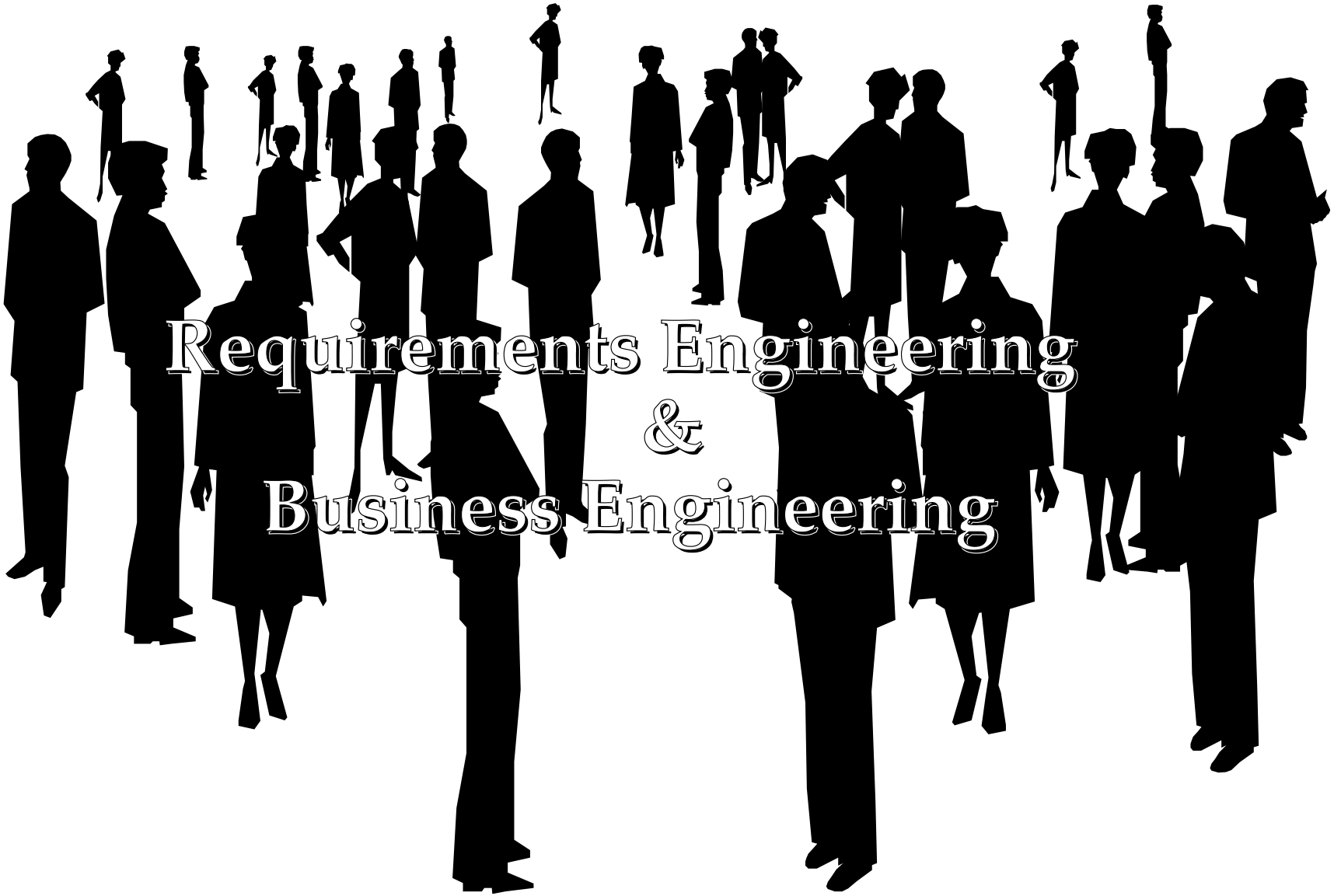


Requirements Engineering & Business Engineering

Objectives

- To introduce the area of Requirements Engineering (RE) and relate it to Business Engineering (BE)
- To discuss experiences in Software and Requirements Engineering
- To introduce types of Requirements Engineering “products”
- To discuss the Requirements Engineering “process”
- To introduce the Capability Maturity Model

Topics

- Definitions
- The importance of RE
- Two empirical studies
- The products of RE
- The process of RE
- The Capability Maturity Model

TWO DEFINITIONS OF INFORMATION SYSTEMS

By an information system we mean here: A system of information sets needed for decision making and signalling in a larger system (of which it is a subsystem) containing subsystems for collecting, storing, processing, and distributing of information sets. (Langefors, 1965)

Information processing in organisations is primarily concerned with bargaining,contracting and social decision making. ...In this view, the main job for an information technology system is to facilitate co-ordination between separate enterprises or groups within an enterprise, each with its own policies, objectives, values and interests. The IT system can thus be seen as a medium of communication and bargaining, serving as an intermediary in a social process.(Dobson, ESPRIT ORDIT project, 1992)

What is Requirements Engineering ?

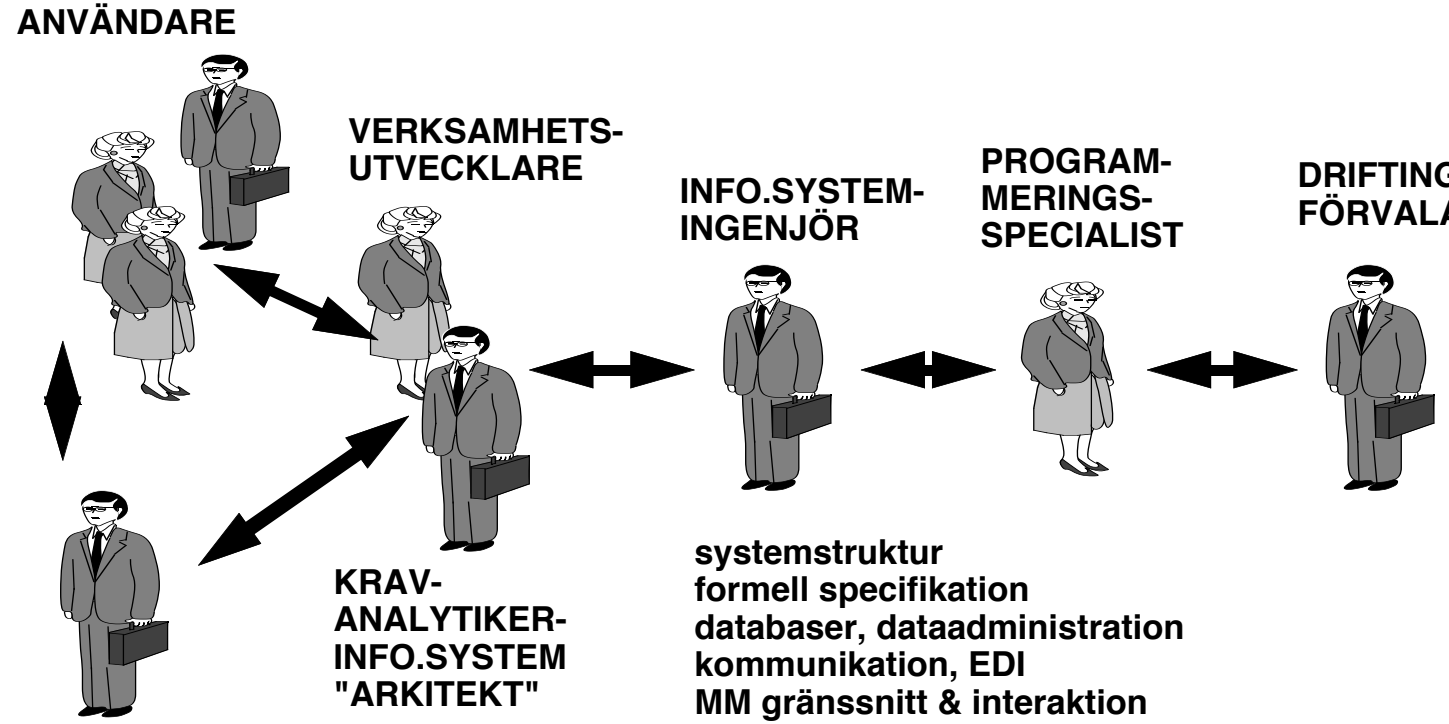
Requirements Engineering is the branch of Systems Engineering concerned with 'real-world' goals for, services provided by, and constraints on software intensive systems

IEEE, 1994

What is Information Systems Engineering?

Information Systems Engineering (ISE) is not one single discipline, but rather a network of related, multi-paradigm, interacting areas that all have the objective to contribute to the development and maintenance of knowledge (principles, theories, methods, practices) concerning aspects of the development of large, data-intensive information and software systems which are active components of real world infrastructures.

YRKESROLLER



verksamhet
organisation
funktionella krav
icke-funktionella d:o
legala aspeker

systemstruktur
formell specifikation
databaser, dataadministration
kommunikation, EDI
MM gränssnitt & interaktion
distribution
real-tidsaspekter
prestanda
tillförlitlighet
säkerhet
återbruk/bibliotekarie

Requirements Engineering as a Discipline

- Traditionally considered as part of Software Engineering
- Nowadays considered as an independent field of study with a number of influences
  - Software Engineering
  - Information Systems
  - Human-Computer Interaction
  - Social & organisational aspects of computing
- Different forums
  - IEEE SMC Society; IEEE series of international conferences; IFIP WG 2.9

What are "Requirements" ?

