Three Lectures on Requirements Engineering

Dr. Frank Padberg
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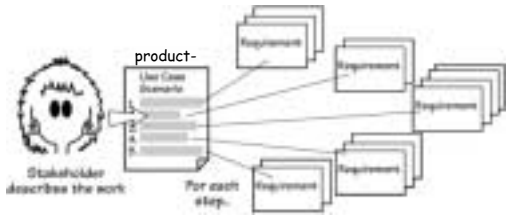
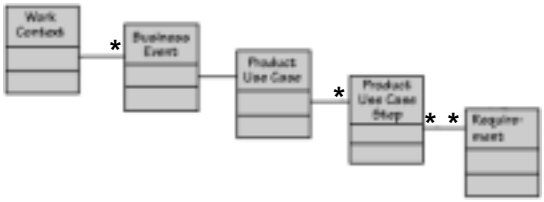
Lecture 3

Where are we now?



we are still in Step 2, trawling the product scenarios for requirements...

Recall: From work context to requirements



Recall: Functional requirements

Functional requirements describe what the product must do to carry out the work for which it is intended. They are independent of any technology used by the product.

⇨ The product shall record the new weather stations.

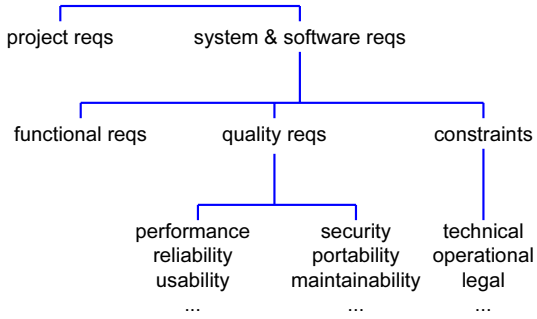
Quality Requirements

More requirements

- software always has to meet a certain quality level; f.e., think of throughput or usability
- software may also have to comply with certain technological or legal constraints
- such properties are *additional requirements* – the qualities that the product and its functions must have

such reqs are often called "non-functional," but this is a nonsense term...

A requirements hierarchy



Scope of quality requirements

quality reqs have different scopes:

- some apply to a particular functional req
- some apply to a use case as a whole
- some apply to the entire product

the quality reqs often are crucial for the success of the product

Trawling for quality reqs (1)

- quality issues naturally come up when trawling for functional requirements
- hence, quality reqs get collected "over time" during analysis
- in addition, the analyst must ask specific quality-related questions when discussing product use cases and functional reqs
- use a checklist of quality categories
  (see, f.e., Robertson p. 175)

Trawling for quality reqs (2)

- when talking to users of the product, ask for
  - usability – look and feel – security – cultural reqs
- when talking about the operating environment of the product, ask for
  - performance – interface – maintainability – security reqs
- when talking to managers and marketing people, ask for
  - look and feel – political – security – legal reqs

Ex: A functional requirement

Produce road de-icing schedule

6. Product schedules available trucks from the relevant depots.
7. Product advises the engineer of the schedule.

this product use case scenario will give a functional requirement:

⇨ The product shall produce a de-icing schedule showing the roads to be treated and the trucks allocated to them.

Ex: A usability requirement

- for sure, the stakeholders want the schedule to enable an engineer to *easily* direct the trucks to the correct roads
- this gives a usability requirement:

⇨ The product shall produce a schedule that is easy to read.

Ex: Another usability requirement

- when thinking about the targeted users of the product, more usability reqs come up
- f.e., the customer tells you that they often employ new junior engineers
- this gives another usability requirement:

⇨ The product shall be intuitive to use.

- but how to make sure that this property has been achieved?

Fit criteria

- to clarify a quality req, it helps to establish a fit criterion that will measure whether the software meets the req or not

⇨ The product shall be intuitive to use.

Criterion: A new engineer shall be able to produce a correct de-icing forecast within 10 mins of encountering the product for the first time without reference to any out-of-product help.

- conformance could be tested in a user study

Ex: Look and feel requirements

⇨ The product shall conform to the established look and feel of the organization's products.

Criterion: Sixty percent of the target audience will recognize the product as belonging to the corporation within 5 secs of encountering it for the first time.

note that this req does *not* say the company logo must be prominent, nor does it talk about the colors to be used; simply conform to whatever the standards are

Ex: Performance requirements

⇨ The product shall accommodate the largest geographical area of any road authority in the UK.

again, a fit criterion should be added

alternatively, when specifying numbers a rationale should explain the numbers:

⇨ The product shall have the capacity for 5000 roads.

