

Requirements Engineering Processes

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Topics covered

- › Feasibility studies
- › Requirements elicitation and analysis
- › Requirements validation
- › Requirements management

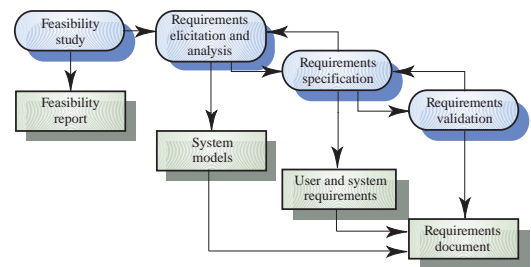
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Requirements engineering processes

- › The processes used for RE vary widely depending on the application domain, the people involved and the organisation developing the requirements
- › However, there are a number of generic activities common to all processes
 - Requirements elicitation
 - Requirements analysis
 - Requirements validation
 - Requirements management

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The requirements engineering process



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Feasibility studies

- › A feasibility study decides whether or not the proposed system is worthwhile
- › A short focused study that checks
 - If the system contributes to organisational objectives
 - If the system can be engineered using current technology and within budget
 - If the system can be integrated with other systems that are used

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Feasibility study implementation

- › Based on information assessment (what is required), information collection and report writing
- › Questions for people in the organisation
 - What if the system wasn't implemented?
 - What are current process problems?
 - How will the proposed system help?
 - What will be the integration problems?
 - Is new technology needed? What skills?
 - What facilities must be supported by the proposed system?

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Elicitation and analysis

- › Sometimes called requirements elicitation or requirements discovery
- › Involves technical staff working with customers to find out about the application domain, the services that the system should provide and the system's operational constraints
- › May involve end-users, managers, engineers involved in maintenance, domain experts, trade unions, etc. These are called *stakeholders*

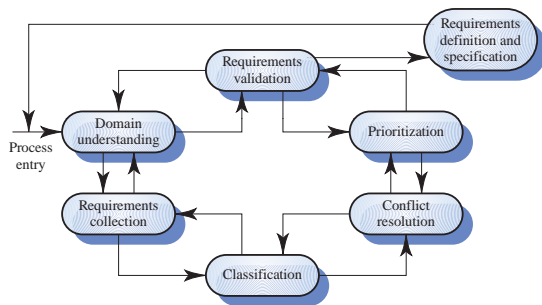
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Problems of requirements analysis

- › Stakeholders don't know what they really want
- › Stakeholders express requirements in their own terms
- › Different stakeholders may have conflicting requirements
- › Organisational and political factors may influence the system requirements
- › The requirements change during the analysis process. New stakeholders may emerge and the business environment change

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The requirements analysis process



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Process activities

- › Domain understanding
- › Requirements collection
- › Classification
- › Conflict resolution
- › Prioritisation
- › Requirements checking

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System models

- › Different models may be produced during the requirements analysis activity
- › Requirements analysis may involve three structuring activities which result in these different models
 - Partitioning. Identifies the structural (part-of) relationships between entities
 - Abstraction. Identifies generalities among entities
 - Projection. Identifies different ways of looking at a problem
- › System models covered in Chapter 7

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Viewpoint-oriented elicitation

- › Stakeholders represent different ways of looking at a problem or problem viewpoints
- › This multi-perspective analysis is important as there is no single correct way to analyse system requirements

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Banking ATM system

- ▶ The example used here is an auto-teller system which provides some automated banking services
- ▶ I use a very simplified system which offers some services to customers of the bank who own the system and a narrower range of services to other customers
- ▶ Services include cash withdrawal, message passing (send a message to request a service), ordering a statement and transferring funds

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Autoteller viewpoints

- ▶ Bank customers
- ▶ Representatives of other banks
- ▶ Hardware and software maintenance engineers
- ▶ Marketing department
- ▶ Bank managers and counter staff
- ▶ Database administrators and security staff
- ▶ Communications engineers
- ▶ Personnel department

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Types of viewpoint

- ▶ Data sources or sinks
 - Viewpoints are responsible for producing or consuming data. Analysis involves checking that data is produced and consumed and that assumptions about the source and sink of data are valid
- ▶ Representation frameworks
 - Viewpoints represent particular types of system model. These may be compared to discover requirements that would be missed using a single representation. Particularly suitable for real-time systems
- ▶ Receivers of services
 - Viewpoints are external to the system and receive services from it. Most suited to interactive systems

