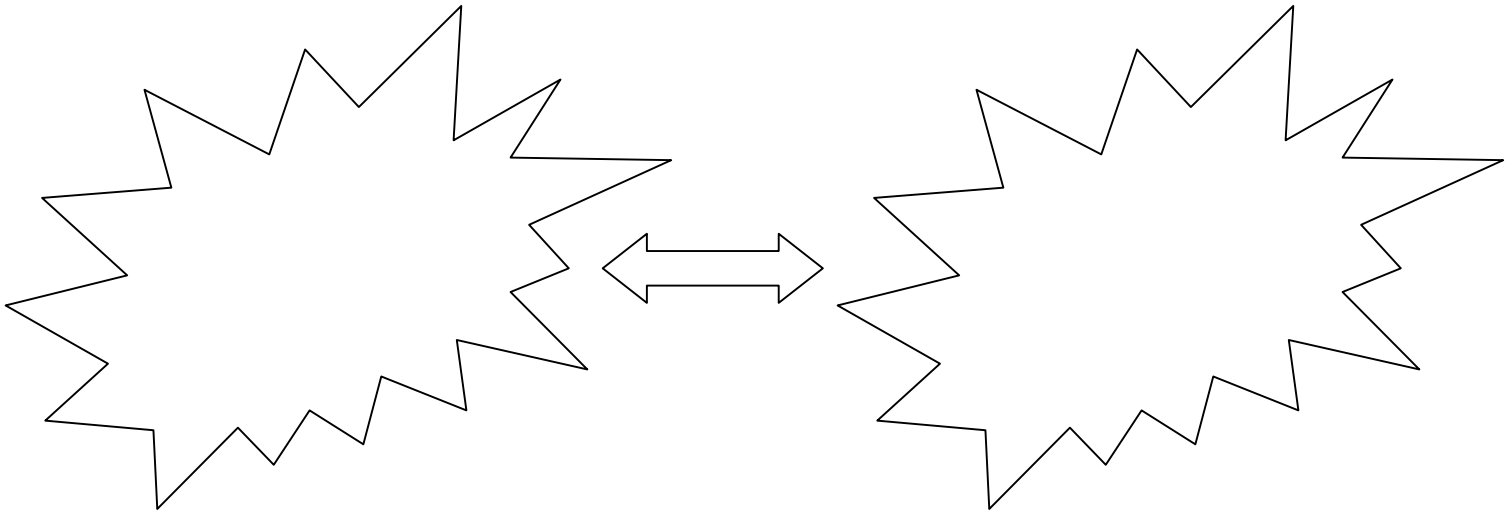
What is a requirement

- IEEE Standard Glossary of Software Engineering Technology: A requirement is:
  1. A condition or capability needed by a user to solve a problem or achieve and objective.
  2. A condition or capability that must b e met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document
  3. A documented representation of a condition of capability as in 1 or 2
- User view: What - all about the user's domain
- Developer view: How - all about the software development domain

The Gap: Customers understand the business domain; Developers the systems development domain



System development domain **Business domain**

Requirements are an attempt to bridge the Gap

Chaos article factors

Success	Challenged	Impaired
user involvement	lack of user input	incomplete requirmts
executive support	incomplete requirmts	lack of user input
clear requirements	changing requirmnts	lack of resources