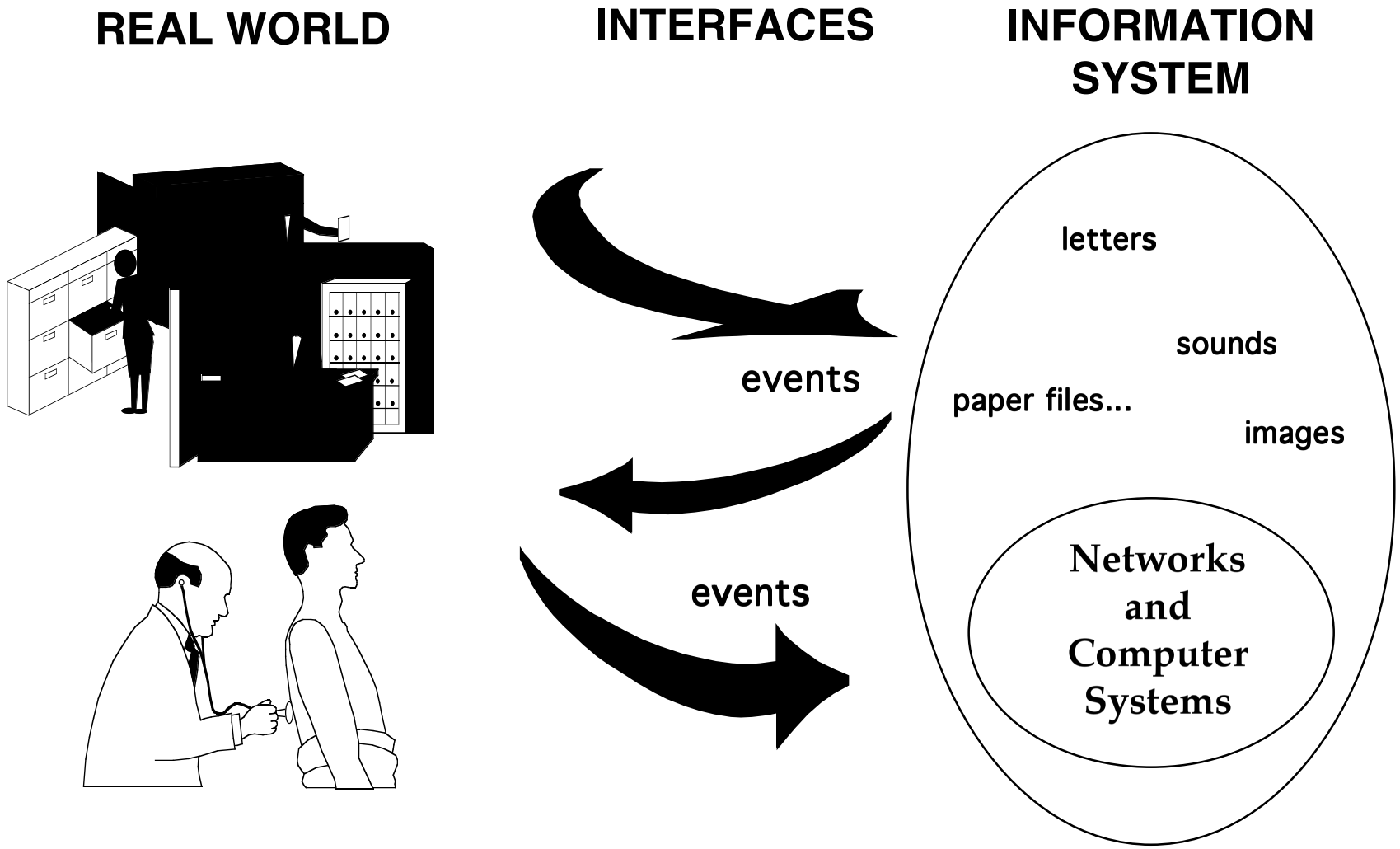
(1) A condition or capacity needed by a user to solve a problem or achieve an objective.

(2) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.

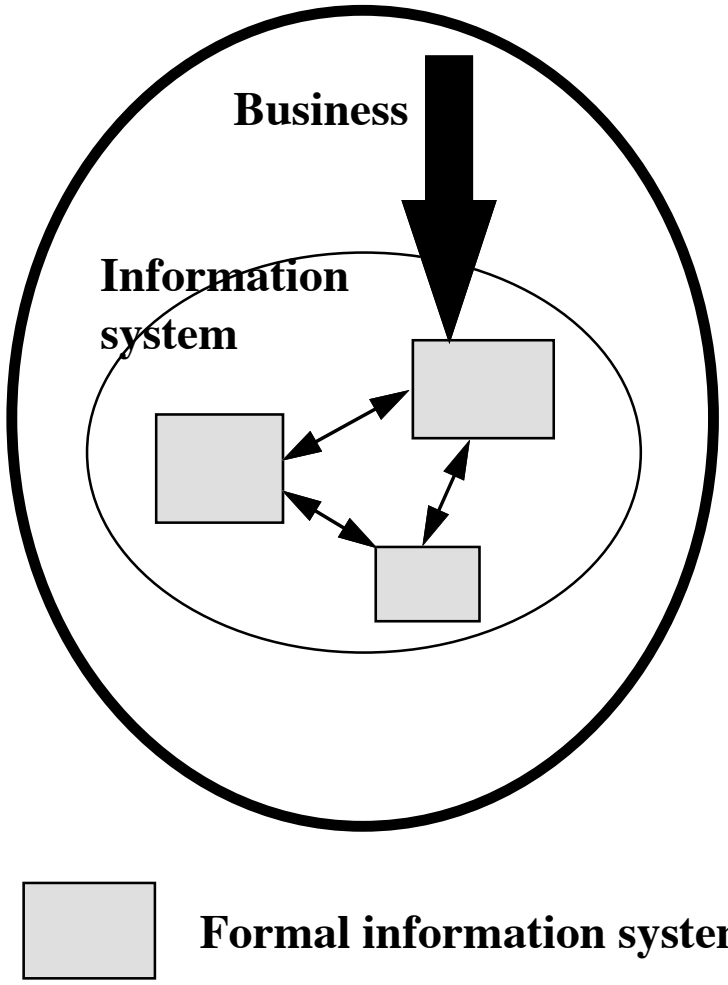
(3) A documented representation of a condition or capability as in (1) or (2).

Std.610-1990, IEEE Standard Glossary of Software Engineering Terminology

I.S. as a Model of the 'Real-World'

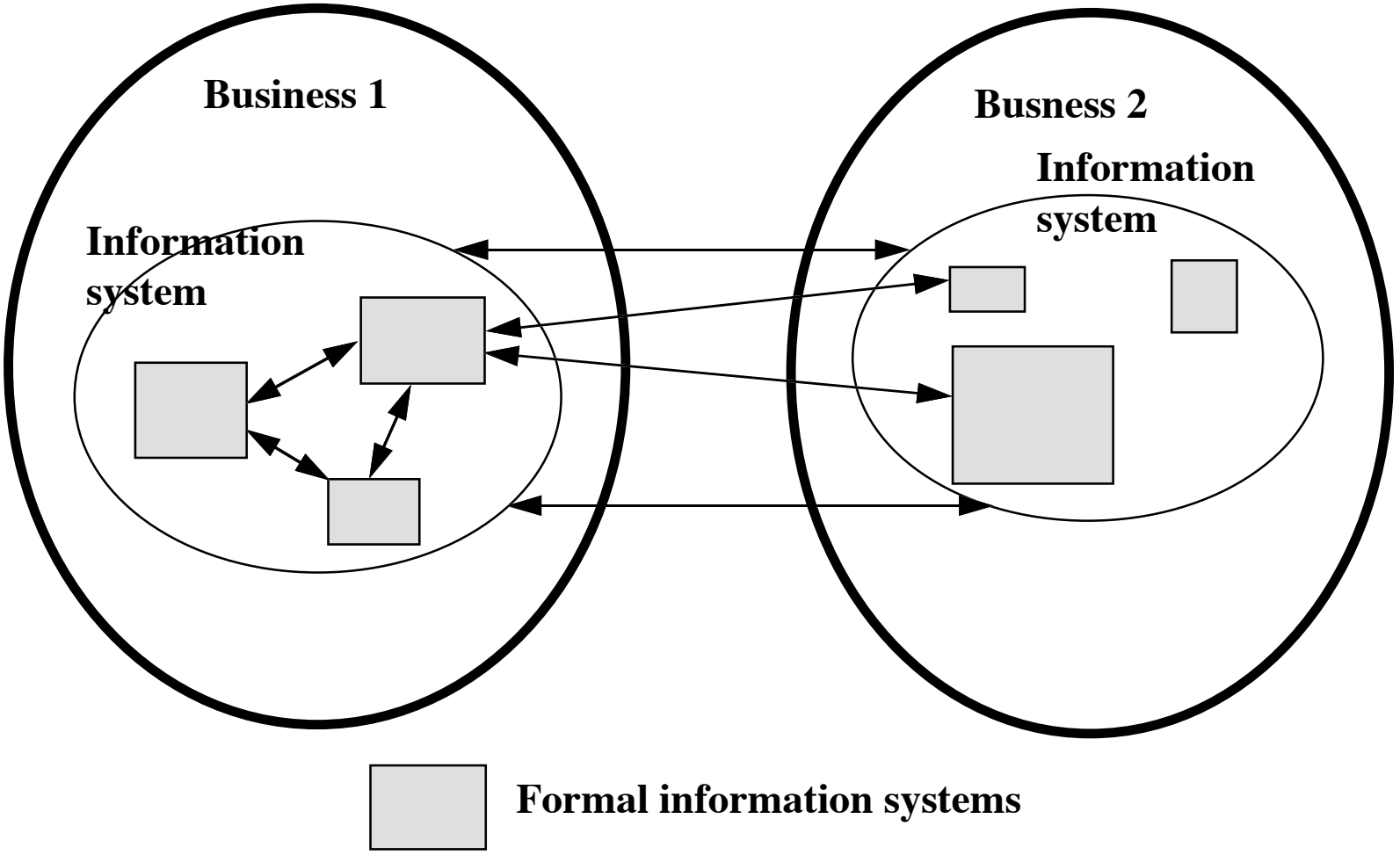


Business vs. its Information System(s)

