CS1632, Lecture 3: Requirements

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What are requirements?

- The specifications of the software
  - Often collected into a SRS, Software Requirements Specification
  - SRS comes in legal binders hundreds of pages long
- That is, the finished software is required to meet the requirements
- This is how developers know what code to write, and (more importantly for this class), testers know what to test

Do you need requirements?

- Do you really need that hundreds of pages long legal binder?
- Yes?
- No?

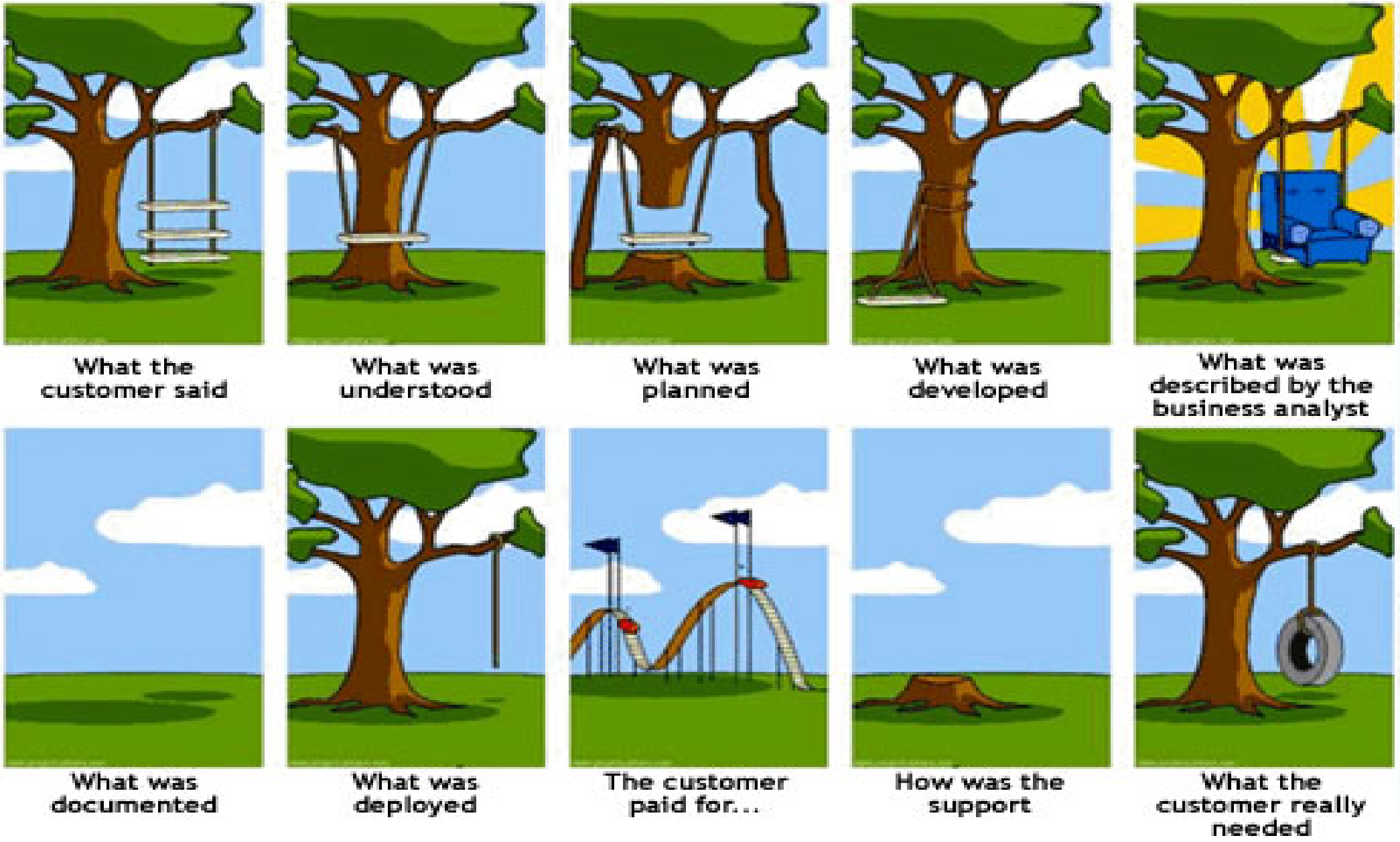
Requirements Example – Bird Cage

- The cage shall be 120 cm tall.
- The cage shall be 200 cm wide.
- The cage shall be made of stainless steel.
- The cage shall have one dish for food, and one dish for water, of an appropriate size for a small bird.
- The cage shall have two perches.
- At least 90% of birds shall like the cage.