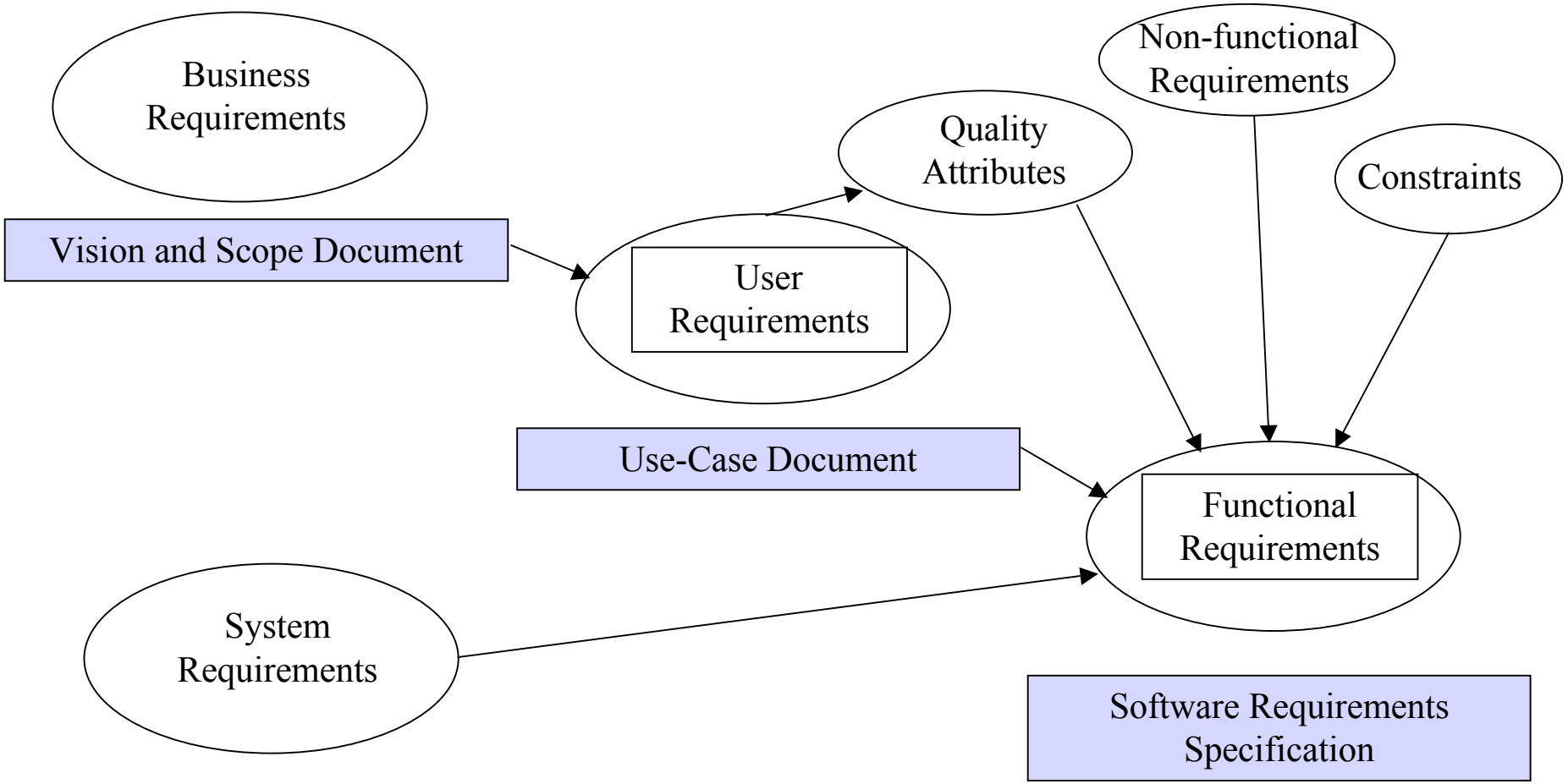
Success potential (these factors, weighted, have been used to evaluate and predict success in actual cases)

- user involvement
- exec management support
- clear statement of requirements
- proper planning
- realistic expectations
- small project milestones
- competent staff
- ownership
- clear vision
- hardworking staff

