Writing Requirements

A User-Centered Human-Machine Systems Engineering Process

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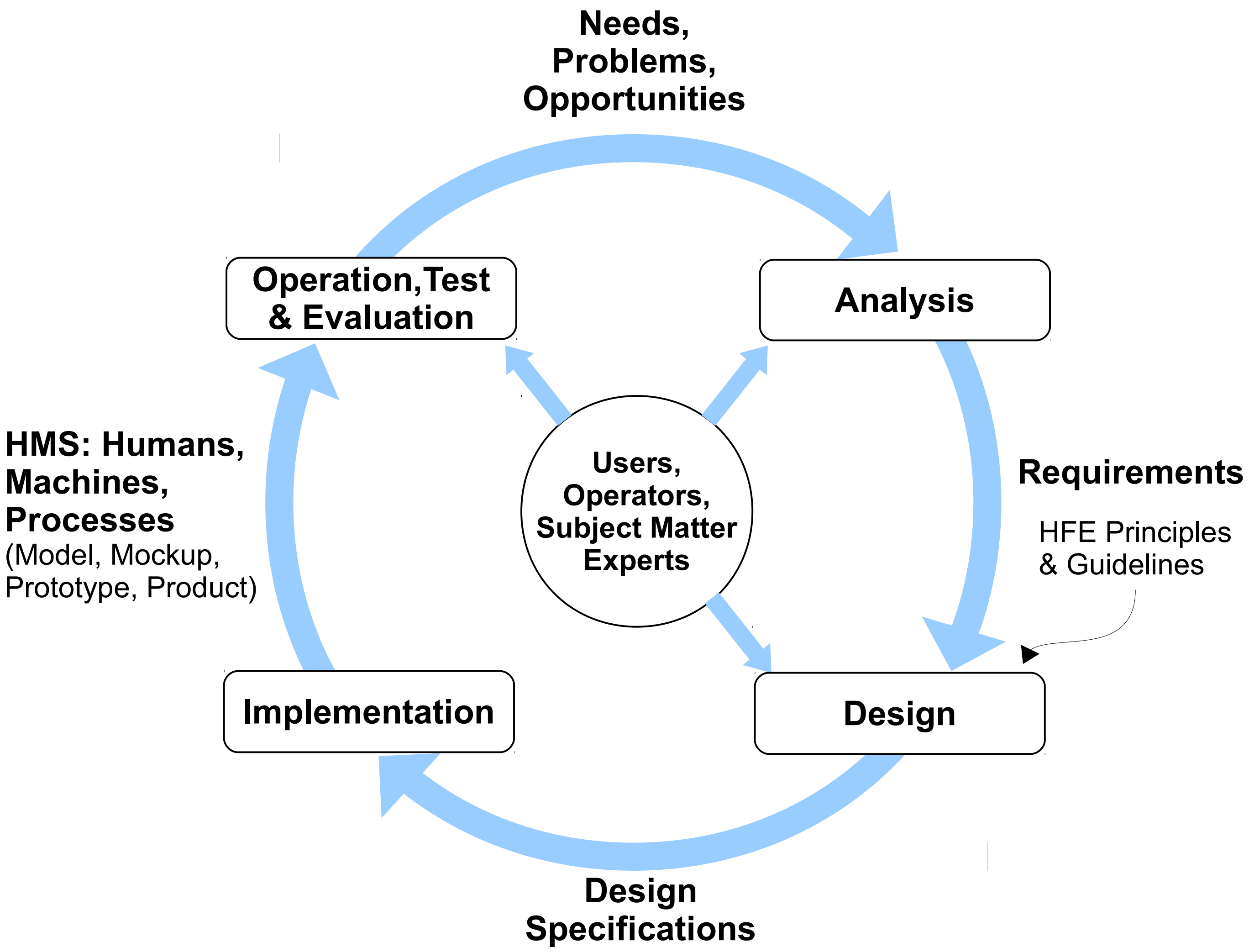
Needs,
Problems,
Opportunities
Operation,Test & Evaluation
Analysis
Users, Operators, Subject Matter Experts
HMS: Humans, Machines, Processes
(Model, Mockup, Prototype, Product)
Requirements
HFE Principles & Guidelines
Implementation
Design
Design Specifications

Writing Requirements

Guidelines for a Requirements Document:

- Requirements state something:
  - Necessary
  - Verifiable
  - Attainable
  - and they state it clearly.
- Common Problems:
  - Making bad assumptions
  - Writing implementation (HOW) instead of requirements (WHAT)
  - Describing operations instead of writing requirements
  - Using incorrect terms
  - Using incorrect sentence structure or bad grammar
  - Missing requirements
  - Over-specifying

Making bad assumptions

- No access to appropriate information
  - Solution: Make information available to all authors by, e.g.,
    - Notebook
    - Website
- Information does not exist
  - Solution: Authors should document all assumptions

Writing implementation (HOW) instead of requirements (WHAT)

- Example:
  - The workstation shall include an RDM hydraulic lift, adjustable-height work table. (IMPLEMENTATION)
- The requirement should state WHAT is needed not HOW it is to be provided.
- Solution: Ask the question: WHY do you need the requirement?