Rationale: The maximum number of roads in the area of any potential customer for the product.

Ex: Performance fit criteria

⇨ The product must produce the road de-icing schedule in an acceptable time.

gets clearer when thinking about how failure of this req could be measured:

⇨ The product must produce the road de-icing....

Criterion: The road de-icing schedule shall be available to the engineer within 15 secs from making his request for 90 percent of the times. It shall never take longer than 20 secs.

Ex: Maintainability requirements

⇨ The product shall enable the addition of new road authority areas within two days.

already contains its fit criterion; conformance could be tested in a user study

Ex: Legal requirements

⇨ The product shall comply with ISO 93.080.99.

legal reqs often lead to additional *functional* reqs, f.e.:

⇨ The product shall produce an audit report of all road schedules and their subsequent treatments.

⇨ The product shall retain all ice predictions for all occasions the schedule is run.

Ex: Operational constraints

⇨ The product shall interface with the DM31 weather stations.

Criterion: The interfaces to the Rosa Weather Station shall be certified as complying with the National Transportation Communication ITS Protocol (NTC/IP).

again, this constraint will lead to additional functional reqs, such as establishing a radio network connection, matching data formats ...

Ex: Project constraints

time...

⇨ The product must be available at the beginning of the new tax year.

...and money

⇨ The budget for building the product is £500,000.

Volere Step 2d: Modeling the Data

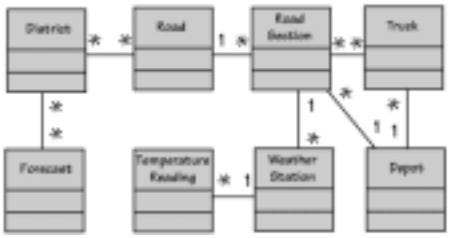
Business Data

- during analysis, model only business data
- business data objects naturally occur in the stakeholder's process descriptions
- model the statics – business data objects and their logical relationships
- caution: it is tempting, but doesn't make much sense to specify "operations" for data objects during analysis – operations are *design* information

Variety of data diagrams

- long-standing:
  - entity-relationship diagram (ERD)
  - statechart
  - state transition table
- with UML:
  - class diagram
  - state diagram

Ex: Business objects as a class diagram



a simple UML class diagram that shows key business data objects and their relationships

Ex: Functional reqs from data

- when talking about the business data objects, additional reqs naturally come up
- f.e., business data often must be stored in the product – a functional req:

⇨ The product shall record air-temperature readings, humidity readings, precipitation readings, and road-temperature readings received from weather stations.

engl. *precipitation*: Niederschlagsmenge

Ex: Quality reqs from data

- data often lead to additional quality reqs
- f.e., performance reqs:

⇨ The product shall record data transmitted from a weather station within half a second.

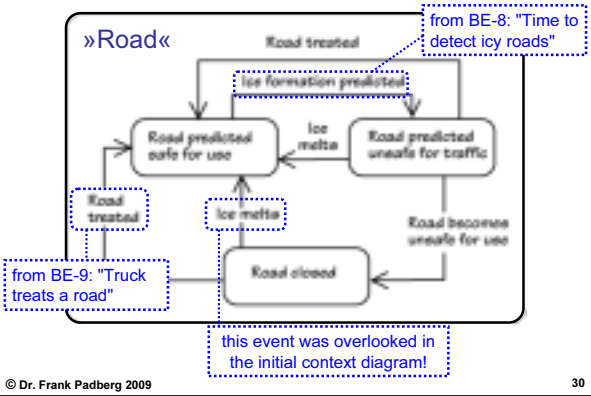
- f.e., security reqs:

⇨ The product shall ensure that data recorded from a weather station cannot be altered, except by a supervising engineer.

State diagrams

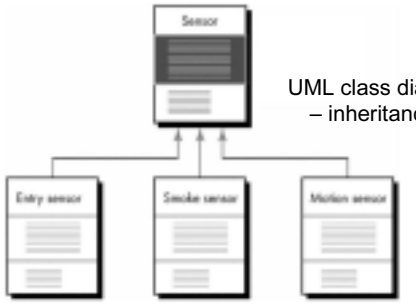
- show the states of an object, plus the events that make the object move to its next state
- here: business data object and business events
- often helps to identify additional requirements
- caution: state diagrams have a tendency of getting too close to design...