Recommendations

- Lots of milestones
- Iterative development

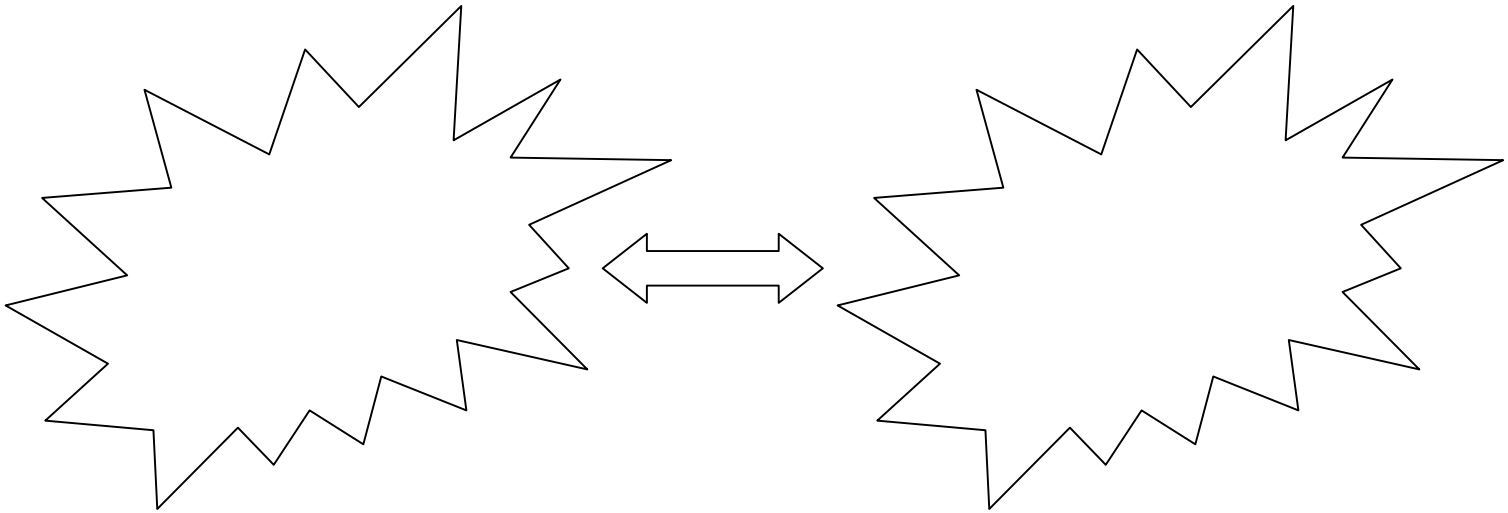
How do you develop software requirements?



Customer oriented practices can increase the likelihood of a successful outcome

- Proactive approach to communication aimed at
  - mutual understanding
  - clear, timely communication
- Leads to better relationship
  - improved perception of SW development for the customer
  - improved perception of the business issues by the development team
  - increased visibility/transparency
- Functionality, timeliness, and quality that match customer needs

Bridging the Gap: Step1 - Vision and scope document
Develop understanding before committing to requirements



System development domain

Business domain

(*remember: this is the only reason engineers are needed!*)

Add structure to the development *process* that encourages understanding of the important role of the customer

- Budget time and $$ for
  - review meetings
  - client management
  - client monitoring of progress
  - clarifying project goals and requirements
- clearly defined points of
  - contact
  - responsibility

KEY: Customer needs to understand the level of commitment required and the impact of not living up to their commitments BUT think Win-Win

Levels of Requirements

- Business requirements
  - ⇒ Project vision and scope
- User requirements
  - ⇒ use case or scenario descriptions
- Functional and non-functional requirements
  - ⇒ Software Requirements Specification
    - ⇒ Development
    - ⇒ Testing
    - ⇒ QA
    - ⇒ Project Management (schedule, budget, etc.)

Risks from inadequate requirements

- Insufficient user involvement
- Feature Creep
- Gold plating
- Minimal specification
- Overlooked use cases
- Inaccurate planning

Can you add to this list? Any actual cases you can discuss?

Requirements engineering

Requirements Engineering

Requirements development
- Elicit
- Analyze
- Specify
- Verify

Requirements management
- Define baseline
- Process for change
- Tracking status

Agenda for Labs: Prepare for client meeting (schedule it!)

- Project notebook (journal):
  - Meeting minutes
  - Team makeup etc.
- Think about your approach to gaining a background understanding before your next client interview (detail a process)
- Information sources for *competitive intelligence* - Web, books
- Create a very preliminary set of questions (think about what you think the answers are:)
  - client's desired outcome, how this SW differs from what is available
  - what tradeoffs is the client willing to make given time and budget constraints
- **Assign action items for each member of the group**

Dealing with the client:
How customers pose risks to project success

Customers

- don't understand what they want
- won't commit to written requirements
- insist on new requirements without understanding impacts
- are slow to respond to communication
- will not participate in reviews
- technically unsophisticated
- insist on being involved (inappropriately) in technical details
- don't understand the process
- are new!!

This is "normal" to some extent even with the "best," most sincere and diligent clients

Good rapport is easier said than done

- Both sides consider canceling 40% of all out-sourced projects and 65% of all fixed price contracts

Customers

impossible delivery dates

new requirements without additional $$

omitting clear acceptance criteria

inadequate involvement

inadequate visibility

Developers

promising impossible schedules

bidding too low

lacking skills

low quality

missed deadlines

Business and user requirements

Business Requirements

Why

Guiding framework
- product concept
- business rationale

Describe objectives that
- customer wants to achieve or value the system provides

User Requirements

What

Actual system behavior
- Tasks that need to be performed
- Non-functional characteristics

Describe with use case and user scenarios

Stages of requirements development

- Business requirements

  ⇒ Project vision and scope
- User requirements

  ⇒ Use case or Scenario descriptions
- Functional and non-functional requirements (distinction? Look!)