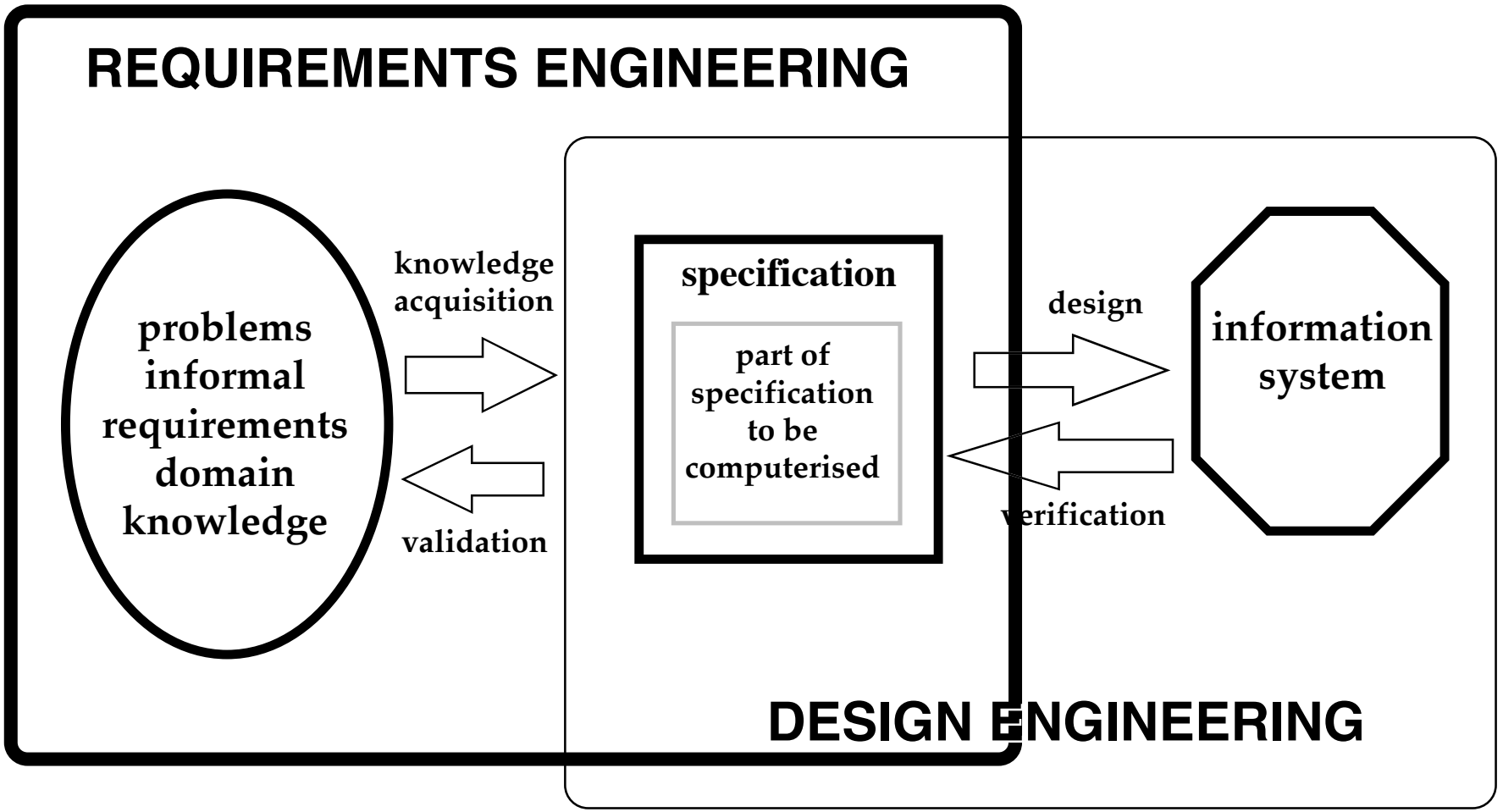


Formal information systems

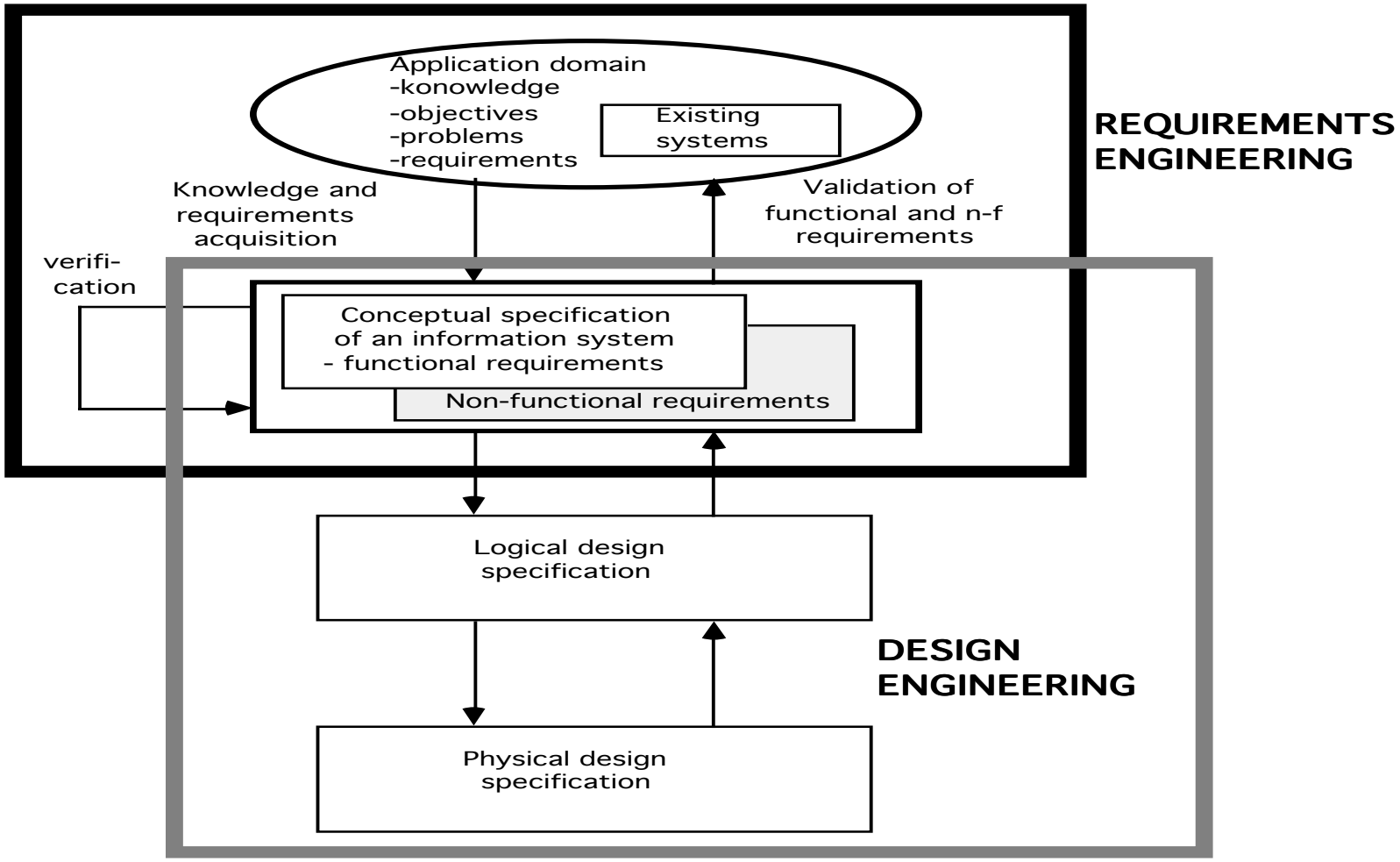
Business and Information Systems



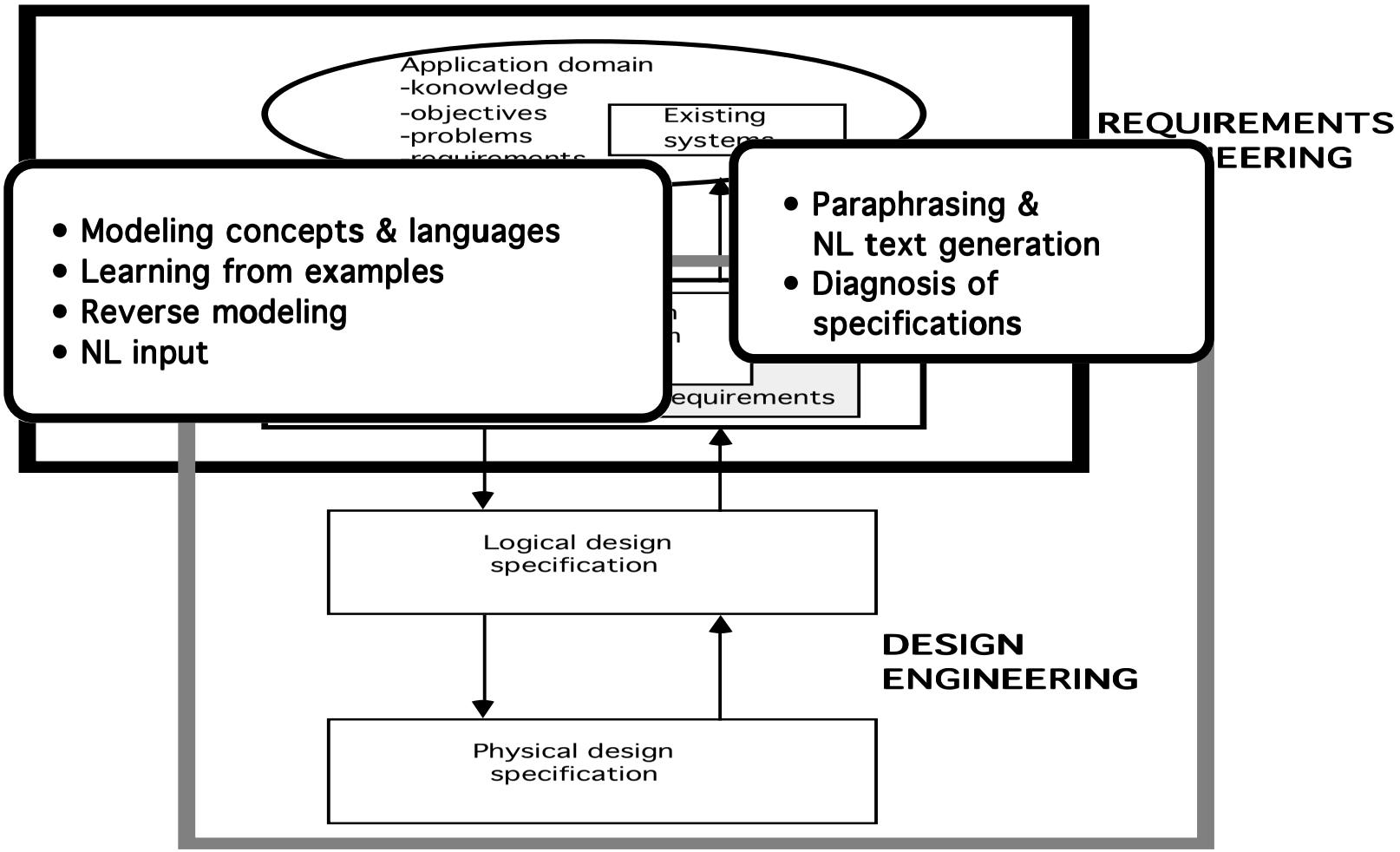
A Model of the R.E. Process



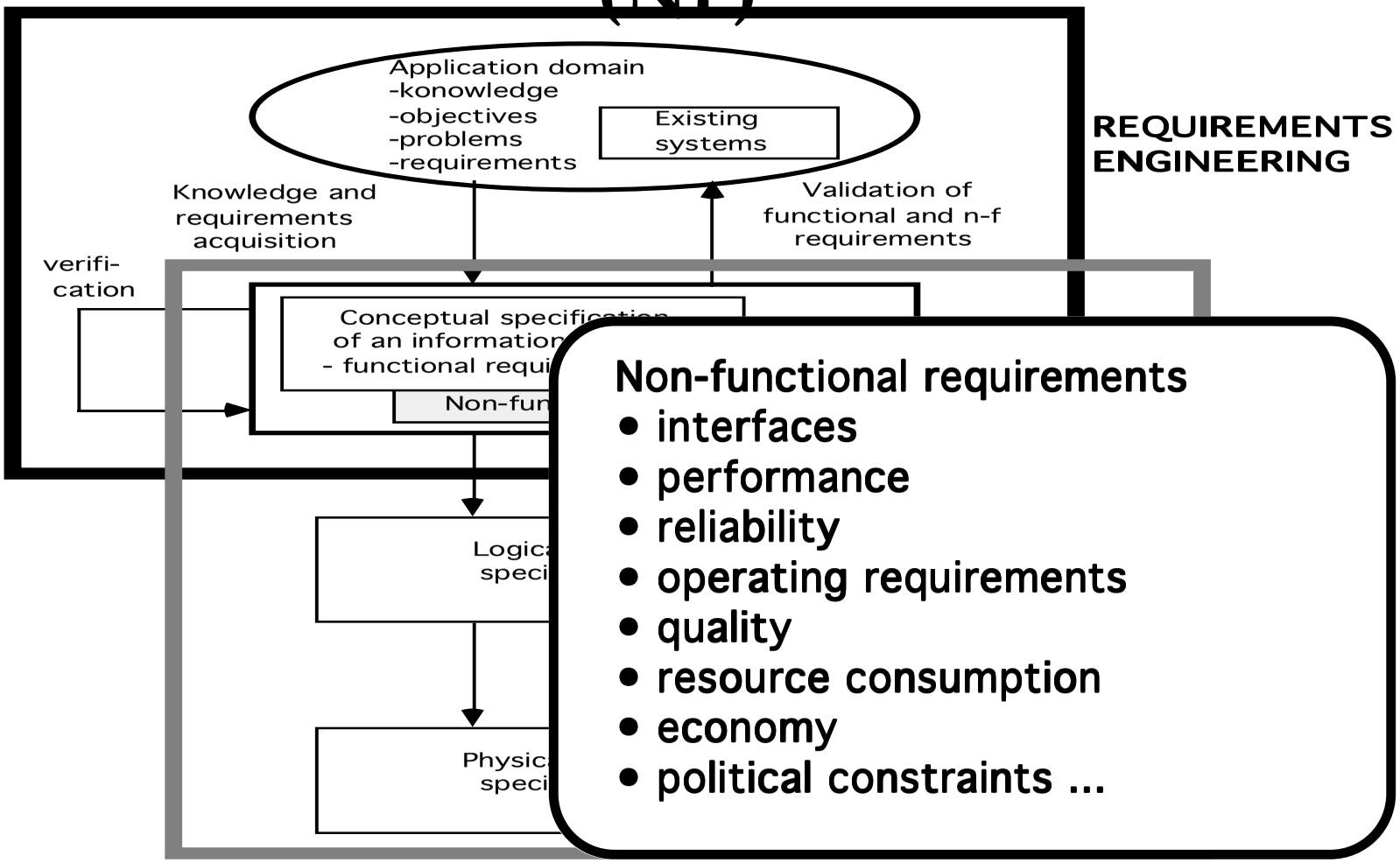
REQUIREMENTS ENGINEERING