Ex: Business object states



Cross-check against Pressman's Book

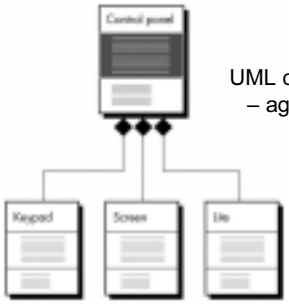
SafeHome: Sensor data model



UML class diagram
– inheritance –

Pressman (5th) p. 589

SafeHome: ControlPanel data model



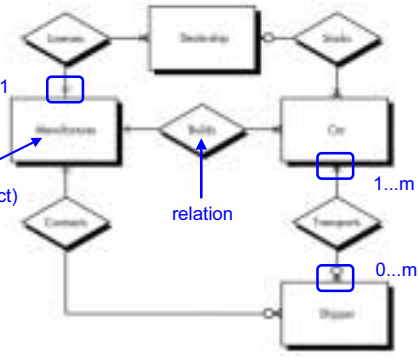
UML class diagram
– aggregation –

Pressman (5th) p. 589

Entity-relationship diagram (ERD)

- originally invented in the 70s for the design of relational databases
- shows data objects, attributes, relationships, and cardinalities
- is the point of origin of the OO class diagrams of various sorts

Sample ERD



Pressman (5th) p. 308

SafeHome: Multiple relationships

simple ERD form where relationships are not drawn as diamonds but appear as labels at the arrows; it almost looks like a UML class diagram...

Pressman (5th) p. 321

Data dictionary

- an organized listing of all data elements that are pertinent to the system
- gives precise, rigorous definitions
  - inputs and outputs (information flows)
  - component of stores
- may even elaborate on intermediate data calculations
- invented in the late 80s

engl. *pertinent*: gehörig

Sample data dictionary entry

Name:	telephone number
Aliases:	phone number, number
Where/How used:	read-phone-number (input) display-phone-number (output) analyze-long-distance-calls (input)
Description:	telephone no. = [local extension | outside no.] outside no. = 9+[service code] domestic no.] service code = [211 | 411 | 611 | 911] domestic no. = [0] + area code] + local number area code = "three numeral designator"
Format:	alphanumeric data

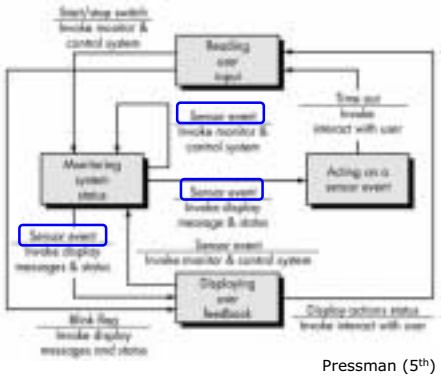
Pressman (5th) p. 330

Ex: Data dictionary entry for weather station reading

weather station reading =

+ weather station identifier
+ temperature
+ moisture content of road surface
+ date and time

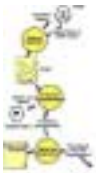
SafeHome: State diagram



Pressman (5th) p. 326

SafeHome state diagram – comments

- the state diagram shows the behavior of the *whole* product and should be read as an alternative to the DFD's shown earlier
- strange things occur:
  - all transitions from the monitoring state are triggered by the *same* event...
  - such a sensor event is the *only* way to return to user input...

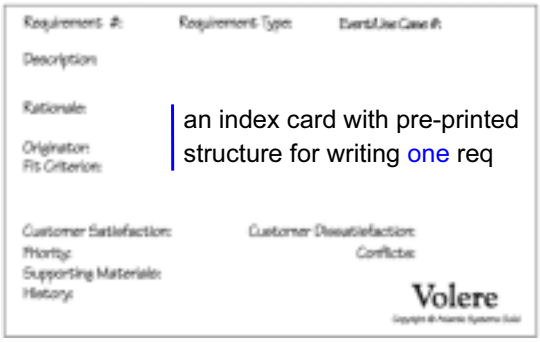


Volere Step 3: Writing the Requirements

Writing individual requirements

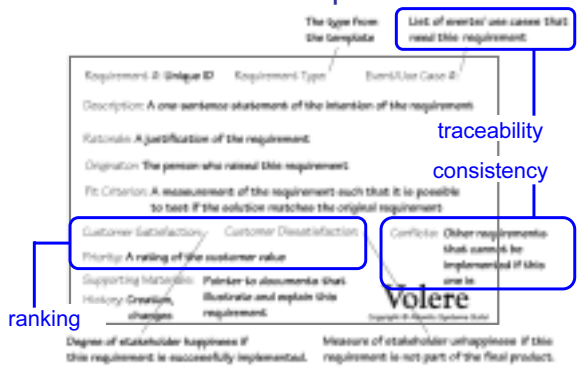
- is actually done during trawling
- the individual reqs must be written down in a structured form ("formalized")
- helps with bookkeeping
- helps avoid defects, such as reqs that are incomplete or not traceable to a use case
- uses a template, in paper form or electronic form