  ⇒ Software Requirements Specification

Fact: Requirements change

Build in flexibility -- Even if you don't use it - it improves resulting design (don't overdo it! cf Agile/Xtreme philosophy!)

- Design
  - reviews
  - build in time for changes (when appropriate)
- Implementation
  - readable, modifiable requirements, design and code: think about interfaces
  - mini milestones to keep project visible for customer
  - involve the customer in the entire lifecycle model
    - appropriate levels of involvement for interest and ability

Interviewing and questioning techniques

- Be prepared, polite, succinct, diplomatic, and empathetic
  - make the client's job of helping you as easy as possible
    - make my job of teaching you as easy as possible
      - make it as easy as possible for me to assign you an "A"
- Avoid jargon unless it is the customer's native tongue
  - document agreed upon definitions that have any relevance to the problem
- Understand who the customer/user is, their area of expertise, responsibility and tailor questions appropriately
  - who is your client, background, interests?
    - with respect!

The Customer-Developer Partnership: Rights and Responsibilities of Software Customers

- Want a collaborative partnership
- Customer Rights -- Developer Responsibilities
- Customer Responsibilities -- Developer Rights
- See Wiegers for details

- Sign-off (our main concern - meet reqts or solve problem?)
  - **NOT** a way to freeze requirements
  - **NOT** a meaningless ritual; document not subject to arbitrary change
  - **IS** a baseline from which the impacts of changes can be assessed, especially in time, $$, and resources

Good Practices for Requirements Engineering

- http://www.processimpact.com/articles/customer.html (go now if time!)
- Apply selectively and appropriately
- A *lifecycle model* provides a framework for understanding the appropriateness and impact of the practice
- Types of Practices
  - Knowledge
  - Requirements management
  - Project management
  - Requirements development
    - Elicitation
    - Analysis
    - Specification
    - Verification

Project Vision and Scope: Milestone 1 (Figure 5-2)

1. Business requirements
   - Background
   - Business opportunity
   - Business objectives
   - Customer or market requirements
   - Value provided to customers
   - Business risks
2. Vision of solution
   - Vision statement
   - Major features
   - Assumptions and dependencies

Project Vision and Scope:

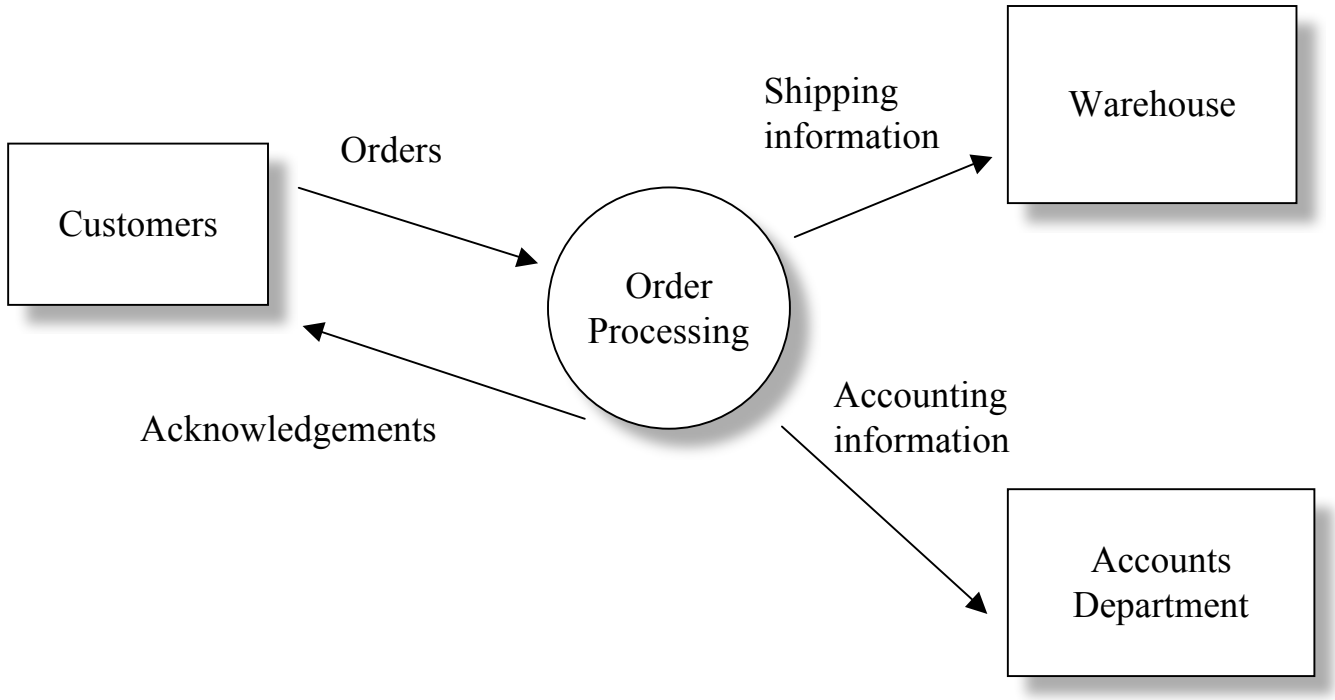
3. Scope and limitations
   - Scope of initial release
   - Scope of subsequent releases
   - Limitations and exclusions
4. Business context
   - Stakeholder profiles
   - Project priorities
   - Operating environment
5. Product success factors
   - How will success be defined, measurable criteria