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External viewpoints

- ▶ Natural to think of end-users as receivers of system services
- ▶ Viewpoints are a natural way to structure requirements elicitation
- ▶ It is relatively easy to decide if a viewpoint is valid
- ▶ Viewpoints and services may be used to structure non-functional requirements

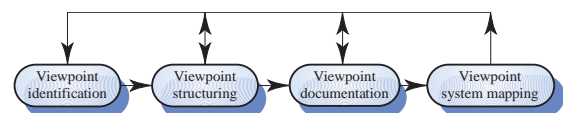
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Method-based analysis

- ▶ Widely used approach to requirements analysis. Depends on the application of a structured method to understand the system
- ▶ Methods have different emphases. Some are designed for requirements elicitation, others are close to design methods
- ▶ A viewpoint-oriented method (VORD) is used as an example here. It also illustrates the use of viewpoints

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The VORD method



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VORD process model

- ▶ Viewpoint identification
 - Discover viewpoints which receive system services and identify the services provided to each viewpoint
- ▶ Viewpoint structuring
 - Group related viewpoints into a hierarchy. Common services are provided at higher-levels in the hierarchy
- ▶ Viewpoint documentation
 - Refine the description of the identified viewpoints and services
- ▶ Viewpoint-system mapping
 - Transform the analysis to an object-oriented design

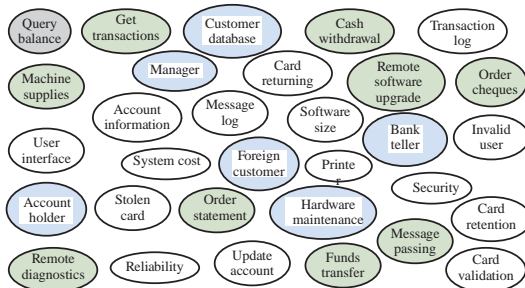
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VORD standard forms

Viewpoint template		Service template	
Reference:	The viewpoint name.	Reference:	The service name.
Attributes:	Attributes providing viewpoint information.	Rationale:	Reason why the service is provided.
Events:	A reference to a set of event scenarios describing how the system reacts to viewpoint events.	Specification:	Reference to a list of service specifications. These may be expressed in different notations.
Services:	A reference to a set of service descriptions.	Viewpoints:	List of viewpoint names receiving the service.
Sub-VPs:	The names of sub-viewpoints.	Non-functional requirements:	Reference to a set of non-functional requirements which constrain the service.
		Provider:	Reference to a list of system objects which provide the service.

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Viewpoint identification



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Viewpoint service information

ACCOUNT HOLDER	FOREIGN CUSTOMER	BANK TELLER
Service list	Service list	Service list
Withdraw cash Query balance Order cheques Send message Transaction list Order statement Transfer funds	Withdraw cash Query balance	Run diagnostics Add cash Add paper Send message

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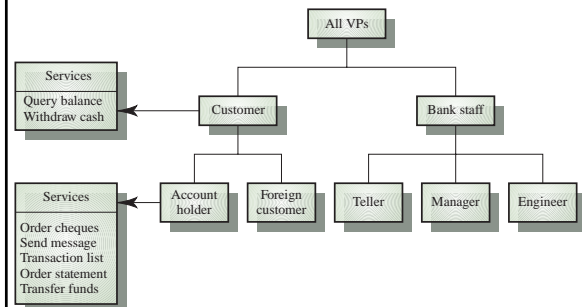
Viewpoint data/control

ACCOUNT HOLDER

Control input	Data input
Start transaction Cancel transaction End transaction Select service	Card details PIN Amount required Message

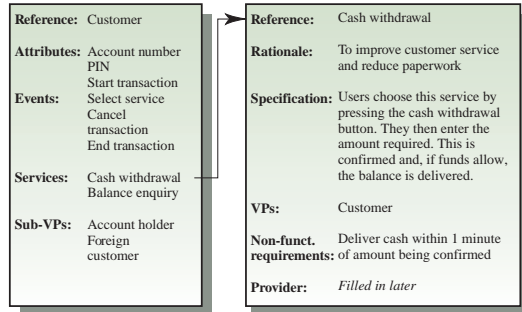
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Viewpoint hierarchy



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Customer/cash withdrawal templates