REQUIREMENTS ENGINEERING (2)

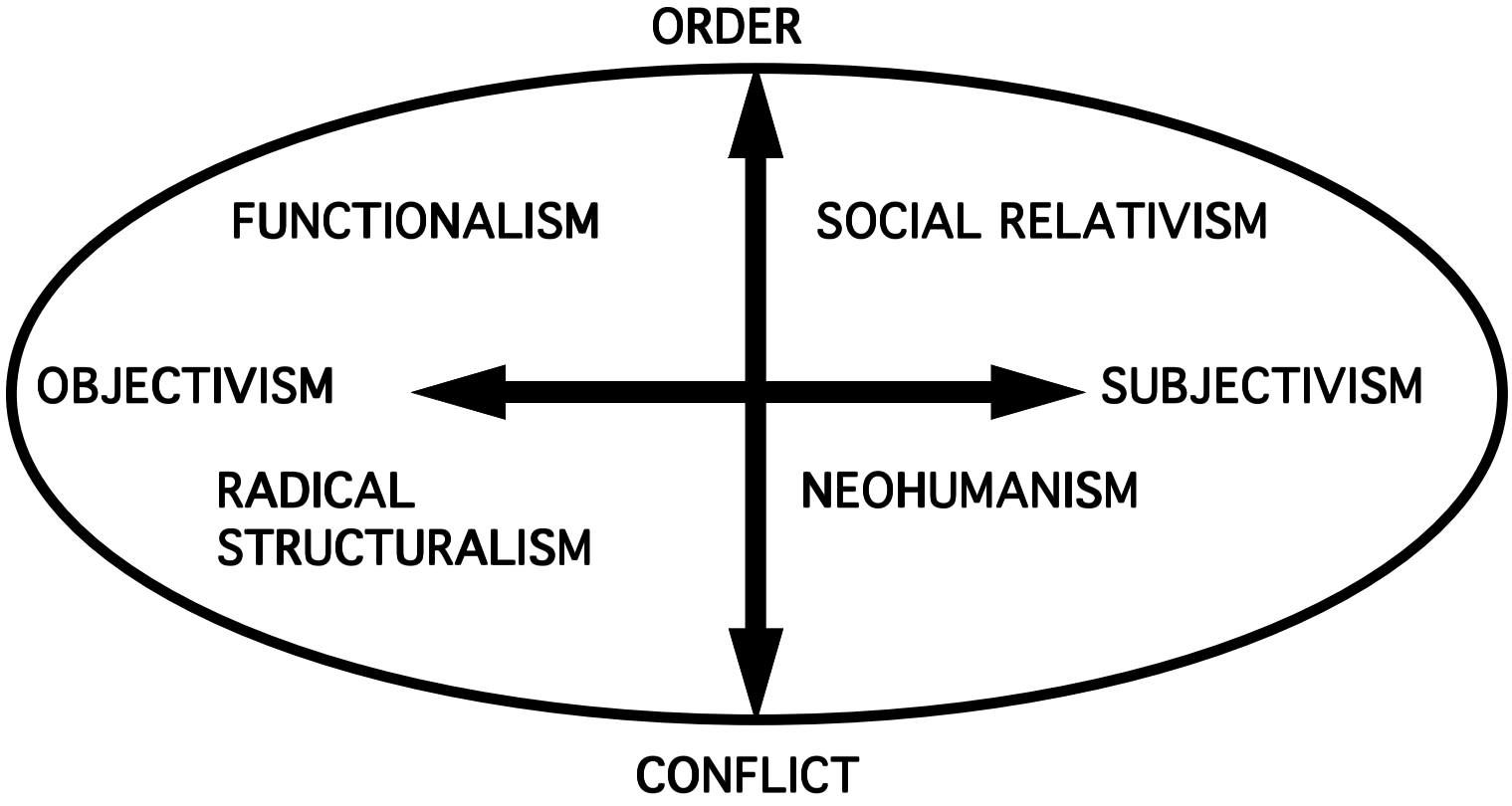


REQUIREMENTS ENGINEERING (NE)



FOUR PARADIGMS

HIRSCHHEIM&KLEIN (1989)



Different 'Targets' for Requirements

Market-Driven Projects

- Informal
- Customer/user not well identified
- Marketing approaches rather than systems

