

Software Process and Requirements Engineering

Information Aesthetics

ART 452, CS 491, DES 452, MKTG 577

UIC Innovation Center

Fall 2013 and Spring 2014

Instructors: Daniel Sauter, Kim Moon, Matt Wizinsky and Ugo Buy

Requirements engineering

- Activities aimed at discovering what the product will do and what qualities it should have
- What are requirements?

“Requirements are what the software product, or hardware product, or service, or whatever you intend to build, is meant to do and to be. Requirements exist whether you discover them or not, and whether you write them down or not. Obviously, your product will never be right unless it conforms to the requirements, so in this way you can think of the requirements as some kind of natural law, and it is up to you to discover them.”

(R&R, 3rd Edition, Page 1)

- Although we won't write formal specs, we must still understand product requirements

Requirements engineering

Three kinds of requirements

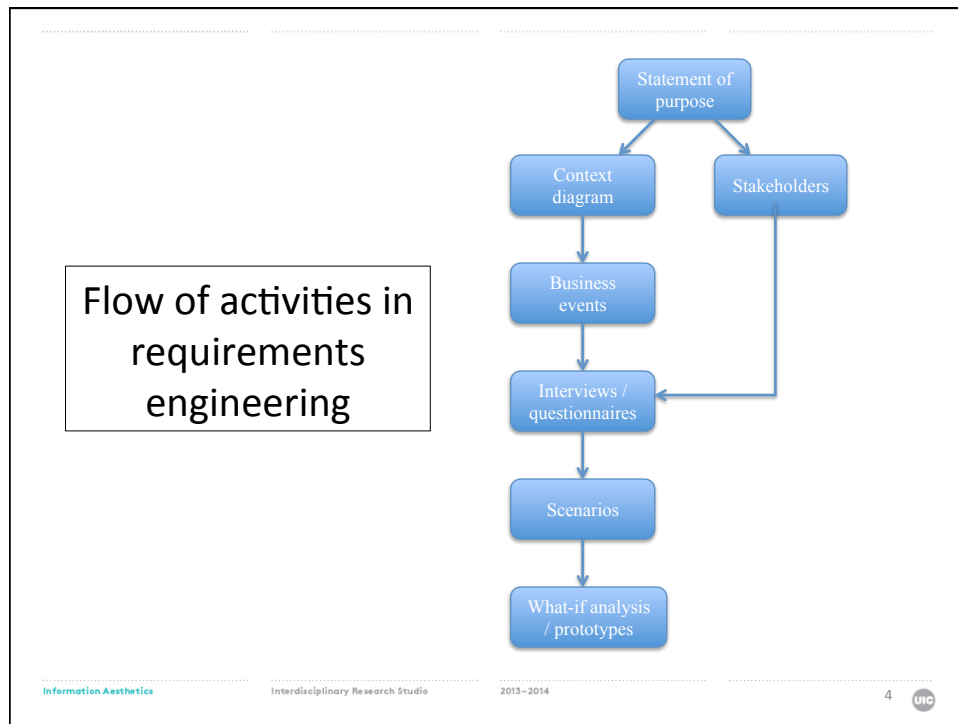
1. *Functional requirements*—What the product should do
2. *Nonfunctional requirements*—The qualities it should possess
Usability, Security, Performance, Legal, Cultural, Operational, etc.
3. *Constraints*—Non negotiable facts (e.g., established by the client)
Product deadlines, development platforms

The requirements engineering process

Typically four phases

1. *Project blastoff*
Goals of the project (financial, quality of service)
Domains of interest (targets of secondary research)
Stakeholders
Scope of work (often as *context diagram*)
2. *Requirements elicitation*—Our primary research methods
Interviews, questionnaires, prototypes, *business events*, *scenarios*
3. *Requirements writing*—Produce a System Requirements Specification (SRS)
4. *Requirements management*—Track evolution of system

We focus on (1) and (2) above, no need to formally write requirements as long as we understand what our wireframe will do