The Context Diagram

- Graphical illustration of the system and how it relates to the outside world
  - users
  - other application software
  - databases
  - defines the “boundaries” of the system to be built
- Can be part of the Vision and Scope document but also in the Software Requirements Specification

What about Reality?

- Wiegers recognizes Jackson's ideas about context diagrams



- The top level of a hierarchical collection of dataflow diagrams
  - process in the middle, the system to be developed
  - rectangles represent sources or sinks for system data
- The main focus of the diagram is the system to be developed
  - not the sources or sinks (DeMarco back in 1978)
  - the "context" is for the *system,* the *machine*, not the "problem"
- Jackson thinks this should be more of a **problem context** diagram
  - show all the domains that are relevant to the problem, not just direct sources or sinks for the machine
  - loose notion of connections between domains (not just dataflow)
  - the machine element does not have a special symbol

Simple Problem

Patient Monitoring System

A patient monitoring program is required for the ICU in a hospital. Each patient is monitored by an analog device which measures factors such as pulse, temp, bp, and skin resistance. The program reads these factors on a periodic basis (specified for each patient) and stores the factors in a database. For each patient, safe ranges for each factor are also specified by medical staff. If a factor falls outside a patient's safe range, or if an analog device fails, the nurses' station is notified.

“Context”

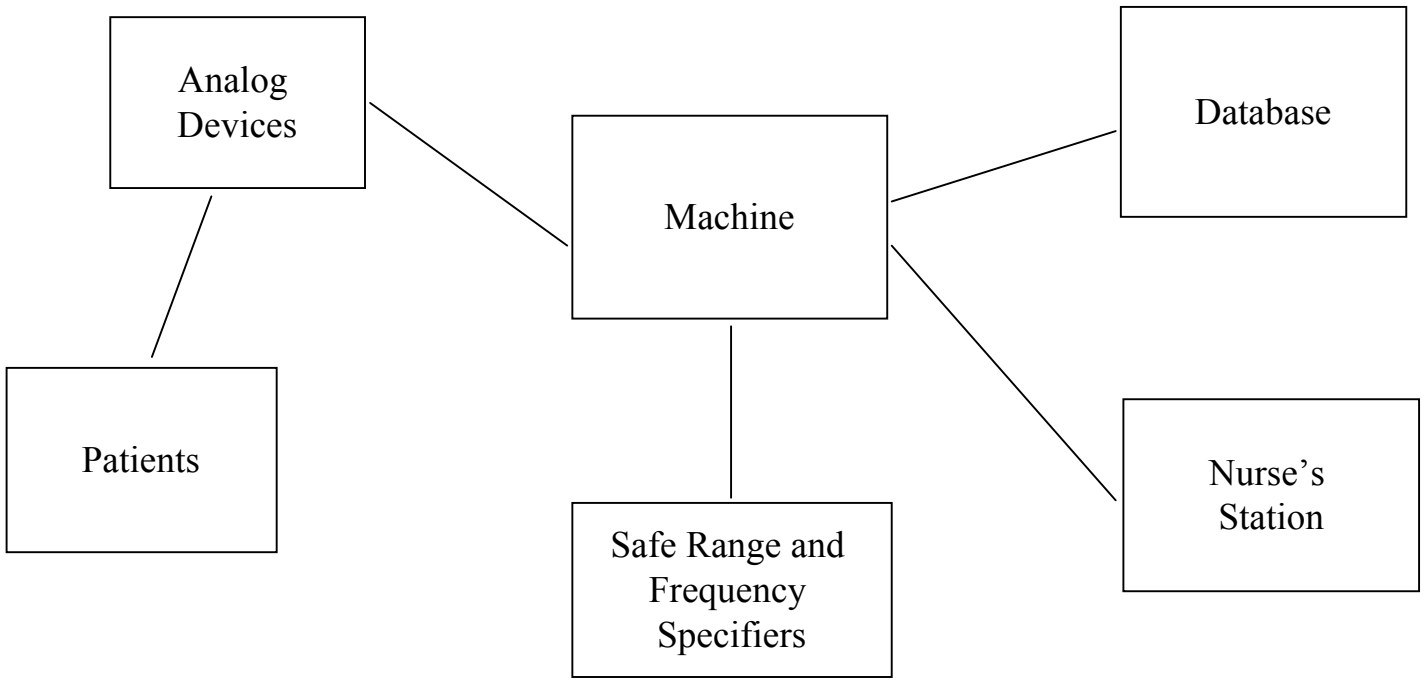
- Every context diagram has exactly one machine domain
- All domains in the context diagram are physical (not conceptual)
  - parts of the world where your customer will check for observable effects
- The **machine domain** is the computer (we design and build by creating its software)
- A **designed domain** is the physical representation of some information
  - that we are free to design to some extent
    - such as on a magnetic strip card or HD.
- A **given domain** is a problem domain whose properties are given
  - we are not free to design the domain
    - such things must be a part of our analysis but not design

Shared Phenomena

- The domains are physical
  - the interfaces between them are also physical
  - don't think of them as streams or pipes
    - THINK: events, states, values that are shared between connected domains
    - Each interface is an interface of **shared phenomena**
      - In our example, the interface between machine and the nurses' station consists of shared "notify" events. The machine can cause a notify event, and both the machine and the nurses' station then participate in this same event