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Scenarios

- ▶ Scenarios are descriptions of how a system is used in practice
- ▶ They are helpful in requirements elicitation as people can relate to these more readily than abstract statement of what they require from a system
- ▶ Scenarios are particularly useful for adding detail to an outline requirements description

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Scenario descriptions

- ▶ System state at the beginning of the scenario
- ▶ Normal flow of events in the scenario
- ▶ What can go wrong and how this is handled
- ▶ Other concurrent activities
- ▶ System state on completion of the scenario

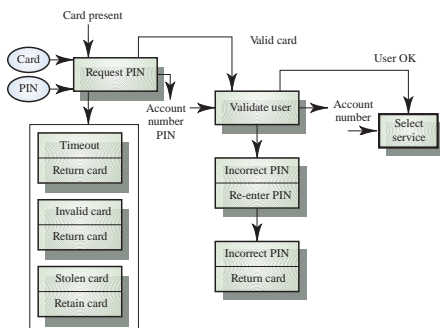
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Event scenarios

- ▶ Event scenarios may be used to describe how a system responds to the occurrence of some particular event such as 'start transaction'
- ▶ VORD includes a diagrammatic convention for event scenarios.
 - Data provided and delivered
 - Control information
 - Exception processing
 - The next expected event

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Event scenario – start transaction



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Notation for data and control analysis

- ▶ Ellipses. data provided from or delivered to a viewpoint
- ▶ Control information enters and leaves at the top of each box
- ▶ Data leaves from the right of each box
- ▶ Exceptions are shown at the bottom of each box
- ▶ Name of next event is in box with thick edges

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Exception description

- ▶ Most methods do not include facilities for describing exceptions
- ▶ In this example, exceptions are
 - Timeout. Customer fails to enter a PIN within the allowed time limit
 - Invalid card. The card is not recognised and is returned
 - Stolen card. The card has been registered as stolen and is retained by the machine

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Social and organisational factors

- ▶ Software systems are used in a social and organisational context. This can influence or even dominate the system requirements
- ▶ Social and organisational factors are not a single viewpoint but are influences on all viewpoints
- ▶ Good analysts must be sensitive to these factors but currently no systematic way to tackle their analysis

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Example

- ▶ Consider a system which allows senior management to access information without going through middle managers
 - Managerial status. Senior managers may feel that they are too important to use a keyboard. This may limit the type of system interface used
 - Managerial responsibilities. Managers may have no uninterrupted time where they can learn to use the system
 - Organisational resistance. Middle managers who will be made redundant may deliberately provide misleading or incomplete information so that the system will fail

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Ethnography

- ▶ A social scientist spends a considerable time observing and analysing how people actually work
- ▶ People do not have to explain or articulate their work
- ▶ Social and organisational factors of importance may be observed
- ▶ Ethnographic studies have shown that work is usually richer and more complex than suggested by simple system models

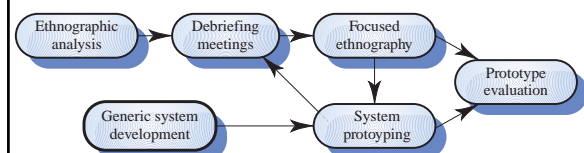
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Focused ethnography

- ▶ Developed in a project studying the air traffic control process
- ▶ Combines ethnography with prototyping
- ▶ Prototype development results in unanswered questions which focus the ethnographic analysis
- ▶ Problem with ethnography is that it studies existing practices which may have some historical basis which is no longer relevant

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Ethnography and prototyping



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Scope of ethnography

- › Requirements that are derived from the way that people actually work rather than the way I which process definitions suggest that they ought to work
- › Requirements that are derived from cooperation and awareness of other people's activities

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Requirements validation

- › Concerned with demonstrating that the requirements define the system that the customer really wants
- › Requirements error costs are high so validation is very important
 - Fixing a requirements error after delivery may cost up to 100 times the cost of fixing an implementation error

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Requirements checking

- › Validity. Does the system provide the functions which best support the customer's needs?
- › Consistency. Are there any requirements conflicts?
- › Completeness. Are all functions required by the customer included?
- › Realism. Can the requirements be implemented given available budget and technology
- › Verifiability. Can the requirements be checked?