Volere »Shell«



an index card with pre-printed structure for writing one req

Volere shell explanation



Conflicting requirements

- one particular req can make another one less feasible; for example:

⇨ The product shall compute the shortest route to each destination.

⇨ The product shall compute the quickest route to each destination.

- nothing unusual when asking different people
- must be resolved, with the client

Ex: Functional req in a shell

Ex: Quality req in a shell

»The spec«

- a document that contains all requirements
- SRS = *S*oftware *R*equirements *S*pecification
- must contain clear, complete, and testable instructions about what to build
- is the basis for the contract with the client
- is clearly structured – uses some sort of template
- can be paper, but is often stored using a software tool for reqs management

Writing the spec

this means:

assembling all the analysis results

- blastoff deliverables – project purpose, constraints, work context diagram
- trawling results – product use case diagram, product scenarios and process diagrams, data models, functional reqs and quality reqs
- think of this as *building*, not writing

Volere »Reqs Spec Template«

Project Drivers
- Purpose of the project ✓
- Client, customer, and other stakeholders ✓
- Users of the product ✓

Project Constraints
4. Mandated constraints
5. Naming conventions and definitions
6. Relevant facts and assumptions

Functional Requirements
7. The scope of the work ✓
8. The scope of the product ✓
9. Functional and data reqs ✓

Nonfunctional Requirements
10. Look and feel reqs ✓
11. Usability and humanity reqs ✓
12. Performance reqs ✓
13. Operational and environmental reqs ✓
14. Maintainability and support reqs ✓
15. Security reqs
16. Cultural and political reqs
17. Legal reqs ✓

Project Issues
18. ....
    [f.e., risks; cost; solution ideas]
27. ....

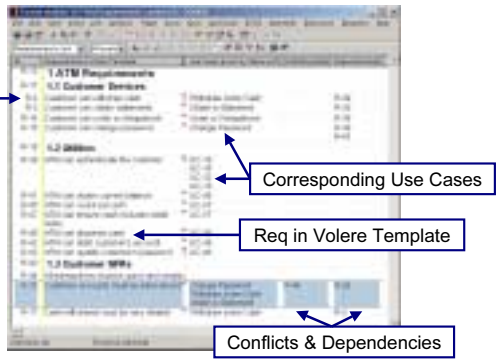
IEEE Guide to SRS

1. Introduction
   - 1.1 Purpose
   - 1.2 Scope
   - 1.3 Definitions, Acronyms, and Abbreviations
   - 1.4 References
   - 1.5 Overview
2. General Description
   - 2.1 Product Perspective
   - 2.2 Product Functions
   - 2.3 User Characteristics
   - 2.4 General Constraints
   - 2.5 Assumptions and Dependencies
3. Specific Requirements
   - 3.1 Functional Reqs [organized by req id]
   - 3.2 External Interface Reqs [UI, HW, SW]
   - 3.3 Performance Reqs
   - 3.4 Design Constraints
   - 3.5 Attributes [security, maintainability...]
   - 3.6 Other Reqs [data base, operations...]

Appendixes
Index

(ANSI/IEEE Standard 830-1984, resp., -1998)

Telelogic DOORS

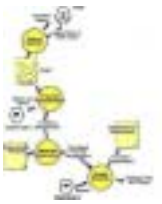


A word on tools

"Despite the claims of some vendors, there is no requirements tool that can actually interview a user or determine what your client really needs."

(Robertson, p. 348)

Where are we now?