Problems With Our Requirements?

- What if the cage is 120.001 cm tall.. OK?
- What if the cage is 120 km tall.. OK?
- Is 120 cm tall and 200 cm wide an appropriate size for a small bird?
- How can we know birds like it?
- Do we have to ask all the birds in the world to see if 90% like it?
- Food dishes are plastic... OK?
- The perches are wood... OK?
- 2 cm gaps between cage wires... OK?
- 60 cm gaps between cage wires.. OK?
- How many birds should it support?
- Cage has no door... OK?
- Cage has 17 doors, which are opened via elaborate puzzles... OK?

Most software is more complex than a bird cage!



You need to understand requirements!

- Why? Because they describe the expected behavior!
  - Expected behavior vs observed behavior is the foundation of testing software
- A Software Requirements Specification (SRS) is in a sense a contract
  - A (legal) contract between user, developer, and tester
- Requirements are not (usually) set in stone and do evolve
  - But a clear understanding of them is crucial during the entire process
  - As a QA engineer, you will participate in its evolution

Requirements should say WHAT to do, not HOW to do it!

- **GOOD:** The system shall store all logins for future review.
- **BAD:** The system shall use an associative array in a singleton class called AllLoginsForReview to store all logins.

- **GOOD:** The system shall support 100 concurrent users.
- **BAD:** The system shall use a BlockingQueue in order to support 100 concurrent users.

Requirements should say WHAT to do, not HOW to do it! Why?

- User cares about what the behavior is, not how it happens
  - Generally true for (almost) all software
- Specifying how restricts developers from improving implementation
- Black-box testing is impossible if implementation details are required
  - End-user would need source code to verify requirements have passed

Verification vs Validation

- Verification – Are we building the ***software right***?
  - Ensure that requirements are met by software (testing)
  - Ensure that there are no unexpected failures, observed behavior meets the requirements, corner cases are handled, etc.

- Validation – Are we building the ***right software***?
  - Ensure that software does what customer/user actually wants
  - Ensure that requirements don’t contain any inconsistencies
  - Ensure that requirements are verifiable

Requirements Validation

- Should happen before writing the first line of code
- Should happen throughout development as requirements evolve
- Aspects of requirements validation:
  - Validity check – does SRS align with user needs?
  - Completeness check – does SRS cover all aspects of software?
  - Consistency check – is SRS internally consistent? Any conflicts?
  - Realism check – is SRS realistic in terms of technology / budget / delivery date?
  - Ambiguity check – does SRS contain room for interpretation?
  - Verifiability check – are the requirements something that can be tested?

Validity Check

- Requirements should align with stakeholders needs and wants
- Common misconceptions
  - Misconception: “More is better” – more functionality, more modes, etc.
    Truth: “Less is more” – ease-of-use and elegance suffers with “more”
  - Misconception: Stakeholders are limited to users
    Truth: Stakeholders include users, operators, managers, investors
  - Misconception: Stakeholders know what they need and want
    Truth: What looks good on paper often is a flop when seen in real life
    ☛ Motivation to do early prototyping and demos in front of stakeholders

Completeness Check

- Requirements should cover all aspects of a system
  - Anything not covered is liable to different interpretation
  - If you care that something should occur a certain way, it should be specified

Consistency Check

- Requirements must be internally consistent
  - Requirements must not contradict each other.
- Example
  - Req 1: "The system shall shut down if the temperature reaches **-20 C**“
  - **BAD** Req 2: "The system shall turn on LOWTEMP warning light whenever temperature is **-40 C** or colder."
  - **GOOD** Req 2: "The system shall turn on LOWTEMP warning light whenever temperature is **0 C** or colder."