Recipe for finding business events

- Start from a *statement of purpose*
- Identify the *work*
 - Business activity in which the software will operate
- Identify the *adjacent systems*
 - The environment (external entities) in which the work takes
 - People, other electronic systems, etc.
- Business events will originate in adjacent systems and cause some work to be done

Statement of purpose

- Brief description of customer wants and needs
 - Can be written by client directly, or by developers after talking to client
 - Can be very short (< 1 page)
- Developers should read and dissect very carefully
- Statement of purpose will lead to:
 - Quantifiable outcomes
 - Identifying domains of interest
 - Identifying core stakeholders
 - Defining glossary for project

Example of statement of purpose

- **IceBreaker** project

“Roads freeze in winter, and icy conditions cause road accidents that kill people. We need to be able to predict when ice will form on a road so we can schedule a de-icing truck to treat the road in time. We expect a new system to provide more accurate predictions of icy conditions. This will lead to more timely de-icing treatment than at present, which will reduce road accidents. We also want to eliminate indiscriminate treatment of roads, which wastes de-icing compounds and causes environmental damage.” (R&R, Chapter 3)

Example of statement of purpose

- **Computer-Aided Dispatch** project

“The London Ambulance Service is responsible for receiving emergency calls, dispatching ambulances based on an understanding of the nature of the calls and the availability of resources, and monitoring progress of responses to calls. In the current manual system, an operator first fills a form with information about an emergency; the form is placed on a conveyor belt to the dispatch room where human allocators assign resources to emergencies. Information about resources is kept in paper files in the dispatch room. The LAS wishes to automate the process of tracking ambulance locations, allocating resources, and monitoring the progress of each response. The new computerized system will reduce personnel cost, increase the efficiency of resource allocations, and reduce emergency response times.”

(Source: “A Comedy of Errors: the London Ambulance Service Case Study” by Finkelstein and Dowell, IWSSD 96)

Example of statement of purpose

- **Osbert Overby Art Dealer** project

“Osbert Overby runs a business buying and selling art pieces, such as paintings. In the past, his business sometimes incurred losses because Osbert overpaid for certain paintings that he then sold below cost. The product is to assist Osbert in setting appropriate purchase and resale prices for three kinds of paintings, namely masterpieces, masterworks, and other paintings. The price of a painting is affected by such factors as the artist, the size, and the category of the painting. The product will specifically indicate the maximum purchase price and the minimum resale price for paintings in each category. (Schach, Classical and OO S/W eng, Chap. 10)

Quantifiable outcomes for Icebreaker project

1. Decrease use of de-icing compounds at least by 20%
 2. Decrease total road accidents at least by 10%
 3. Decrease road accidents due to icy conditions at least by 20%
- Caveats:
 - Must establish measures early on
 - Mutually agreed-upon by client and developers

Quantifiable outcomes for OOAD project

1. Decrease number of paintings sold at a loss at least by 50%
2. Increase OOAD's gross profits at least by 20%

Kinds of adjacent systems

1. Active adjacent systems

- Usually human
- Interactive behavior
- Easy to predict goals, aspirations...
- Reasonably reliable, but consider possible errors