Volere Step 4: Quality Gateway

Quality gateway

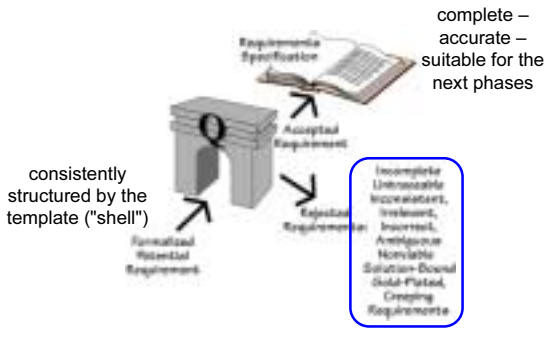
- is the gateway into the specification
- each potential req must be tested before it enters the spec
- that is, we are talking about the quality of the reqs and spec itself
- can be (and should be) done incrementally, whenever the analysis of a use case is completed

engl. *gateway*: Einfahrt, Tor

Why test requirements?

recall that most defects originate in requirements or design, and are expensive to correct downstream

The gateway



rejecting a requirement

Completeness and consistency

- completeness and traceability of reqs to business use cases should be ensured by using the template (or reqs tool)
- but better check again...
- for consistency, check that terms are used consistently and match their definition given in the glossary

Ex: Ambiguity (1)

⇨ The product shall show the weather for a day.

a somewhat ambiguous requirement:

- its meaning depends on the context within the spec
- forecast for the next 24 hours, or until the end of this day?
- could easily be specified more precisely

Ex: Ambiguity (2)

⇨ The product shall communicate all roads predicted to freeze.

another somewhat ambiguous requirement:

- its meaning depends on the context within the spec
- every road known to the product, or just the set of roads currently examined by the user?
- it helps to group reqs by product use case
- but beware of "overspecifying" – this can make specs really hard to read; recall that you are just giving a *description* of the req

Ex: Relevance (1)

⇨ The product shall maintain a lookup table of the times of sunrise and sunset throughout the year.

an irrelevant requirement:

- the temperature of the road surface matters, not day or night
- discard this req

Ex: Relevance (2)

⇨ The product shall record the durations of truck activity.

looks irrelevant, but actually is not:

- de-icing trucks may not be scheduled for more than 20 hours out of each 24-hour period
- hence, this req indirectly contributes to the project goal
- this rationale should be given in the template

Ex: Not solutions

⇨ The product shall beep and put a flashing message on the screen if a weather station fails to transmit readings.

a badly shaped functional requirement:

- it contains the means of implementation
- it consignes the alert message to a screen
- there might be better solutions for the alert (e-mail, diagnostic application, telephone)

⇨ The product shall issue an alert if a weather station fails to transmit readings.

better!

Not solutions – more examples (1)

⇨ The product shall require a password to access account data.

a badly shaped security requirement:

- again, it contains the means of implementation
- it adopts the current standard solution to access control even if better solutions come up

⇨ The product shall ensure that account data can be accessed only by authorized users.

better!

Not solutions – more examples (2)

⇨ The product shall use a mouse.

a badly shaped usability requirement:
- it contains the means of implementation
- changing "mouse" to "pointing device" is no better

⇨ The product shall allow the user to directly manipulate all interface items.

better!

express any req in its essential form, leaving the designer free to choose the best way to implement it

Ex: Viability

⇨ The truck drivers shall receive weather forecasts and schedule their own de-icing.

an inviable requirement:
- truck drivers cannot predict when a road will freeze and do not know which roads have been treated
- contradicts the constraint "targeted user group"
- discard this req
- other common reasons for inviability:
  - lack of technological skills to build the req
  - lack of resources to build the req
  - lack of acceptance among the stakeholders

Other common reqs problems

- *gold plating*:
  features that contribute more to the cost of a software than to its usefulness
- *creep*:
  any reqs that enter the spec after it has been considered complete
- *leakage*:
  unrecognized and uncontrolled creep

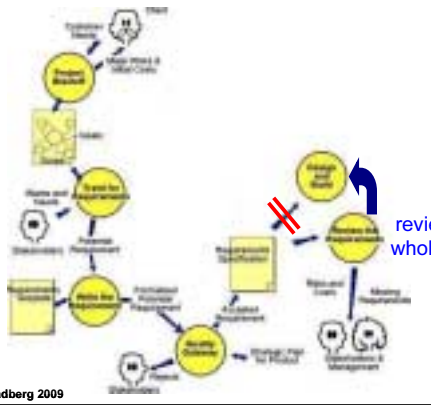
Implementing the gateway

- try to keep it "lean"
  - often done by one analyst, supported by one tester
  - may involve a stakeholder
  - reqs are marked off when approved
- formal reviews may be needed for complex, technical subject matters

engl. *to mark off*: abhaken

Step 4+:
Reviewing the Specification

Volere RE process loop



Quality of the specification

- we need a quality gateway for the spec as a whole
- the gateway must be in the main RE process loop – *before* entering design and build
- the spec must be correct and complete (w/t the current release or iteration)
- the spec must be suitable for its purpose (which is to serve as a basis for the design)