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Requirements validation techniques

- › Requirements reviews
 - Systematic manual analysis of the requirements
- › Prototyping
 - Using an executable model of the system to check requirements. Covered in Chapter 8
- › Test-case generation
 - Developing tests for requirements to check testability
- › Automated consistency analysis
 - Checking the consistency of a structured requirements description

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Requirements reviews

- › Regular reviews should be held while the requirements definition is being formulated
- › Both client and contractor staff should be involved in reviews
- › Reviews may be formal (with completed documents) or informal. Good communications between developers, customers and users can resolve problems at an early stage

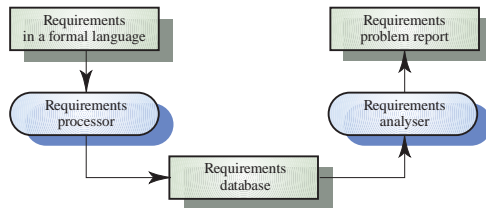
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Review checks

- › Verifiability. Is the requirement realistically testable?
- › Comprehensibility. Is the requirement properly understood?
- › Traceability. Is the origin of the requirement clearly stated?
- › Adaptability. Can the requirement be changed without a large impact on other requirements?

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Automated consistency checking



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Requirements management

- ▶ Requirements management is the process of managing changing requirements during the requirements engineering process and system development
- ▶ Requirements are inevitably incomplete and inconsistent
 - New requirements emerge during the process as business needs change and a better understanding of the system is developed
 - Different viewpoints have different requirements and these are often contradictory

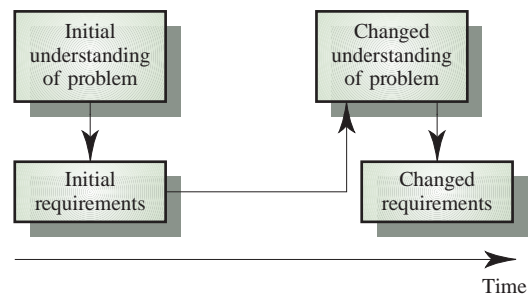
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Requirements change

- ▶ The priority of requirements from different viewpoints changes during the development process
- ▶ System customers may specify requirements from a business perspective that conflict with end-user requirements
- ▶ The business and technical environment of the system changes during its development

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Requirements evolution



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Enduring and volatile requirements

- ▶ Enduring requirements. Stable requirements derived from the core activity of the customer organisation. E.g. a hospital will always have doctors, nurses, etc. May be derived from domain models
- ▶ Volatile requirements. Requirements which change during development or when the system is in use. In a hospital, requirements derived from health-care policy

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Classification of requirements

- ▶ Mutable requirements
 - Requirements that change due to the system's environment
- ▶ Emergent requirements
 - Requirements that emerge as understanding of the system develops
- ▶ Consequential requirements
 - Requirements that result from the introduction of the computer system
- ▶ Compatibility requirements
 - Requirements that depend on other systems or organisational processes

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Requirements management planning

- ▶ During the requirements engineering process, you have to plan:
 - Requirements identification
 - How requirements are individually identified
 - A change management process
 - The process followed when analysing a requirements change
 - Traceability policies
 - The amount of information about requirements relationships that is maintained
 - CASE tool support
 - The tool support required to help manage requirements change

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Traceability

- ▶ Traceability is concerned with the relationships between requirements, their sources and the system design
- ▶ Source traceability
 - Links from requirements to stakeholders who proposed these requirements
- ▶ Requirements traceability
 - Links between dependent requirements
- ▶ Design traceability
 - Links from the requirements to the design

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CASE tool support

- ▶ Requirements storage
 - Requirements should be managed in a secure, managed data store
- ▶ Change management
 - The process of change management is a workflow process whose stages can be defined and information flow between these stages partially automated
- ▶ Traceability management
 - Automated retrieval of the links between requirements

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Requirements change management

- ▶ Should apply to all proposed changes to the requirements
- ▶ Principal stages
 - Problem analysis. Discuss requirements problem and propose change
 - Change analysis and costing. Assess effects of change on other requirements
 - Change implementation. Modify requirements document and other documents to reflect change

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Requirements change management



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Key points

- ▶ The requirements engineering process includes a feasibility study, requirements elicitation and analysis, requirements specification and requirements management
- ▶ Requirements analysis is iterative involving domain understanding, requirements collection, classification, structuring, prioritisation and validation
- ▶ Systems have multiple stakeholders with different requirements

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Key points

- Social and organisation factors influence system requirements
- Requirements validation is concerned with checks for validity, consistency, completeness, realism and verifiability
- Business changes inevitably lead to changing requirements
- Requirements management includes planning and change management

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