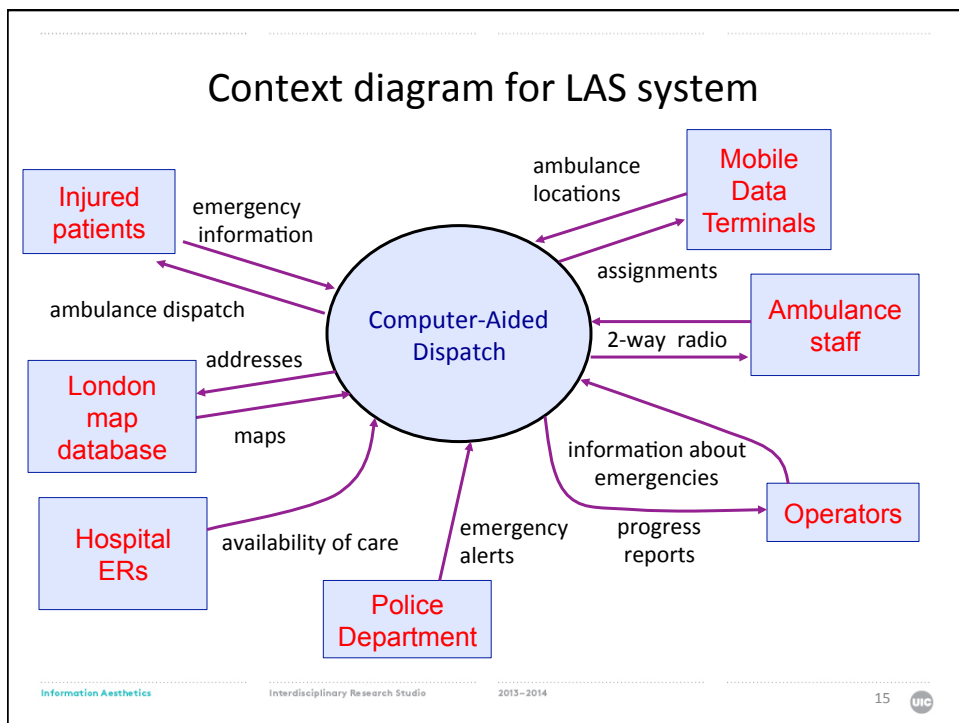
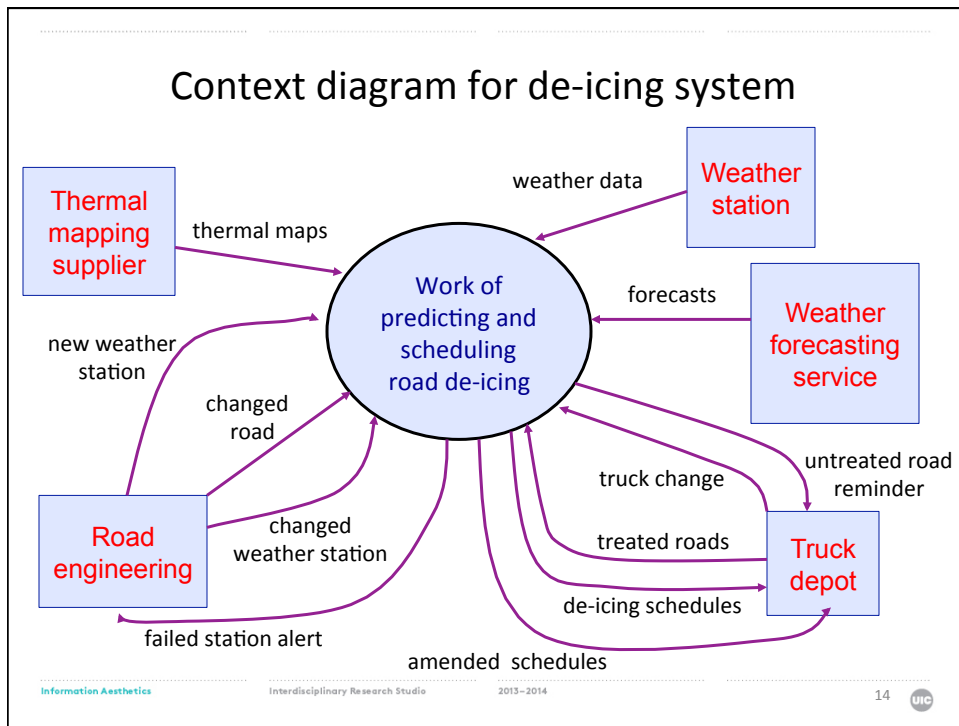
2. Autonomous adjacent systems

- One-way data flow
- External body
- E.g., weather station, forecasting service, etc.

Kinds of adjacent systems (cont'd)

3. Cooperative adjacent systems

- Usually computers or databases
- Reliably answer queries
- E.g., thermal map supplier



General guidelines

- Generally keep an open mind as to what system should do
- Understand the “work context”: (R&R, page 72)

“The work context includes anything that you are permitted to change, and anything that you need to understand to decide what can and should be changed.”