requirements validation

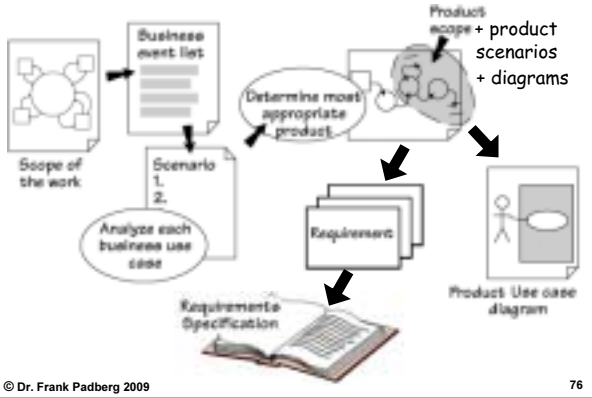
Reviewing the spec

- spans from informal reviews to full, formal software inspections
- review a small pack of use cases at a time – this is an ongoing activity
- check for
  - conflicting reqs
  - missing reqs
  - more quality reqs
  - inconsistent diagrams
  - incomplete data handling
  - risky and costly reqs

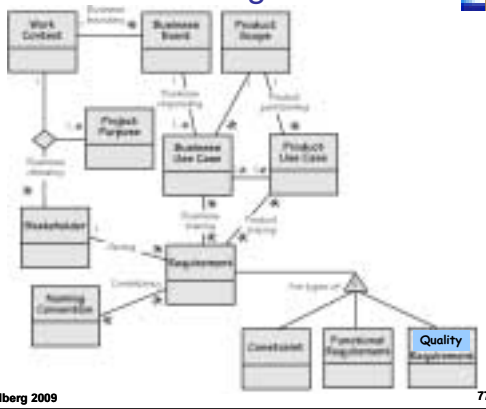
connects to software quality assurance, cost estimation, and risk analysis

Wrap-up

From work scope to specification



Volere knowledge model



Tools

- mostly "low-tech paper"
  - scenario template
  - reqs shell
  - reqs specification template
  - [paper prototypes]
- some software tools
  - diagramming tools
  - reqs management tools

recall that low-tech is a good thing when trawling for reqs

The Volere RE process

RE »Leftovers«

- low-tech analysis prototypes
- reuse of requirements
- prioritizing the requirements

see

- inspections for specifications
- requirements change management
- cost estimation

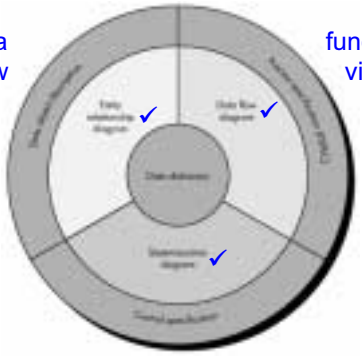
see the upcoming lectures

- transition to design

Elements of the analysis model

data view

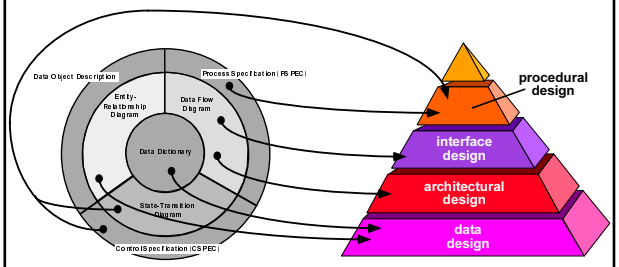
function view



behavior view

Pressman (5th) p. 301

Analysis maps to design

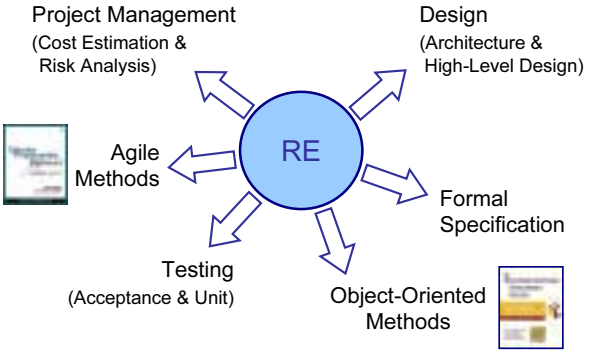


Analysis "Model"

Design "Model"

Pressman (5th) p. 337

RE – reaching out...



End of the Lectures