Documentation & Maintenance

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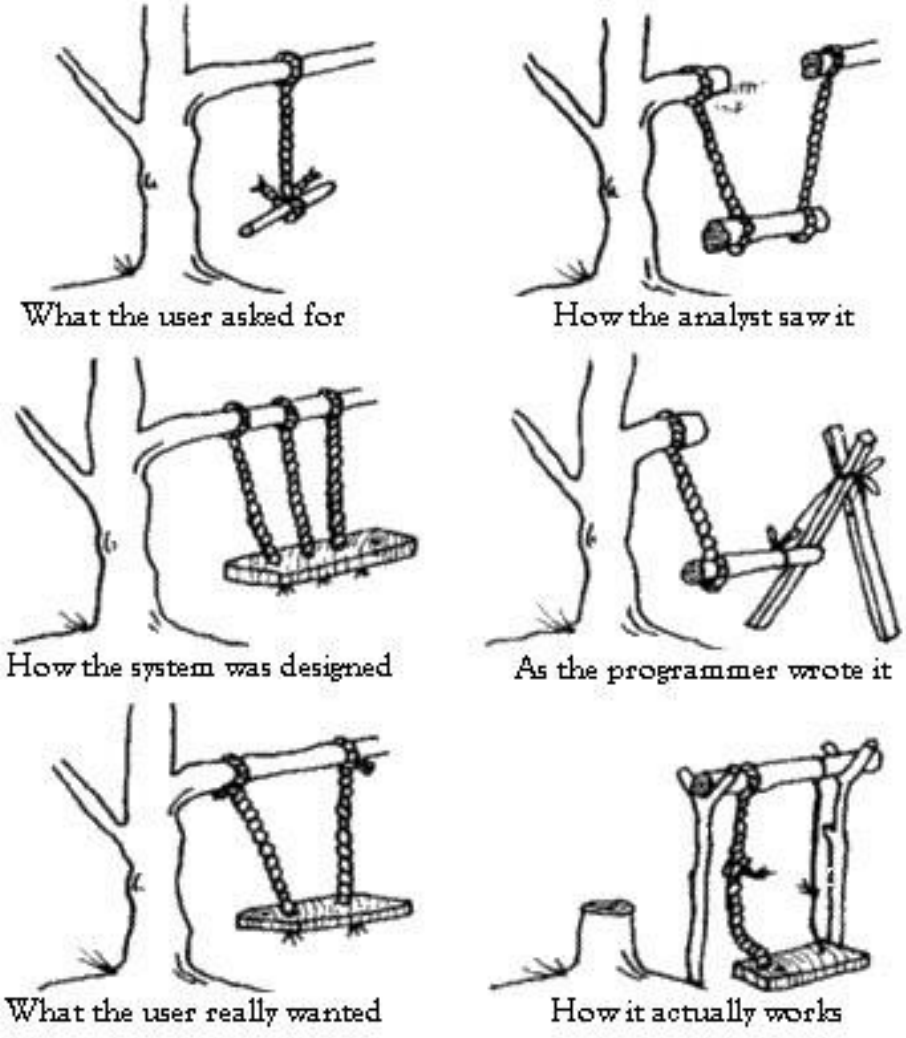
Documentation

Why documentation?

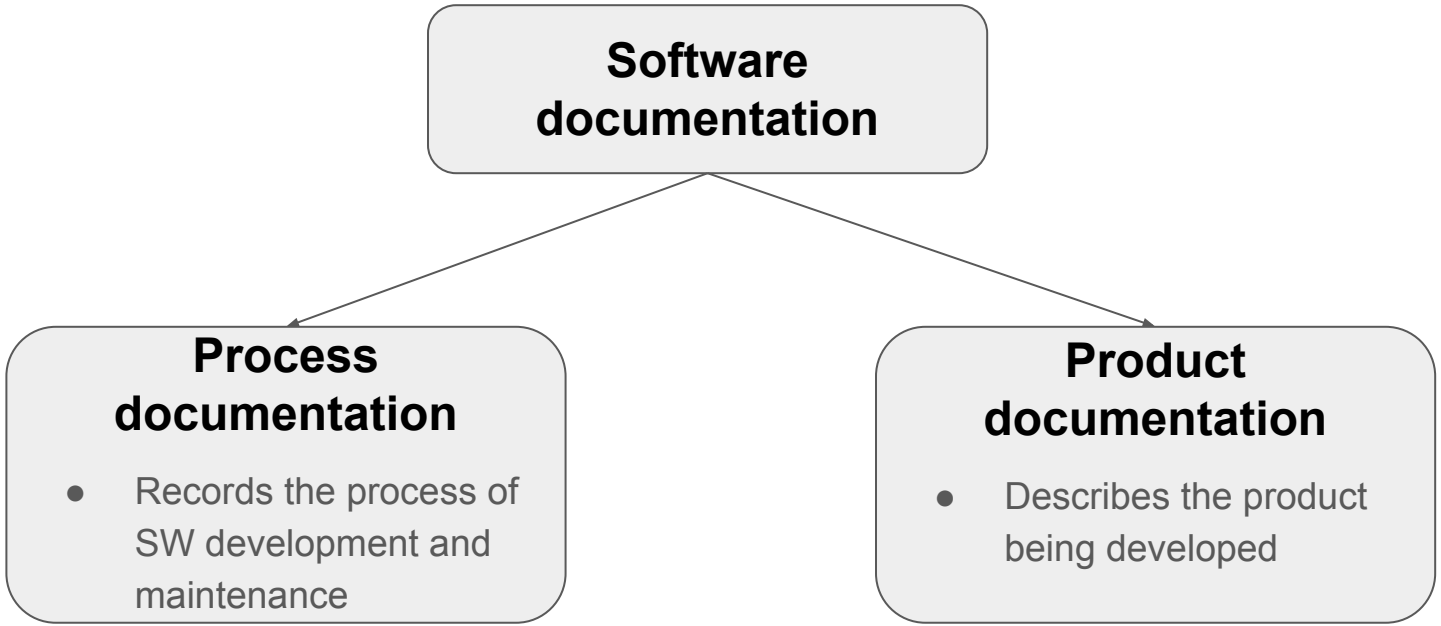
1. Facilitates communication
   - Within the development team itself
   - Between the development team and the project management
   - With customer
2. Records contracts and agreements