Realism Check

- Requirements must be realistic in technology / budget / delivery date
- Example
  - **BAD:** The system shall communicate between Earth and Mars with a round-trip latency of less than 25 ms (That's faster than the **speed of light**!).
  - **GOOD:** The system shall communicate between Earth and Mars with a round-trip latency of less than 42 minutes at apogee and 24 minutes at perigee.
- Is it unrealistic to communicate faster than the speed of light?
  - Quantum entanglement signaling is known to travel faster than speed of light
  - Then, question becomes can you deliver system within budget by delivery date

Ambiguity Check

- Requirements should not be open to interpretation
- Example
  - **BAD**: When database stores an invalid Date, it shall be set to default value.
  - **GOOD:** When database stores an invalid Date, it shall be set to 1 Jan 1970. (1 Jan 1970 happens to be time “0” in all Unix and Linux systems)
- Example
  - **BAD**: The system shall on error shut down gracefully in a timely manner.
  - **GOOD:** The system shall on error store all pending requests in a checkpoint file configurable on the command line and then shut down within 5 seconds.

Verifiability Check

- Requirements must be testable
  - Should be documented to the level where it is testable
  - Should be testable within the given budget and delivery date
- Example
  - **BAD**: The calculator subsystem shall be awesome.
  - **GOOD**: The calculator subsystem shall include functionality to add, subtract, multiply, and divide any two integers between MININT and MAXINT.
- Example
  - **BAD:** The system shall process a 100 TB data set within 4,137 years.
  - **GOOD:** The system shall process a 1 MB data set within 4 hours.

FUNCTIONAL REQUIREMENTS AND QUALITY ATTRIBUTES (NON-FUNCTIONAL REQUIREMENTS)

- **Functional Requirements**
  - Specify functional behavior of system
  - The system shall do X [under conditions Y].
- **Quality Attributes**
  - Specify overall qualities of system, not a specific behavior
  - The system shall be X [under conditions Y].
- Note “do” vs “be” distinction!

FUNCTIONAL REQUIREMENT EXAMPLES

- **Req 1:** The system shall return the string "NONE" if no elements match the query.

- **Req 2:** The system shall turn on the HIPRESSURE light when internal pressure reaches 100 PSI.

- **Req 3:** The system shall turn off the HIPRESSURE light when internal pressure drops below 100 PSI for more than five seconds.

QUALITY ATTRIBUTE EXAMPLES

- **Req 1** - The system shall be protected against unauthorized access.
- **Req 2** - The system shall have 99.999 uptime and be available.
- **Req 3** - The system shall be easily extensible and maintainable.
- **Req 4** - The system shall be portable to other processor architectures.

SOME CATEGORIES OF QUALITY ATTRIBUTES

- Reliability
- Usability
- Accessibility
- Performance
- Safety
- Supportability
- Security

You can see why quality attributes are sometimes called "-ility" requirements!

Quality attributes are often more difficult to test than functional requirements.

- Why?

- Can be very subjective
- Often difficult to measure
- No standardized rules for considering them "met"

Solution

Agree with stakeholders upon quantifiable requirements that ensure quality.

Converting Qualitative to Quantitative

- **Performance:** transactions per second, response time
- **Reliability:** Mean time between failures
- **Robustness**: How many failures can the system cope with
- **Portability:** Number of systems targeted, or how long it takes to port
- **Safety:** Number of accidents per year
- **Usability:** Average amount of time required for training
- **Accessibility**: Percentage of population who can use system

Qualitative to Quantitative Example

- Quality attributes should be expressed in a quantitative way
  - Or else they are ambiguous
- Example
  - **BAD:** The system shall be highly usable.
  - **GOOD:** Over 90% of users shall have no questions using the software after one hour of training.
- Example
  - **BAD:** The system shall be reliable enough to be used in a space station.
  - **GOOD:** The system shall have a mean-time-between failures of 100 years.

Now Please Read Textbook Chapters 5

- If you are interested in further reading:

  IEEE Recommended Practice for
  Software Requirements Specifications (IEEE Std 830-1998)

- Can be found in resources/IEEE830.pdf in course repository