      - Example - an ICU patient has a certain skin resistance: that is a state shared with an attached analog device.
      - There is NO notion of patients sending messages to analog devices or analog devices sending messages to the machine.
        - » both of the sharing participants can see the state or value, but only one of them can change it…

Problem Context diagram

- Patient monitoring system



- Patients domain included even though no direct connection
  - patients are of central interest in the problem
- Analog devices domain is included as integrity of data must be checked
- This diagram is more abstract than DeMarco's
  - and should be provided as the higher level view
  - the other view should also be provided if the information is meaningful

Context: Boundary of the Problem to be Solved

- Circular relation between problem and its context
  - iterative process between problem and context knowledge

Project Risks (at the Requirements level of development)

- **No** risk management is potentially costly to a project
  - as is the lack of configuration control, defect tracking, productivity or schedule
  - lots of data to show this is a serious ongoing problem
  - always remember "costs and benefits" of any process
    - the right balance to match individual project factors such as size, dollar amount, other QA factors
    - in this class we only consider larger projects of some complexity where benefits or risk management have proven necessary
- *Risk* is a condition that could cause some loss or otherwise threaten the success of a project
  - hasn't arisen yet, but we'd like to keep it from arising or doing too much damage (or get out before it does :-)

Fundamentals of Risk Management

- Some common risks
  - scope and requirements creep
  - dependencies on external entities
    - subcontractor
    - other COTS expected to be used
- Common causes of risks
  - poor estimation
  - rejection of accurate estimates
  - insufficient visibility into project status
  - staff turnover
  - micro management in the way of the work

Elements of Risk Management

- Risk management consists of the following:
  - Risk assessment
    - identification (of potential risks)
    - analysis (potential consequences)
    - prioritization (probability times consequence potential gives *risk exposure*)
  - Risk avoidance (don't do the risky thing!)
  - Risk control
    - management planning
      - mitigation, contingency plans, owners of risk items, timelines
    - resolution
      - executing plans for mitigating / resolving each risk
    - monitoring
      - how well the plans are working, review the plans given current state of process

