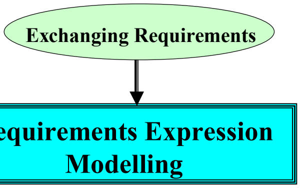
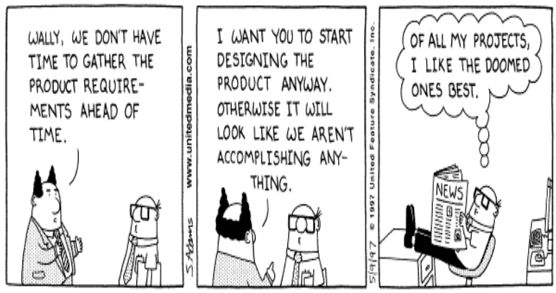
Requirements Expression and Modelling



Exchanging Requirements

Requirements Expression Modelling

RE According To Dilbert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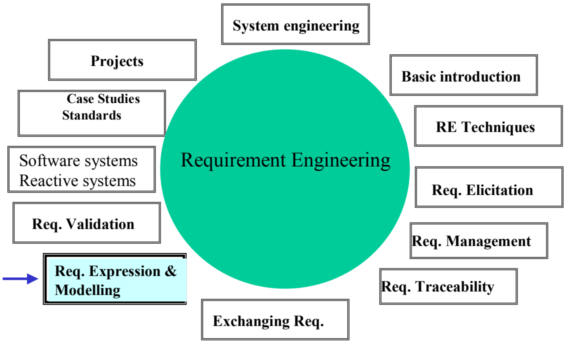
Requirement expression and Modelling



System engineering

Projects

Basic introduction

Case Studies
Standards

RE Techniques

Software systems
Reactive systems

Requirement Engineering

Req. Elicitation

Req. Validation

Req. Management

Req. Expression & Modelling

Req. Traceability

Exchanging Req.

Introduction

Most confused notion in requirement engineering :

It concerns the notation in view for <u>exchange</u>, communication and <u>validation</u> for further development

The natural way

- Use natural language : many systems were developped and still being developped using natural language
- Everyday life and social activity is made through natural language
- **BUT** .....
- No precise semantics
- No structuring
- No abstraction
- No Validation ... Except some exceptions

Content

- Requirements for a requirements notation
- Classes of languages, models, tools, methods, techniques
- Review of basic related aspects (*seen in other courses*)
- Main methods used in industry
- Formal notations and associated methods
- Case study and lab : Statecharts

Requirements for a requirements notation

- Let‘s recall the main processes
  - Elicitation
  - Expression
  - Validation
  - Generation of specification
    - Hardware
    - Software requirements
    - Others systems specification

Requirements for such notation

- Express Behaviour
- Data specification
- Functions (data transformation)
- Supports abstraction
- Executable (ideally)
- Associated method/methodology

What to express

- Requirements that can be understood
- That can have a single meaning
- That can be refined when needed
- That can strcturerd for managing inconsistencies and changes

The modelling Issue

- Modelling can guide elicitation
- Modelling can provide a measure of progess
- Modelling can help to uncover problems (Inconsistencies)
- Central concepts
  - Abstraction
  - Process modelling
  - Data Modelling
  - Data Flow
  - Behaviour
  - Etc ...

Example

- The system must be reliable
  - 1. Not precise
  - 2. Qualitative attribute
  - 3. Add a quantitative attribute
  - Context in which le system must be reliable

  (the context means system internal context and environment)

Writing good requirements : syntax and semantics as any statement

Classes of languages, models, tools, methodes, techniques

- Consider Software systems
- Any language can be a requirement language
- A programming language is a requirement language for the computer to execute what is required
  - Example : While {..} do ....
  - It is well specified and no ambiguity
- **However in RE**
  - There many stakeholders
  - Different cultures (not necessarily computer scientists or familiar with programming languages)
  - Requirements are of many types

Classes

- Programming languages
- Specific notation
- General purpose Methods
  - Informal
  - Semi-formal : Used in industry
  - Formal : Developped by academia
  - Abstract : limited to specific issues (pure academia work)
- Paradigms
  - Function oriented
  - Object

Review of basic related aspects (*seen in other courses*)