“The further away from the anticipated automated system you look, the more useful and innovative your product is likely to be.”
- Practical advise: Look at the Morningstar presentation on 8/29 for inspiration—No need to write statement of purpose explicitly but make sure you understand the needs of your clients and users well.

Business events

- **Business events:** Events that originate in adjacent systems and cause work to be performed
 - Action-triggered events
 - Time-triggered events

Business event identification

1. Starting from context diagram from blastoff, consider each information flow between “work” and an adjacent system
2. Analyze flow
 - What makes the flow happen? Focus on non-timed events
 - Discover the “**root cause**” for the flow
 - Question current practice
3. Redraw context diagram?
 - Include adjacent system in “work”?

Example of event identification

- Ambulance service operator receives phone call from patient or police
 - Is this a good event? This is standard practice
- But what was the root cause?
 - Someone getting injured or suffering an accident
- Can we improve current practice?
 - Consider all ways that adjacent system could communicate with “work”
 - Consider “aspirations” of adjacent system
 - Have call originate from car or text message?

Another example

- Incident happens; Policy-holder (or agent) writes claim; Insurance operator receives claim
 - Again, standard practice ...
- Root cause: Car accident, home intrusion, storm damage, etc.
- Can claim be filed electronically?
 - Adjacent system aspiration: Get payment and repair their house, car, etc. as quickly as possible

Deliverable of business event identification

- Table associating (1) business events with (2) (some) data flows in context diagram
- Recall context diagram for de-icing system

Event table for de-icing system

1. Weather Station transmits data	Weather data (i)
2. Weather Forecasting Service	Forecasts (i)
3. Road engineers advise changed road	Changed road (i)
4. Time to test weather station	Failed station alert (o)
5. Time to detect icy roads	Road de-icing schedule (o)
6. Truck treats road	Treated road (i)
7. Truck depot reports truck problem	Truck breakdown (i) Amended schedule (o)
....

Event table for hypothetical advisor system?

Business event	Information exchanged
Investor requests a trade	Requested trade (i) Trade data (o)
Investor requests advice	Investor question (i) Trading recommendations (o)
Company issues news report	Company news (i) New company outlook (o) Trading recommendations (o)
Investor reports life event	Life event (i) Modified financial plan (o) Trading recommendations (o)
Major political event or market crash.	Modified financial plan (o) Trading recommendations (o)
Time to check investor portfolio.	Modified financial plan (o) Trading recommendations (o)
...	...

Use case scenarios

- **Scenario:** Sequence of actions following business event
 - Sequence of steps, each step described in English
 - Typically, between 3—10 steps
 - Generally ignore conditions and if statements
 - Use different scenarios for different conditions
 - Normal-case vs. exception scenarios
 - Business use case vs. product use case scenarios

Example of business use case scenario

- Airline check-in procedure for international flight (Chapter 6, R&R)
 1. Get passenger's ticket or record locator.
 2. Is this the right passenger, flight and destination?
 3. Check passport is valid and belongs to passenger.
 4. Record the frequent flyer number.
 5. Find a seat.
 6. Ask security questions.
 7. Check baggage onto flight.
 8. Print and handover boarding pass and bag tags.
 9. "Have a nice flight."

Components of scenarios

1. Name
 - Examples: Check passenger into flight; Produce de-icing schedule
2. Triggering business event
 - Record locator, ticket, or identity and flight
3. Preconditions
 - Passenger has reservation

Components of scenarios (cont' d)

4. Active stakeholders
 - Passenger, clerk
5. List of actions
 - See previous slide

Scenario cases

- Scenarios typically have 4 kinds of cases
 1. Main cases: Typical case of normal behavior
 2. Alternative cases: Still normal behavior, scenario completes successfully
 3. Exception cases: Error conditions leading to scenario failure (e.g., expired passport)
 4. Misuse cases: Deliberate abuse of scenarios (e.g., attempted theft or fraud)