Documenting Risks in a Project

- Use a *condition-consequence* format to document risk statements
  - one condition may have several possible consequences
  - several conditions may contribute to the same consequences
  - entire disciplines built around analytical tools to deal with project risks
    - fault tree analysis
    - failure modes and effects analysis
    - lots more
- Use a Risk Item Tracking form
  - use common sense
    - don't spend 20 hours on an item of very small risk potential
    - don't forge ahead if the entire project depends on a very risky item
  - you will **track the *top three* risks** for your requirements project
  - follow them up and keep them current

Requirements related risks list

- Requirements elicitation
  - scope creep
    - project vision and scope should help avoid
  - time spent on this stage
  - completeness, correctness
    - can write usage scenarios, test cases, prototypes
  - highly innovative projects necessarily involve risk
  - nonfunctional requirements notoriously difficult
    - usability, reliability, safety, speed...
  - customer agreement on product requirements
    - takes two consenting adults to agree
  - unstated requirements and assumptions
  - reverse engineering is notoriously difficult

- solutions presented as needs
  - precludes a lot of design flexibility

- Requirements Specification
  - gaps in specifier / customer understanding
    - formal inspections including all stakeholders have significant impacts on this
  - time pressure
    - leaving important TBD's unresolved can be destructive
      - assign responsibility for TBD's and enforce accountability
  - vocabulary problems
    - creates misunderstandings
      - early creation (maintenance) of data dictionaries and glossaries
  - requirements that are actually design (distinctions?)
    - unnecessary constraints on the designers

- Requirements verification
  - use formal inspection, test planning, write user manuals
    - recall the costs of fixing “problems” later in the lifecycle
    - requires commitment and followthrough from customers / users
      - informal, quick pre-reviews may be helpful at the outset
    - requires training of ALL members of verification teams in relevant methods
      - include experienced people
- Requirements management
  - dynamism
    - scope creep happens
      - risk work
        - » delay implementation of changeable requirements till thoroughly understood
        - » design for modifiability

- change process
  - must be carefully defined and respected!
  - supported by a culture of respect for the process
  - impact analysis, change control board to make decisions, tool to implement
- traceability / forgotten requirement
  - traceability matrix
    - responsibility and follow up critical
- scope expansion
  - incremental or phased delivery to iteratively elaborate requirements

Who is the Customer? Where do I get User Requirements?

- Basic steps:
  - identify *sources of user requirements*
  - identify *classes of users* for the project
  - gain access to *individuals who represent the user classes*
  - agree who is the *ultimate decisionmaker* for the project

  Become/remain aware of who are the
  - enemies of the project
  - losers if the project is successful

  WHY is the project <u>really</u> being undertaken?
  - this affects everything!

Sources of Requirements

- Meet the potential users
- Market research in the domain
  - other products
  - market surveys
- System requirements specifications
  - get product spec sheets when possible (markieting materiale)
- Change requests and bug reports from a current system
- Observation or users
- Scenario analysis
  - developed into the use-case approach

User Classes

- Different tasks may be required if userbase not homogeneous
  - big task if you are working on a meta application to generalize for all possible user classes
- Simple example: physician's office automation may need to serve -
  - M.D.'s
  - secretaries
  - nurses
  - physician's assistants
  - insurance companies (via machine interfaces)
  - laboratory technicians
  - DEA auditors
- Find classes, characterize them and document in the SRS

Responsibility - Find a Representative for the User Classes

- User centered development: users should be involved throughout the lifecycle
  - investment of time and energy towards the goal of higher quality products (products that more effectively meet the user's needs)
  - users who represent user classes must be chosen carefully
    - product "champion" approach
  - pay attention to risks you assume by choosing user representatives
    - like the marketing department :-)

Product Champion Approach

- Key participant in development
  - accurate perspective on user class: an actual user
    - who cares about the project
    - in regular communication with other users
    - who is supported by their management (time, money)
    - experience with the problem domain (and technology) is important
  - collects requirements from the class
    - the champion must have standing in the user community
  - responsible for decisionmaking when difficulties arise
    - for best results managers must respect the champion's decisions in most cases
  - developers might want to pay them if critical to the project!
    - or hire a champion separately as part of the development team
  - team up with analyst to write user requirements for user class