- Control structure (behaviour) : seq; //, if .. Else
- Communication (shared data, synch, async, ..)
- Abstraction
- Encapsulation
- Properties
- Invariants

CRITERIA *(CMU-DoD_SEI Taxonomy)*

- Representation

  → Concepts and techniques described using the technique
- Derivation

  → Methods to produce a specification from another
- Validation-Verification

  → Properties that can be determined using the specification technique

REPRESENTATION

- Style
- Concurrency
- Communication
- Non-Determinism
- Fairness
- Modularity
- Time
- Data

DERIVATION

- Transformation

  → Transformation rules from a specification technique to another (e.g multiformalism approach)
- Elaboration

  → Same as above with a refinement process
- Composition

  → Combination of various methods for a complex system

VERIFICATION-VALIDATION

- Equivalence
- Consistency
- Safety and liveness

Methods Criteria	VDM	RDP	Statemate	OMT	SART	LOTOS	SDL	Z	B	Estelle
Rigor	3	3	2	1	1	3	2	3	3	3
Data modeling	3	1	2	3	2	3	2	3	2	2
Function modeling	3	0	2	2	2	1	2	3	3	3
Control structures	2	3	3	2	2	3	2	0	2	3
TC expression	0	2	2	0	1	2	2	0	0	1
Exception handling	2	1	3	0	0	3	2	0	0	0
Verifiability	2	3	1	0	0	3	2	0	0	1
Validability	3	3	3	0	2	3	2	1	2	2
Modularity	2	1	3	3	2	2	2	2	2	1
Level of abstraction	3	1	3	2	2	2	2	3	3	1
Reusability	2	1	3	2	1	2	2	1	3	1
Implementability	2	2	2	2	1	2	3	1	2	3
Friendliness	1	2	3	3	3	1	3	2	1	2
Tool maturity	3	3	3	2	3	2	3	1	1	2
	0	3	3	2	1	3	3	1	1	2

Specific Notation

- Most are in house methods
- Often not available tools
- Do correspond to the needs
- Difficulty to interface witth other notations

Informal

- Mostly based on natural language
- Template
- Simple to use by everybody
- Problem with validation
- Example : Volere template (Natural language)

Main methods used in industry

- Semi-formal
- General purpose and dedicated (example : SDL for communication)
- Validation
  - By Simulation
  - Inspection
- Often Graphical notation
- A semantic (very rarely formal, but precise)

Formal methods

- Formal semantics (*still polemics on the issue mathematical equation and formal notation*)
- Two types
  - Model oriented : VDM, Z, B, SCR, OBJ
  - Behaviour : Petri nets, ‘‘statecharts“, Lotos, ..
- Formal validation
- Automated tool
- Not well established in industry

Abstract oriented modelling

- These are based on agebra, logic
  - Logic
  - Temporal logic and extensions for reactive systems
  - Process algebra

Semi-formal methods

- SADT
- SA-RT
- Statemate
- OOA
- OMT
- UML

Formal notations and associated methods

- See lectures
  - – Petri nets
  - – Statecharts and statemate (the statemate method)
  - – VDM
  - – Formal methods

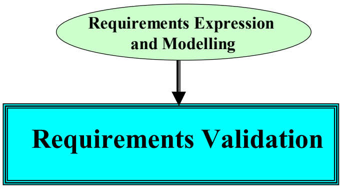
Case study and lab : Statecharts

- Consider the case study on
  - aeronautic application
  - Manufacturing
  - Communication protocols
  - Transportation

Conclusions

- Many methods and tools
- A need for taxonomy for such methods
- A need for a methdology (as UML) for using a number of methods to covers all needs for requirement specification.

Next lecture


Requirements Expression and Modelling

Requirements Validation

Paper Reading and assignments

- **Each student read at least one paper in section 8 and paper 8.D**
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- M. Glinz : An integrated formal model of scenarios based on statecharts. ESEC conf., 1995
- M. Glinz : Improving the quality of requirements with scenarios. World cong on quality, sept 2000
- M. Glinz : Problems and deficiencies of UML as a requirements specification language. Proceedings of the 10th workshop on software spec and design, Nov 2000.
- C. Heitmeyer : SCR , a practical method for requirements specification. NRL report.
- C. Heitmeyer et al : Applying SCR requirement method to a weapons control panel : an experience report.