Writing implementation (HOW) instead of requirements (WHAT)

- Answers:
  - Workers of both genders and various sizes will use the workstation, seated or standing.
  - A typical workpiece requires handwork above the surface supporting it.
  - By ergonomic guidelines, the workpiece should be slightly (~2”) below elbow level.
- This is real requirement:
  - The workstation shall be adjustable so that the work surface is between 20.3” and 45.9” above the floor.
- It leaves lots of options open for implementation.

Describing operations instead of writing requirements

- Similar to the implementation problem
- Examples:
  - Tools shall be returned to dedicated storage spaces when they are no longer needed. (OPERATION)
  - Workers shall place the parts needed for each widget in a separate container for temporary storage and transportation. (OPERATION)
- Real Requirements:
  - A dedicated storage space shall be provided for each tool.
  - A means shall be provided for temporary storage and transportations of the parts required for each widget.

Using Incorrect Terms

- Use of Terms:
  - Requirements use the word “shall”.
  - Statements of fact use “will”.
  - Goals use “should”.

- Terms to avoid:
  - support
  - but not limited to
  - etc.
  - and/or

Using incorrect sentence structure or bad grammar

- Requirements should be easy to read and understand.
- Format:
  - Means shall be provided to …
  - The system* shall be capable of …
  - The system* shall weigh no more than …
  - Users of unexceptional skill shall be able to ...

  - Subsystem #1* shall provide
  - Subsystem #2* shall interface with …

  * Note: The name of the system and subsystem appears in these locations; if the system name is complex, use acronyms.

- Guidelines:
  - Each “shall” should be followed by a single predicate, not by a list.
  - Should not be complicated by explanation of operations, design or other information.

Unverifiable Requirements

- Avoid ambiguous terms:
  - Minimize
  - Maximize
  - Rapid
  - User-friendly
  - Easy
  - Sufficient
  - Adequate
  - Quick
- Be specific.
  - How rapid? 10 per hour, 5 per hour.
  - What is sufficient? 10 units, 100 units.
  - What is user-friendly?
- If you are not sure yet,
  - enclose the term in asterisks (e.g., *rapid*).

Missing requirements

- Use models and other elaboration tools to make sure every aspect of the system is specified.
- Requirements Drivers Checklist (i.e., possible requirements to include) →

- ✓ Functionality
- ✓ Performance
- ✓ Interface
- ✓ Environment
- ✓ Facility
- ✓ Transportation
- ✓ Deployment
- ✓ Training
- ✓ Personnel
- ✓ Reliability
- ✓ Maintainability
- ✓ Usability/Operability
- ✓ Safety
- ✓ Regulatory
- ✓ Security
- ✓ Privacy

Over-specifying

- Major cause of cost overruns and delivery time delays.
- Ask the question why it is needed before writing it as a requirement.
- Be aware of over stringent requirements
  - Allow for tolerances (i.e. if height of a table is specified to be 1000 mm allow for variations, such as 1000 +/- 10mm)

Validation: Making Sure the Requirements Are Correct

- Examine the requirements for:
  - Ambiguity
  - Inconsistencies
  - Completeness/Omissions
  - Errors
- Validation reviewers:
  - Engineers
  - Users
  - Customers
  - Other stakeholders

IE 545 Requirements Management

- Organization of requirements
  - by system processes
  - by categories (functionality, user interface, etc.)
- Optional: Recorded in HMSE workbook
  - Requirement Number
  - Requirement Text
  - Process/Activity ID & Name
  - Author
  - Requirement Status
    - preliminary: not yet verifiable
      ≈ House of Quality Customer Requirement
    - unmet: verifiable but not yet met
      ≈ HoQ Engineering Requirement (unmet)
    - met: verifiable and met
      ≈ HoQ ER (met)
  - Test Procedure
  - Comment

Requirements Examples

SMART: Guidelines For Checking Requirements

S Specific? Well defined and clear to anyone involved in the product/process.

M Measurable? Have a way of quantifiable measurement to know when the requirement is reached, or at least the potential for that. Some flexibility in Customer Requirements.

A Agreed Upon? Agreement between both you and your customer.

R Realistic? Within the availability of resources and knowledge.

T Time Based? Enough time to produce the desired result.