Scenarios: Normal vs. exception cases

- Normal cases cover successful business or product activities
- Alternative cases are other ways to accomplish a step
- Exception cases cover unexpected or erroneous conditions
 - What could go wrong in this step?
 - Could an adjacent system (human or electronic) fail to respond?
 - What happens if this step cannot be completed?
- Exception cases can be separate scenarios or substeps of main scenario steps
 - Alternative cases: Typically substeps

Scenarios: Breaking down steps

- Example: Check passenger passport
 3. Check passport is valid and belongs to passenger
 - 3.1 Passport must not expire before end of trip
 - 3.2 Passport must be valid for destination country
 - 3.3 Visa (when needed) must be current
 - 3.4 There is no “refused entry” stamp from destination country

Examples of other cases

- Example of alternative substeps:
 4. Attach frequent flyer number to the reservation
 - A4.1 Allow FF number to be changed to another airline
 - A4.2 Allow miles to be donated to charity
- Example of exception substeps:
 5. Find a seat
 - E5.1 Passenger's choice of seat not available
 - E5.2 Record request to change seat by gate agent

Example of misuse case

- Example of misuse substeps:
 3. Check passport is valid and belongs to passenger
 - M3.1 Passenger produces passport that is not his
 - M3.2 Call security
 - M3.3 Freeze reservation

Product use case scenario

- Based on business use case scenarios
 - After product boundaries identified, revise scenarios to describe work to be done by product

Example of business use case scenario

- Which of these would you automate?
 1. Get passenger's ticket or record locator.
 2. Is this the right passenger, flight and destination?
 3. Check passport is valid and belongs to passenger.
 4. Record the frequent flyer number.
 5. Find a seat.
 6. Ask security questions.
 7. Check baggage onto flight.
 8. Print and handover boarding pass and bag tags.
 9. "Have a nice flight."

Example of business use case scenario

- The answer:
 1. Get passenger's ticket or record locator.
 2. Is this the right passenger, flight and destination?
 3. Check passport is valid and belongs to passenger.
 4. Record the frequent flyer number.
 5. Find a seat.
 6. Ask security questions.
 7. Check baggage onto flight.
 8. Print and handover boarding pass and bag tags.
 9. "Have a nice flight."

Product use case scenario

- Product scenario: Subset of corresponding business use case scenario
 1. Get passenger's ticket or record locator.
 2. Record the frequent flyer number.
 3. Find a seat.
 4. Check baggage onto flight.
 5. Print and handover boarding pass and bag tags.

"What if" scenarios

- Promote product innovation by exploring infrequent scenarios, not considered previously
- Example: What if passenger calls during ride to airport?
 1. Passenger calls airline en route to airport
 2. Text passenger asking whether check-in desired.
 3. Check passenger, assign seat and send passenger passcode (to be scanned at airport).
 4. Text luggage tags to curbside check-in.
 5. "Have a nice flight".
- "What-if scenarios are intended to stimulate creativity and guide your stakeholders to come up with more innovative products."
(R&R, Chapter 6)

Product scenario for de-icing system

- Name: Produce road de-icing schedule
 1. Engineer provides a scheduling date and district ID.
 2. Product selects the relevant thermal maps.
 3. Product uses thermal maps, station readings, and weather forecasts to predict temperatures for each road section of district.
 4. Product predicts which roads will freeze and when they will freeze.
 5. Product schedules available trucks from relevant depots.
 6. Product advises the engineer of the schedule.

Product scenario for de-icing system

- Name: *Investor Requests Advice*
 1. Advisor reviews current financials of investor.
 2. Advisor reviews investor goals.
 3. Advisor checks performance and outlook of each item in investor's portfolio.
 4. Advisor suggests changes to investor's portfolio.
 5. Investor approves changes suggested by advisor.
 6. Advisor execute changes approved by investor .