Customer-Specific Projects

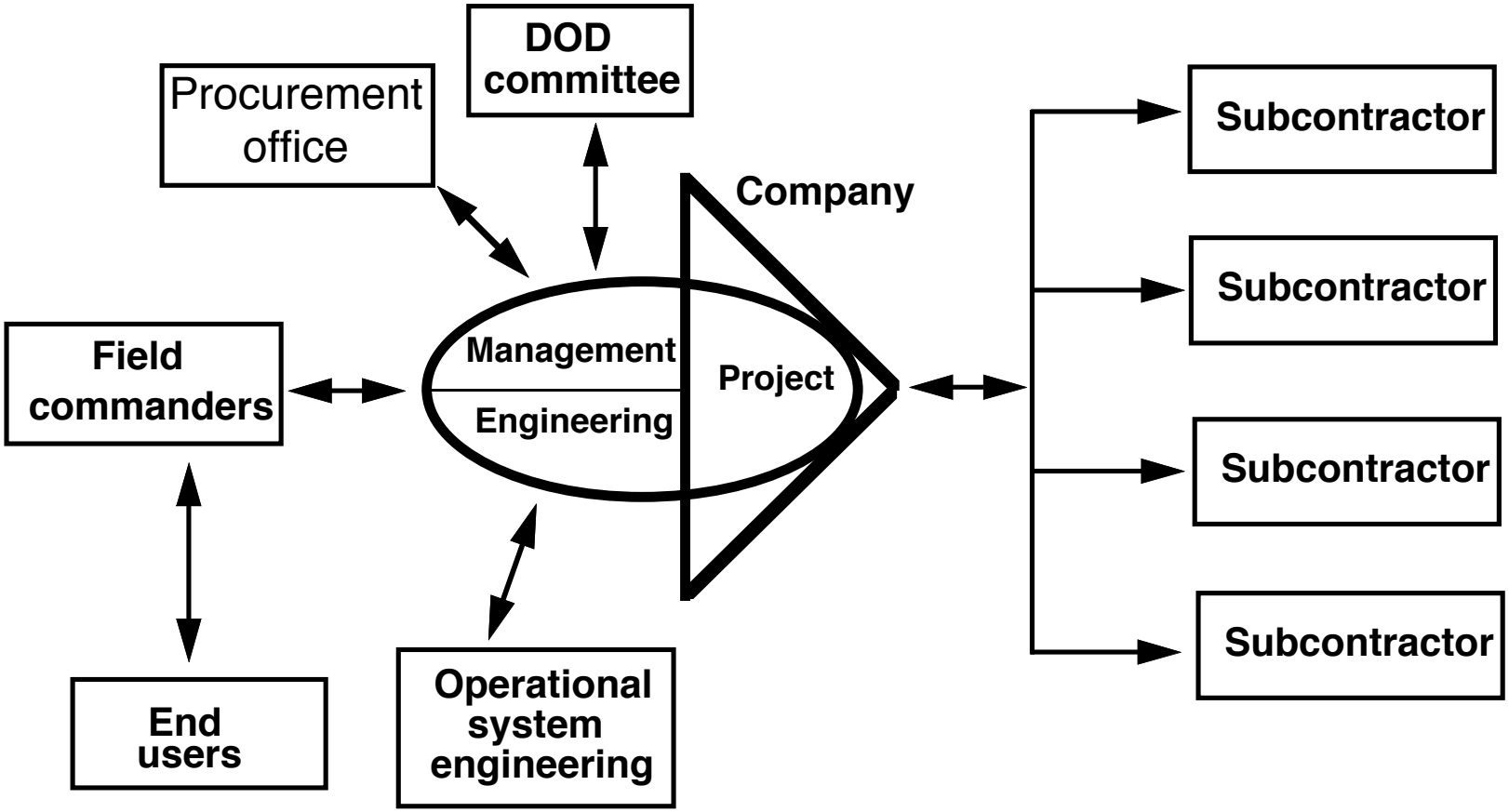
- Voluminous specs
- Domain is clearly identifiable
- Systems approaches used

Approaches to System Development

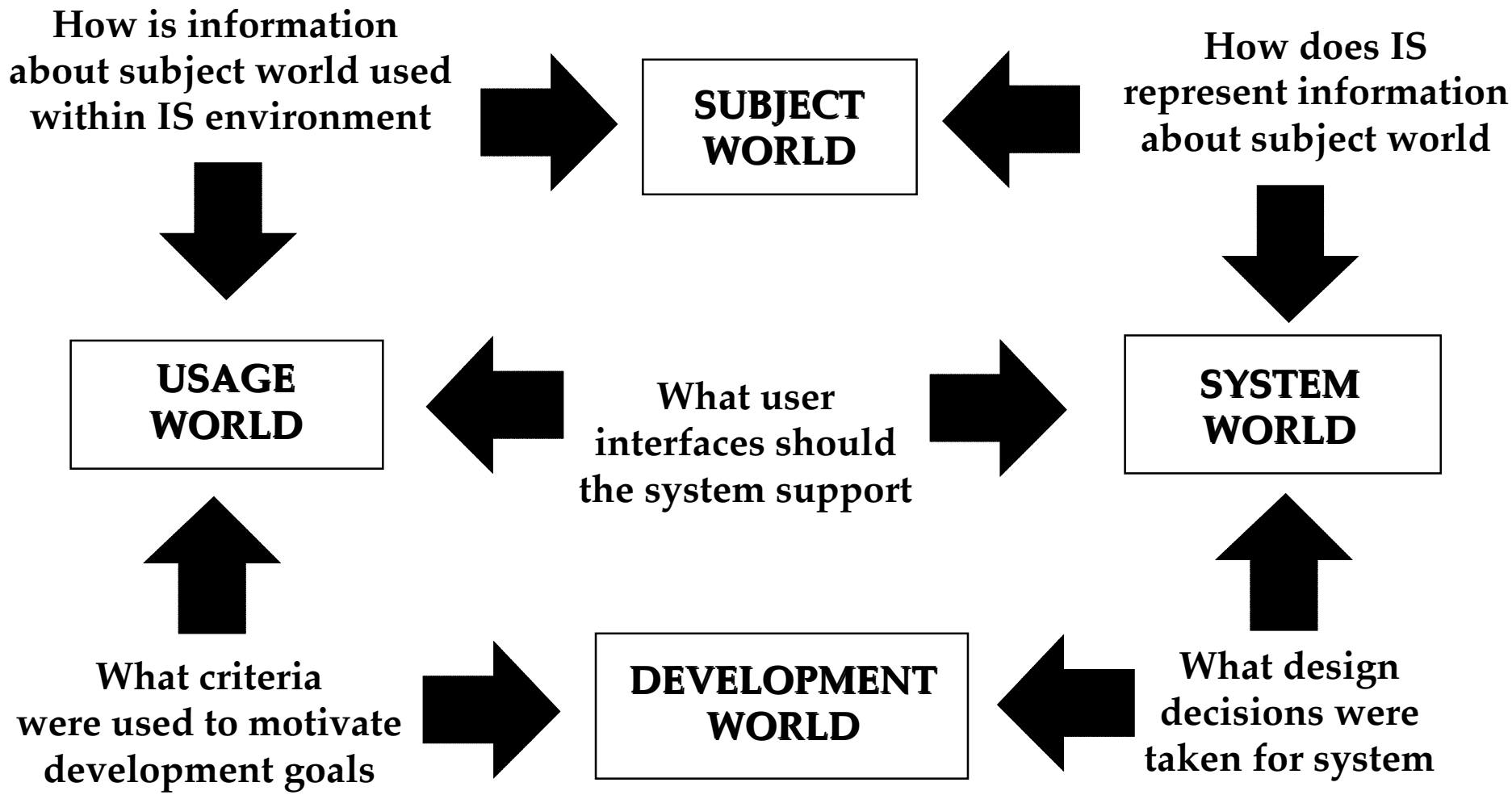
- **Two basic approaches**
  - **procurement**
  - **purpose built**

- **Both approaches necessitate the establishment of a "contract" between the customer and the supplier**
  - **the REQUIREMENTS SPECIFICATION**

Typical Procurement Model



The 4 Worlds of I.S.E.



Topics

- Definitions
- The importance of RE
- Two empirical studies
- The products of RE
- The process of RE
- The Capability Maturity Model

Organisational trends

- the organisation as well as its environment is in a continuous process of evolution and change

- the organisation's interaction with its environment is becoming more diversified and complex

- the products and services of the organisation are becoming increasingly complex

- external pressures on organisations require them to individualise and customise its services and products

- competition requires shortened lead-times for development of new services or products

Analysing the Effects of Requirements

- Much evidence about the importance of requirements
- Influences on
  - technical effectiveness of systems
  - effort required to develop and maintain systems
  - acceptance of systems in the organisation
- Two important empirical studies
  - Curtis et al (1988)

    9 large organisations involving 17 projects
  - Lubars et al (1993)