Why documentation?

3. Provides information
    - For users and system administrators
    - For future maintenance
    - For project management

Classification



Process documentation:

-> Records the process of SW development and maintenance

- PM documents
  - Predict and control the SW process
  - E.g., schedules, plans, estimates
- Reports
  - Report resource usage during the SW process
  - E.g., amount of man-days consumed, deadlines satisfaction
- Standards
  - Set out how the SW process is to be implemented
  - E.g., coding standards, documentation standards
- Communication documents
  - Record the details of everyday communication
  - E.g., memos, e-mail discussions, meeting minutes, version history

➢ These documents becomes quickly **out of date**!

Product documentation

-> Describes the product being developed

➢ These documents have **longer** lifespan

1. **System documentation** -> Describes how the system works
   - Requirements
   - Architecture & design
   - Source code listings (commented)
   - Validation & verification documents (testing,..)
   - Maintenance documents (List of Known Bugs, HW and SW dependencies, ..)
2. **User documentation** -> Tells user how to use the SW product
   - Should take into account all relevant user classes
     - E.g., end users vs. system administrators
   - Should take into account various levels of expertise
     - E.g., beginners -> screenshots, tutorials, use cases/scenarios
       advanced users -> function reference, detailed description

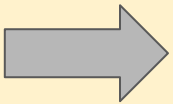
➢ Where does API documentation belong?

➢ Is it easy to change it after publishing?

Document form

- Documents - Office, PDF, text, HTML,..
- Diagrams - UML, ..
- Wiki
- Document/content management systems
- E-mail messages
- Bug/issue reports
- Version history
- …

Each (product) document provides a separate view of the system and these views overlap



It is important to keep all documents up-to-date and mutually consistent !

Documentation management

- Amount of documentation grows quickly
- It is inevitable to manage the documentation efficiently
  - Use predefined document templates
  - Specify location for each type of document clearly
  - Use document (content) management systems
  - Use version control
  - Generate documentation automatically (Doxygen, NDoc, javadoc, EiffelStudio, Sandcastle,...)
  - Swagger/OpenAPI example: PetStore
- Recommended minimal system documentation:
  - Requirements specification, architecture/design documents, commented source code

➢ It is better to provide a minimal but up-to-date and consistent documentation than a comprehensive but poorly maintained documentation

Maintenance & Operations

Software maintenance

= Modifying a system after it has been put into use

✓ Modifies existing components

✓ Adds new components to the system

x (Normally) does not significantly change the system's architecture

Maintenance is not only bug fixing!

But also: adapting the software to changing requirements, changing environment, ...

➢ In fact, corrections represent only about 25% of all maintenance tasks

Why software maintenance?

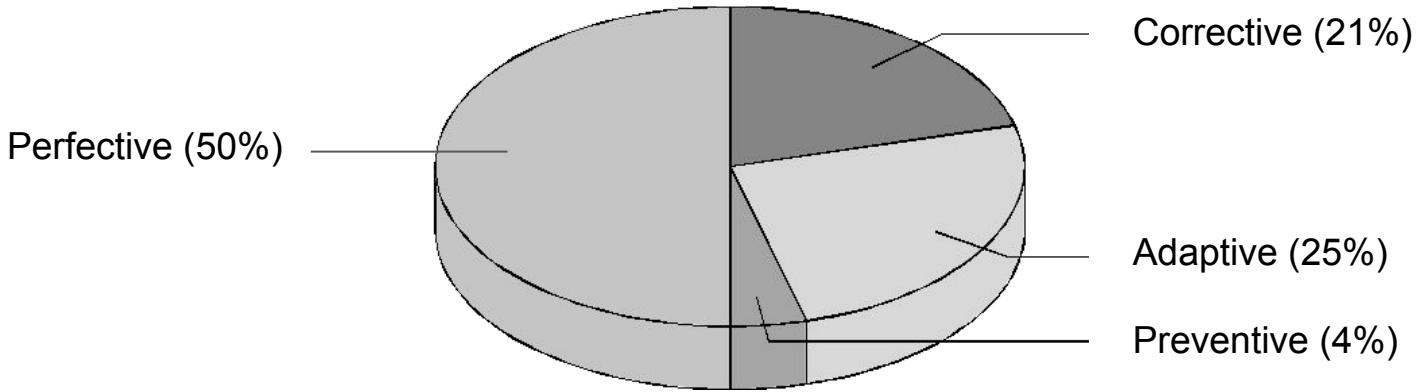
Environment of system operation changes in time