Recommended reading

- Chapters IV, V and VI, Robertson & Robertson

Volere requirements template

- A way of organizing requirements
- Covers pretty much everything that we have seen
- Just decide where to put each requirement within template
- More info at <http://www.volere.org>

Organization of template

- Five parts; each part divided into sections
 1. Project drivers
 2. Project constraints
 3. Functional requirements
 4. Non-functional requirements
 5. Project issues
- Caveat: Not synchronous with requirements process
 - Scope of work, a blastoff deliverable, goes under (3)

Detailed organization of template

- Project drivers
 1. Project purpose
 2. Clients, customers, other stakeholders
 3. Users of product
- Project constraints
 4. Mandated Constraints
 5. Naming Conventions and Definitions
 6. Relevant Facts and Assumptions

Detailed organization of template

- Functional requirements
 7. Scope of work
 8. Scope of product
 9. Functional and data requirements

Detailed organization of template

- Non-functional requirements
 10. Look-and-feel
 11. Usability
 12. Performance
 13. Operational
 14. Maintainability and Support
 15. Security
 16. Cultural and Political
 17. Legal

Detailed organization of template

- Project issues
 18. Open Issues
 19. Off-the-shelf Solutions
 20. New Problems
 21. Tasks
 22. Cutover
 23. Risks
 24. Costs
 25. User Documentation and Training
 26. Waiting Room
 27. Ideas for Solutions

Section 2: Stakeholders

- Examples of stakeholder requirements

“The client for this product is Mack Andrews, the chief executive of Saltwork Systems.”

“The customer of this product is the Northumberland County Highways Department, represented by director Jane Shaftoe.”

“Saltwork Systems eventually hopes to sell this product to other counties in the United Kingdom, and modified versions of this product to agencies in other countries as well.”

Example of users requirement

“Engineers located at the truck depot are the main user group. The engineers have a detailed knowledge of road types, road locations, and road networks. They are all experienced in using personal computers for a wide variety of applications, including word processing and computer-aided design. All have a degree in engineering, and all speak English. Sonia Henning is the Road Engineering Supervisor.”

Section 4: Mandated constraints

- Current hardware constraints

“The product will be used on the personal computers currently in the offices of the Highways Department.”

“The product must interface with the existing Mobile Data Terminals located in ambulance units.”

- Partner applications

“The product must interface with the Thermal Mapping DB.”

“The product must interface with the Road Engineering Software System.”

Section 5: Naming conventions

- Project glossary
 - Define terms, especially from domains of interest
 - “Weather station: A collection of hardware devices capable of measuring air temperature, humidity, precipitation, and road temperature. Four roadside sensors can be attached to one weather station. Each sensor must be within 1 km of the weather station.”
- Dictionary of included models
 - Explain data flows of models in SRS

Section 6: Relevant facts and assumptions

- Miscellaneous information about project and domains of interest, e.g.,
 - “A ton of de-icing compound can treat 3 miles of single lane road.”
 - “The treatment trucks being built will operate at speeds up to 40 miles/hour. They will have a material capacity of two tons.”
 - “De-icing will stop at county boundaries.”
 - “A treated road will not require further treatment for at least 2 hours.”

Section 6: Relevant facts and assumptions

- Additional examples

“Roads treated with Sodium Chloride (NaCl) freeze below 10 degrees Fahrenheit. Roads treated with Calcium Chloride (CaCl) freeze below 5 degrees Fahrenheit.”

“The Bureau’s forecasts will be transmitted according to its specification 1003-7 issued by its engineering department.”

Additional advice (cont'd)

- Replace above with following requirements:

“The product shall determine the temperature of the road adjacent to the weather station”

“The product shall extrapolate temperatures for each meter of road using the thermal map.”

“The product shall predict the temperature for each road-meter for each ten minute interval using the weather forecast.”

“The product shall record roads where ice will form within the given time parameter.”

Look-and-feel and usability

- Important kind of NFRs, but hard to pin to fit criteria
 - Usability alone can make or break product
 - Think iPod (for better) or LAS system (for worse)
- Often fit criteria expressed as percentage of satisfied users, e.g.,
 - “The personnel consultants will like the product.”
 - “Fit criterion: Seventy-five percent of consultants will prefer to use the product after a six week familiarization period.”