    10 large organisations involving 23 projects

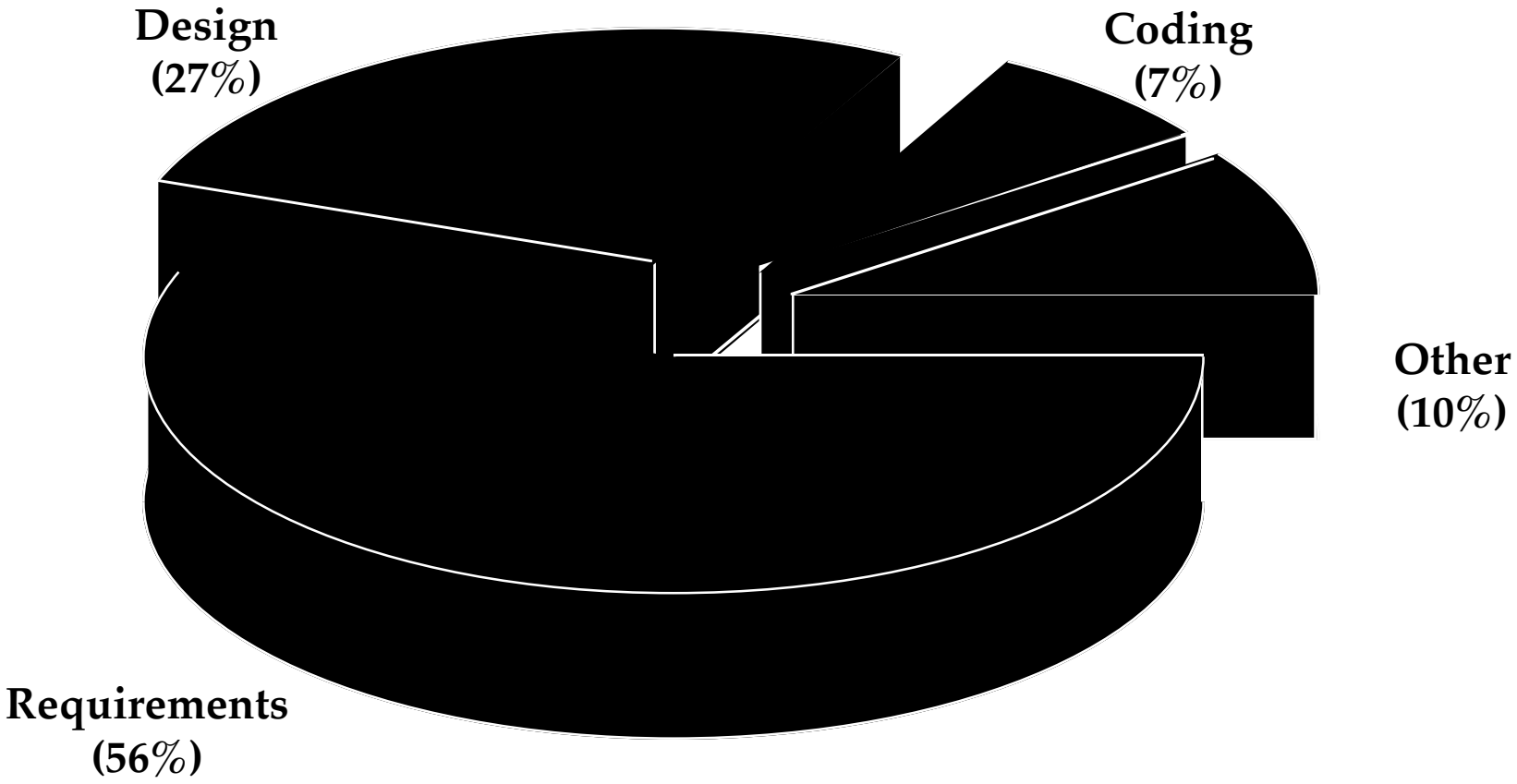
The Problem of Software Delivery

Study of 9 Federal Software Projects

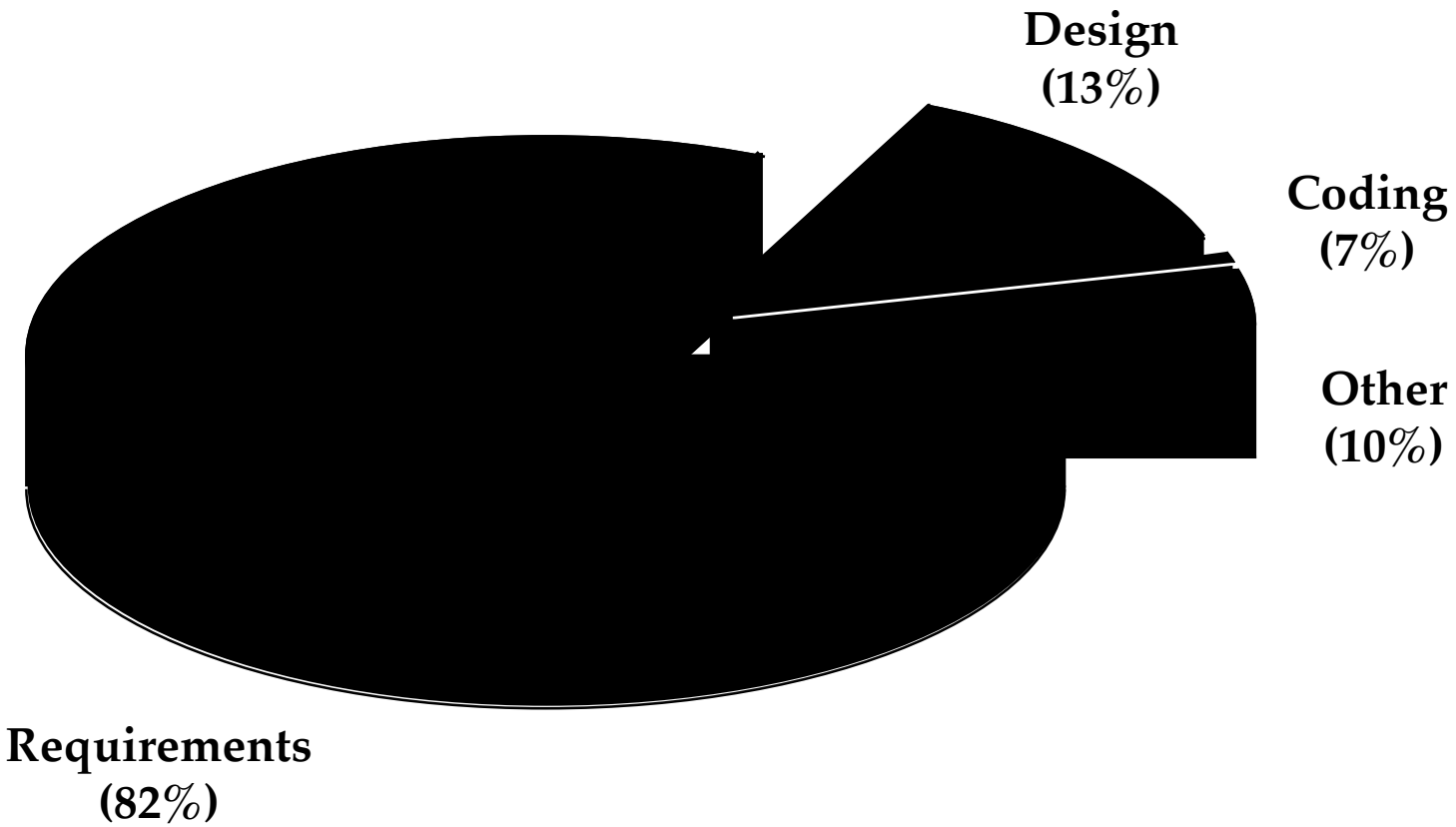
Total Amount 6.8 Million US$

❖ 47%	$ 3.2 M	Delivered but never used
❖ 29%	$ 2.0 M	Paid but never delivered
❖ 19%	$ 1.3 M	Abandoned or reworked
❖ 3%	$ 0.2 M	Used after change
❖ 2%	$ 0.1 M	Used as delivered