-> Requirements on system changes in time (and new requirements emerge)
-> Systems MUST be maintained if they are to remain useful in an environment

Maintenance may significantly overlap with development in agile approaches !

Types of maintenance (ISO/IEC 14764)

1. Adaptive: Modifying the system to cope with environment changes (computer, OS, etc.)
2. Perfective: Modifying the system to satisfy new or modified requirements
3. Corrective: Correcting discovered problems
4. Preventive: Detecting and correcting latent faults before they become effective faults



(Lientz and Swanson,, 1980)

Why does software maintenance cost so much?

- It is usually more expensive to add functionality after a system has been developed rather than design this into the system
- Expensive activity: To figure out
  - WHAT part of code to modify and
  - HOW to modify it

- Overall maintenance costs:
  - Usually 2* to 100* greater than development costs (Ian Sommerville, 2000)
  - Affected by both technical and non-technical factors

Factors affecting maintenance cost

- Team stability
  - Costs are reduced if the same staff are involved for some time
  - In case of staff turnover, "cultural" knowledge of the software is lost
- Contractual responsibility
  - The developers of a system may have no contractual responsibility for maintenance so there is no incentive to design for future change
- Staff skills
  - Maintenance staff are often inexperienced and have limited domain knowledge
  - Maintenance is generally considered as an unglamorous task and is typically assigned to the team newcomers
- Inadequate configuration management
  - Different representations of a system are out of step

Factors affecting maintenance cost

- Inadequate documentation
  - Insufficient, incomplete, inconsistent or out-of-date documentation makes it more difficult to understand the system
  - Reverse engineering may help
- Inflexible design/architecture
  - The architecture and/or design of the system is too rigid to allow for simple implementation of requested changes
  - Costs are increased especially in case that significant changes in original software design are not allowed
- Program age and structure
  - Programs are poorly structured already during the initial development
  - As programs age, their structure is degraded and they become harder to understand and change (e.g., old languages, compilers, programming styles, design patterns)
  - Maintenance corrupts the software structure so makes further maintenance more difficult.

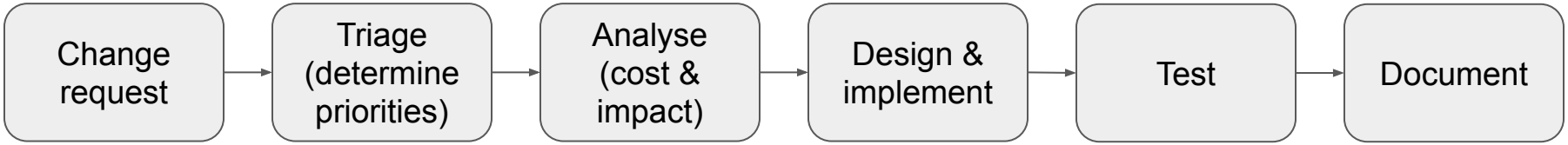
Well-known maintenance examples

- Y2K (1.1.2000) - worldwide
- SKK -> EUR (1.1.2009) - Slovakia

→ Many systems had to be updated
→ In both cases, complex analysis was needed
(find where changes need to be made)

Maintenance process

- Complex and varied (depends on type of maintenance)
- In general - structured maintenance:



- Unstructured maintenance (emergency repair):

Clearly structured maintenance is a more reliable and (usually) a more efficient process - unfortunately, it's not always possible

Maintainable software

- Good initial design & architecture
- Understandable software structure
- Accurate documentation
- Good configuration management
- Use of standards (design, language, coding, etc.)

Operations

= managing, deploying, maintaining, and supporting software systems in a production environment

Traditional setup:

- Separate deployment and operations
- Developers hand off completed code to operations for deployment
- Often caused delays and inefficiencies

Infrastructure as a Code:
Code is used both for SW implementation and for infrastructure management (Terraform, Ansible, Kubernetes, ..)

Modern CI/CD pipelines

- Code is tested and deployed continuously, via automation tools
- Development and deployment processes overlap:
  - ➢ Developers need to understand operations (like infrastructure management) to build deployable code
  - ➢ Operations teams need to understand the application logic to solve issues and optimize performance

DevOps

= a set of principles that aim to integrate and automate the work of development and IT operations

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