and custom nodes (e.g., process, resource, etc.)**
- Knowledge structuring for long term use
  - **Concept map exported as document outline, process model, memos, etc.**

Rapid knowledge construction: Model

Rapid knowledge construction: Process example


Collaboratively built map from a meeting
Requirements specification document
Data flow diagram

Rapid knowledge Construction: Experiences

Context

- Several industrial case studies, including Y2K contingency planning at Bell Atlantic

Results

- Increased meeting efficiency (templates are reused)
- Knowledge reused for other tasks

Summary

- Rationale can be used in project management
  - **To build consensus (WinWin)**
  - **To ensure quality (NFR Framework)**
  - **To elicit knowledge (Compendium)**
- Other applications include
  - **Risk management**
  - **Change management**
  - **Process improvement**
- Open issues
  - **Tool support**
  - **User acceptance**