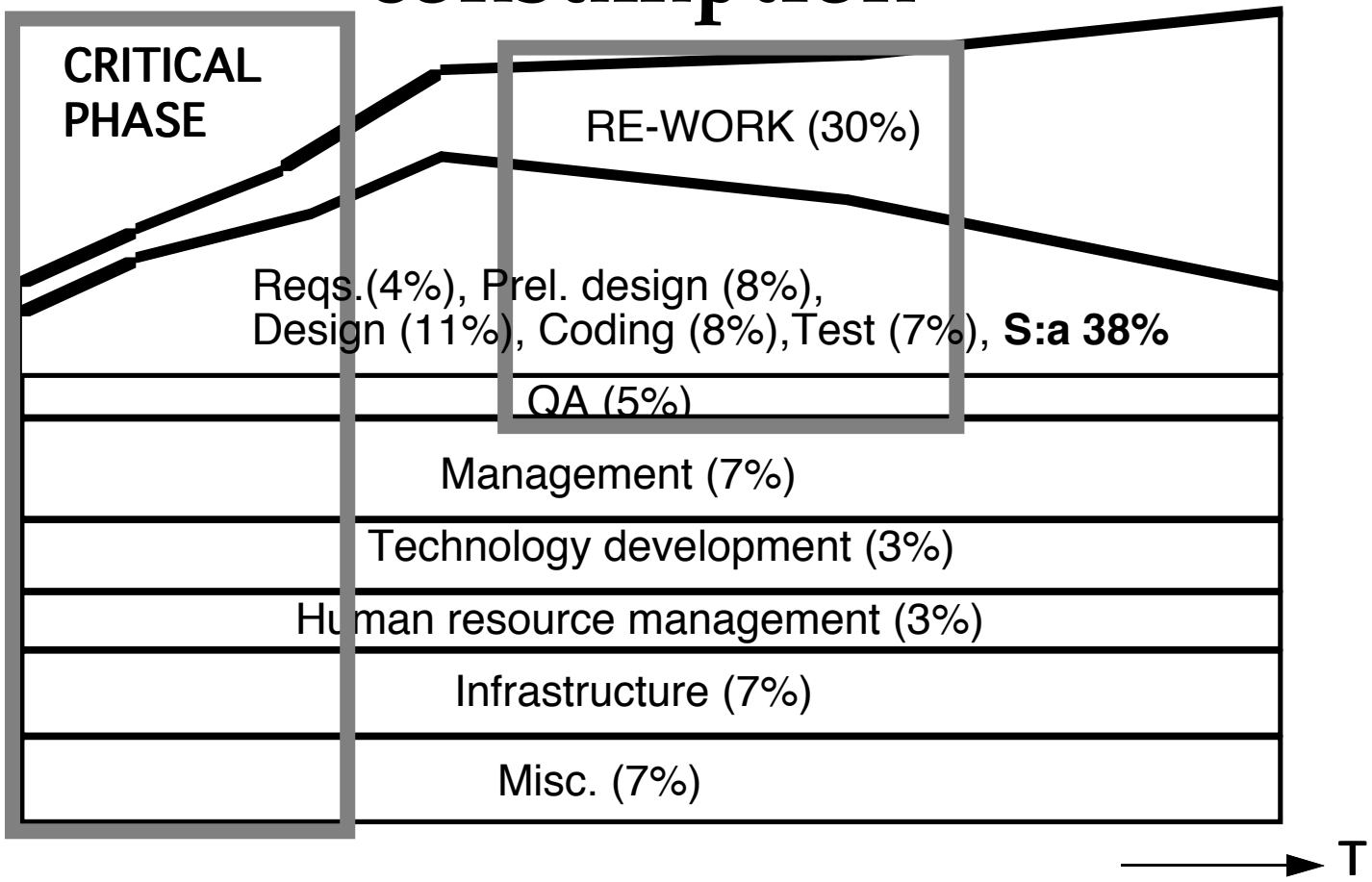
Source of Errors in Maintenace



Effort Required to Correct Errors



Software process resource consumption



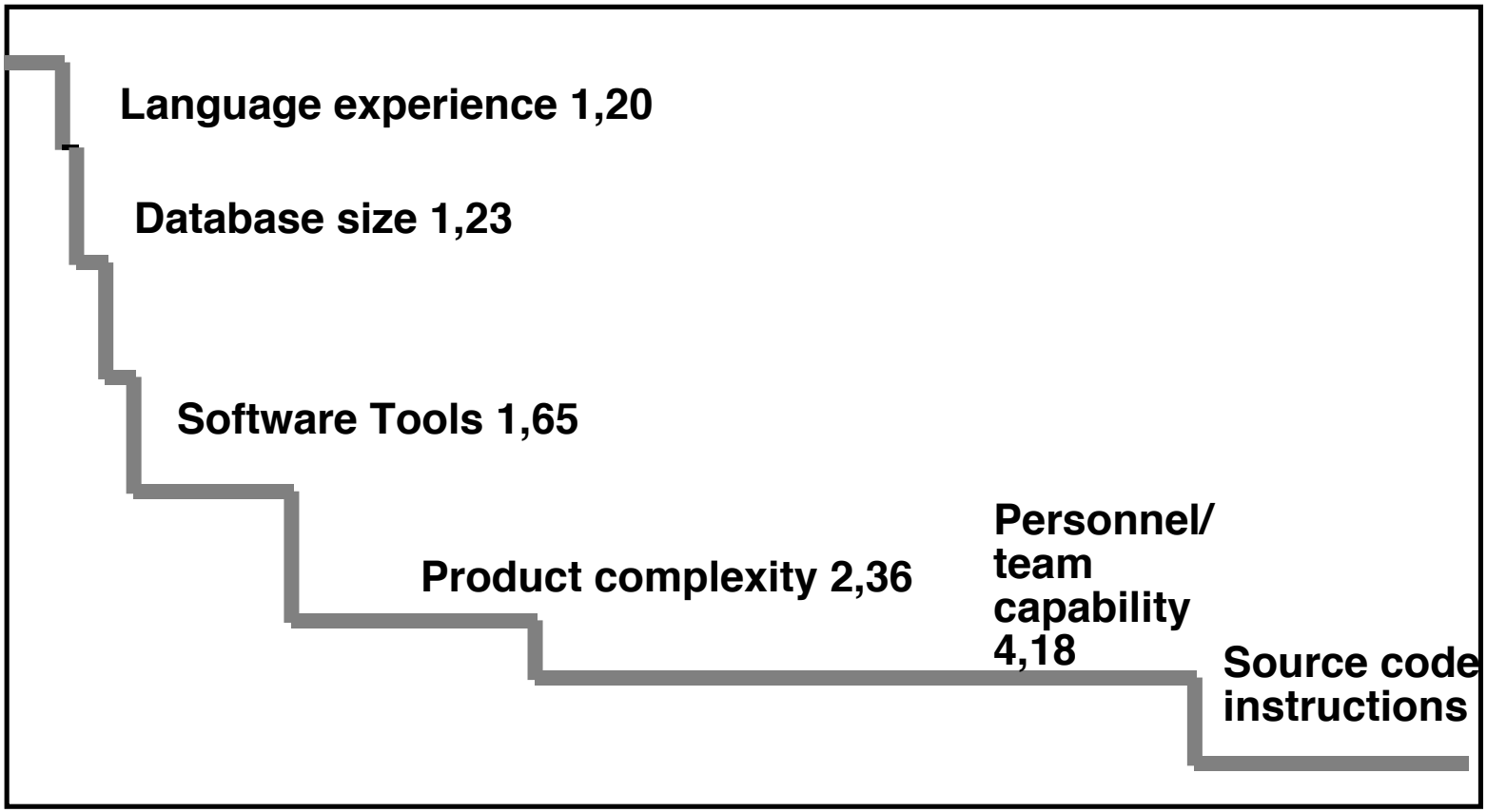
SOFTWARE PRODUCTIVITY

"Studies by [references] have demonstrated the substantial impact of behavioral (i.e. human and organizational) factors on software productivity.

The effects of tools and methods were relatively small in these studies."

From "A FIELD STUDY OF THE SOFTWARE DESIGN PROCESS FOR LARGE SYSTEMS" by Curtis, Krasner, and Iscoe, MCC (The Microelectronics and Computer Technology Center, Austin, TX), Comm. of the ACM, Nov. 1988.

PRODUCTIVITY DRIVER FACTORS



From B. Boehm, IEEE Computer, Sept. 1987 [Boehm, 1987 #226]

Topics

- Definitions
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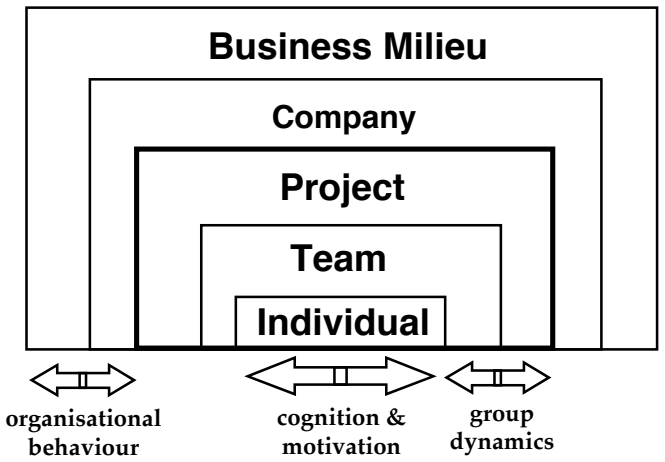
Observations from Empirical Study (Curtis...)

$4.5M - 17 Projects from

- Manufacturing
- Telecommunications
- Consumer electronics
- Aerospace

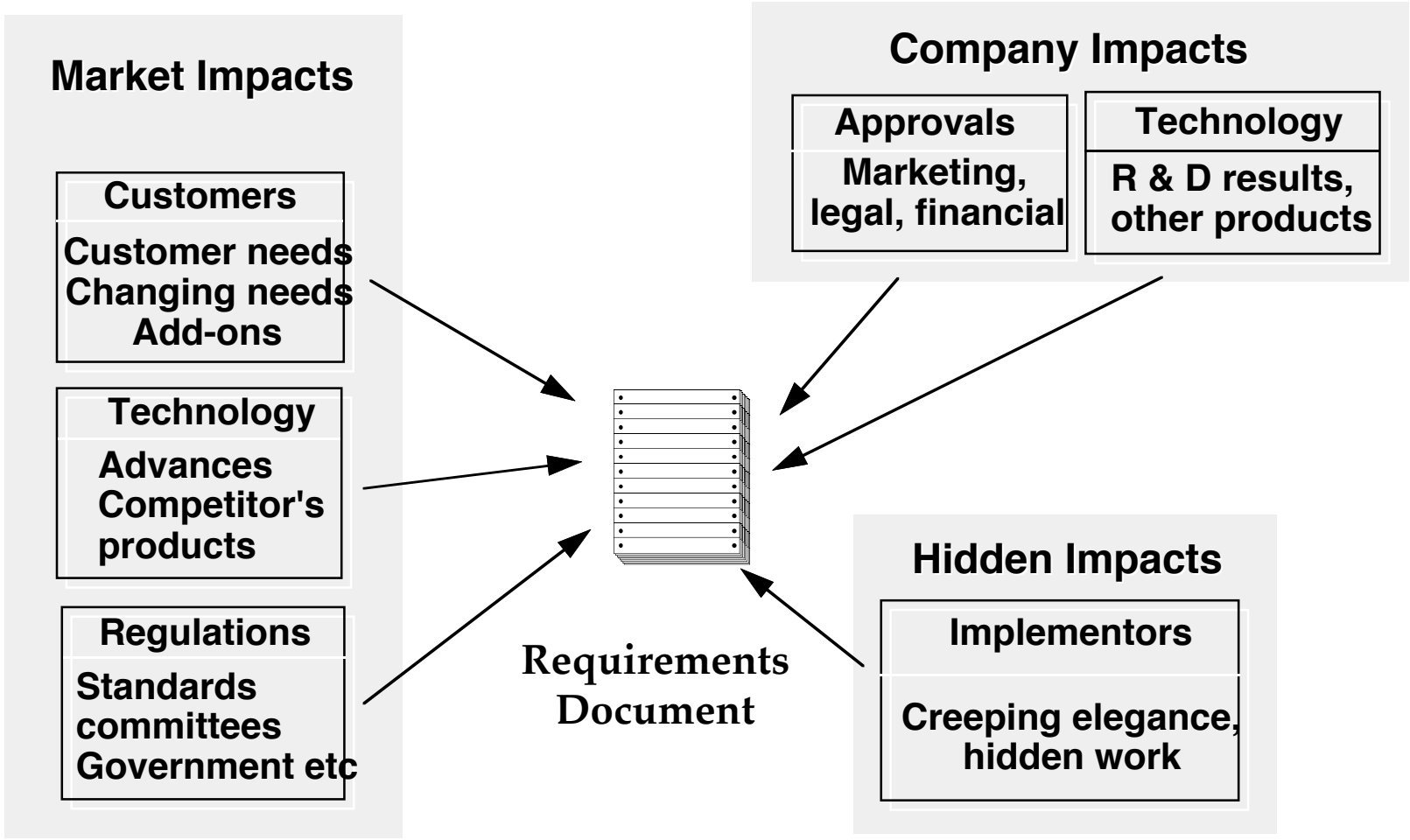
Approach



Findings

- The thin spread of application domain knowledge
- Fluctuating and conflicting requirements
- Communication and coordination breakdowns

Fluctuating & Conflicting Requirements



Notes from [Curtis...]

- Tools do not help overcoming team and organisational problems
- Writing code is not the problem - understanding the problem is
- Exceptional designers
- Education of people is negelected
- Often there are many customers of a project: fluctuating requirements
- Customers do not understand cost & tradeoffs
- Customers bypass formal request channels
- Contractors are forced to assume requirements
- A project often feels the absence of a "mission"
- Programmers often add functionality not requested

Interview questions (Lubars et al)

- General: e.g. "can you describe your work?"
- Req. origination: e.g. "how do the requirements come to you?"
- Elicitation and validaton: e.g. " how do you check you understand requirements?"
- Modelling: e.g. "how do you specify system behaviour?"
- Evolution: e.g. "do the requirements change?"
- Methodology: e.g. "any experience of methods?"

Project categories (Lubars...)

- Customer specific pojects (9)
- Market driven projects (14)

Requirements Definition & Specification (Lubars..)

Market driven

- vague, informal, "slides"
- lack of vision, understanding of purpose
- customer identity unclear
- low response to "customer needs"
- prioritization - commercial aspects
- assumptions should be recorded
- some projects had no req. spec. at all -"there was no time"

Customer specific

- more formal, more "full
- domain experts
- "no misunderstandings"
- customer identity unclear

- few did use any req. def. method
- some scepticism about OO-methods
- difficult to get money to train people in methods
- low use of "upper CASE" tools - complants about CASE

Validation & Evolution of Requirements (Lubars...)

- Validation normally done through formal reviews and HCI simulation
- In customer specific projects: changes in the environment; in market driven projects: competition
- Changes do not cease once the design phase had begun
- Large interest in re-use and "domain models"

General conclusions (Lubars...)

- Organisational solutions preferred over technology
- General purpose technology is preferred to CASE
- Under-capitalisation of requirements activities
- Increasng importance of market driven segment

Implications (Lubars...)

- Documentation support
- Domain knowledge
- Usability
- Development process
- Technical methodology
- CASE technology

Topics

- Definitions
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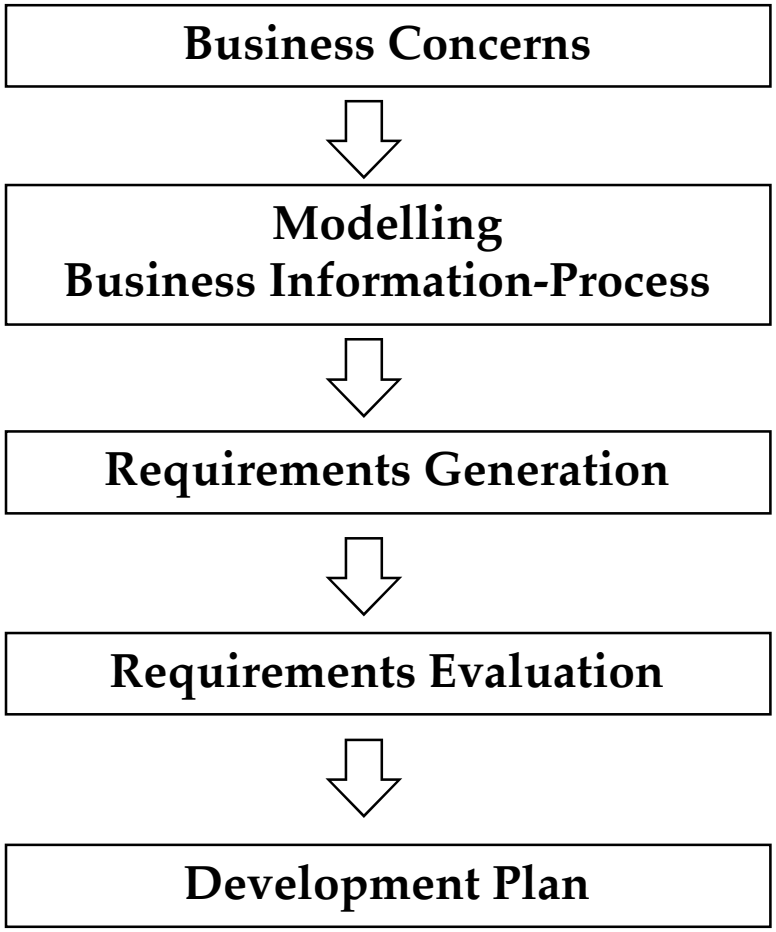
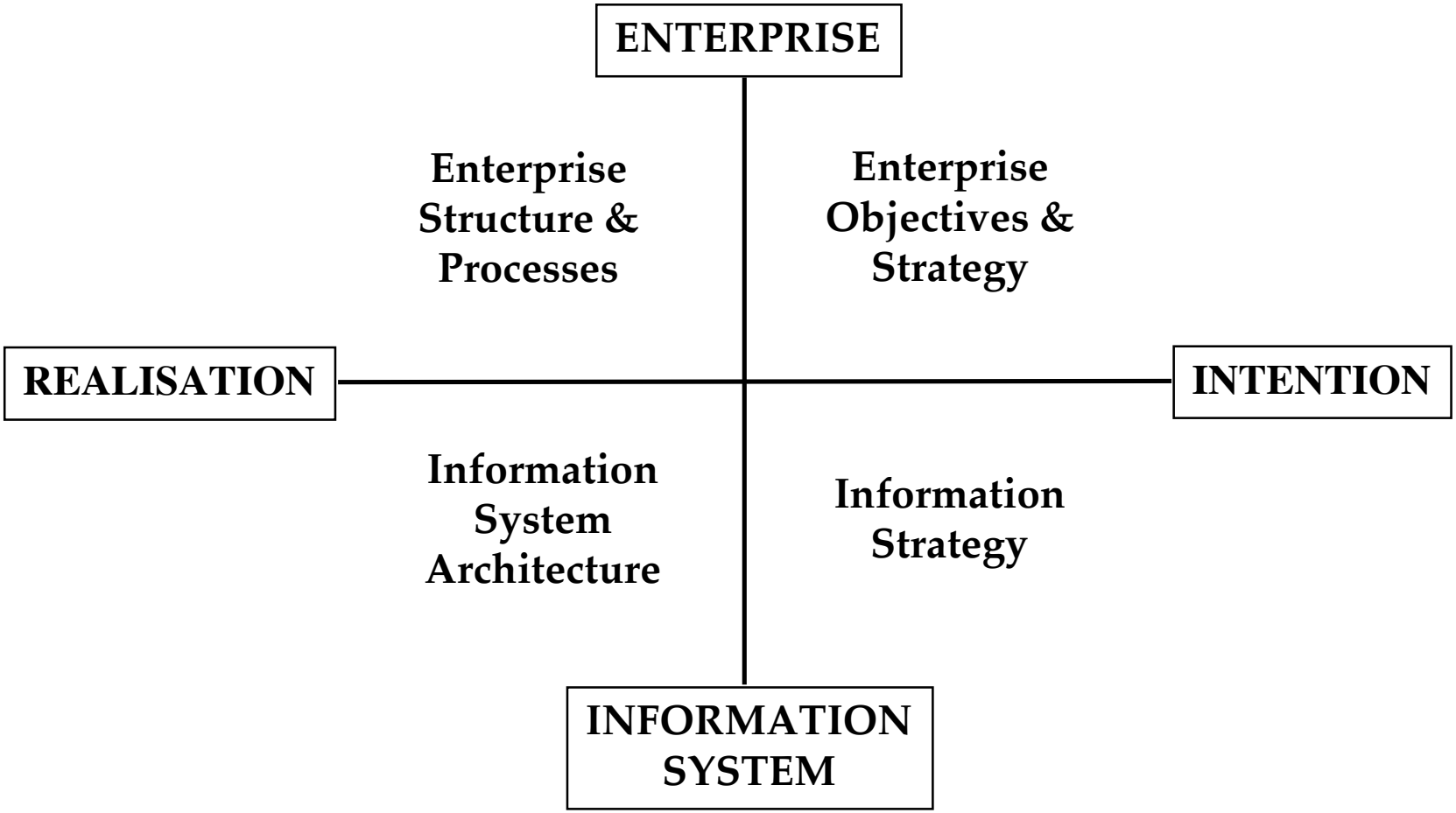
Requirements in Enterprise Evolution



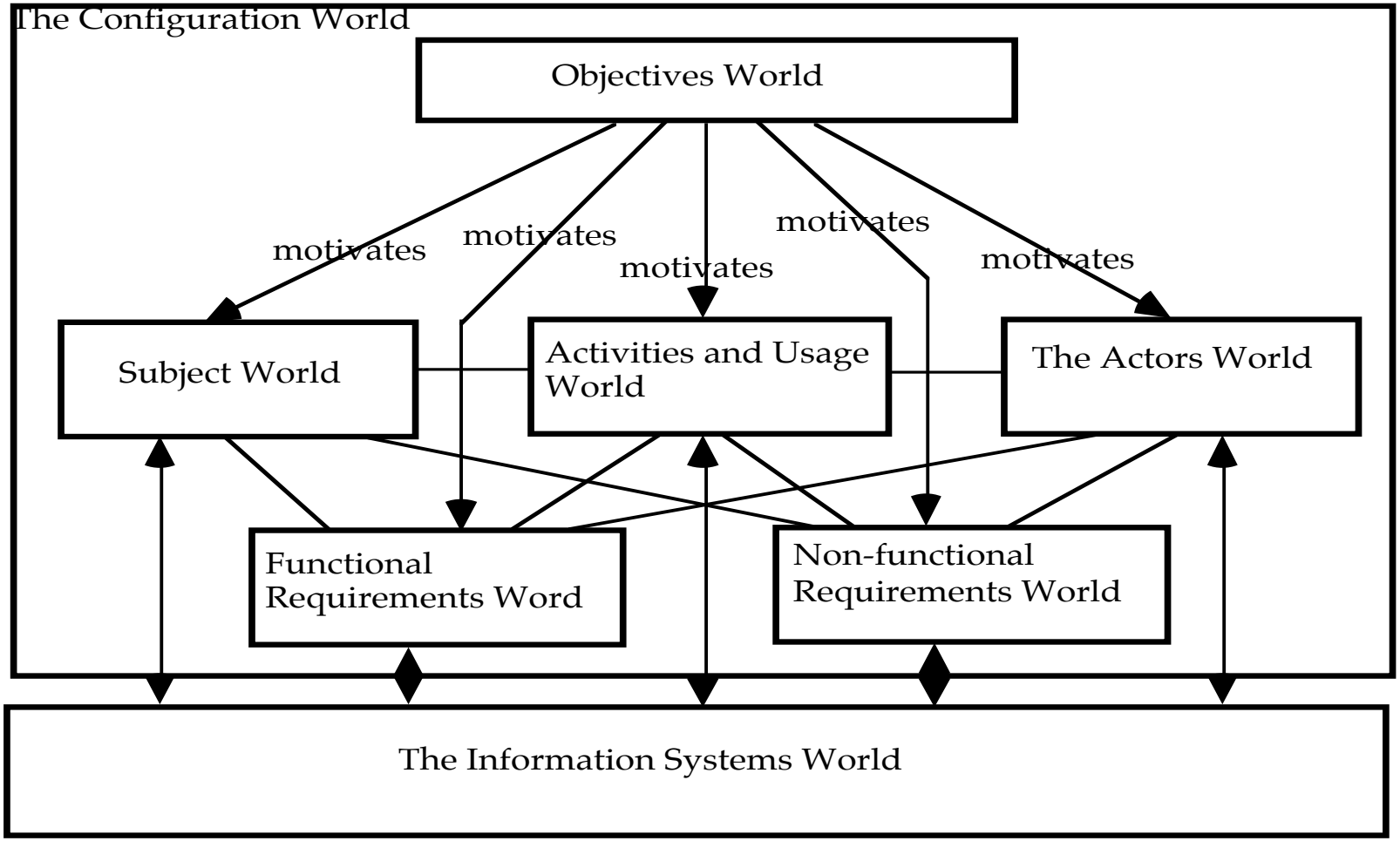
Relationship between Enterprise & I.S.



System Requirements

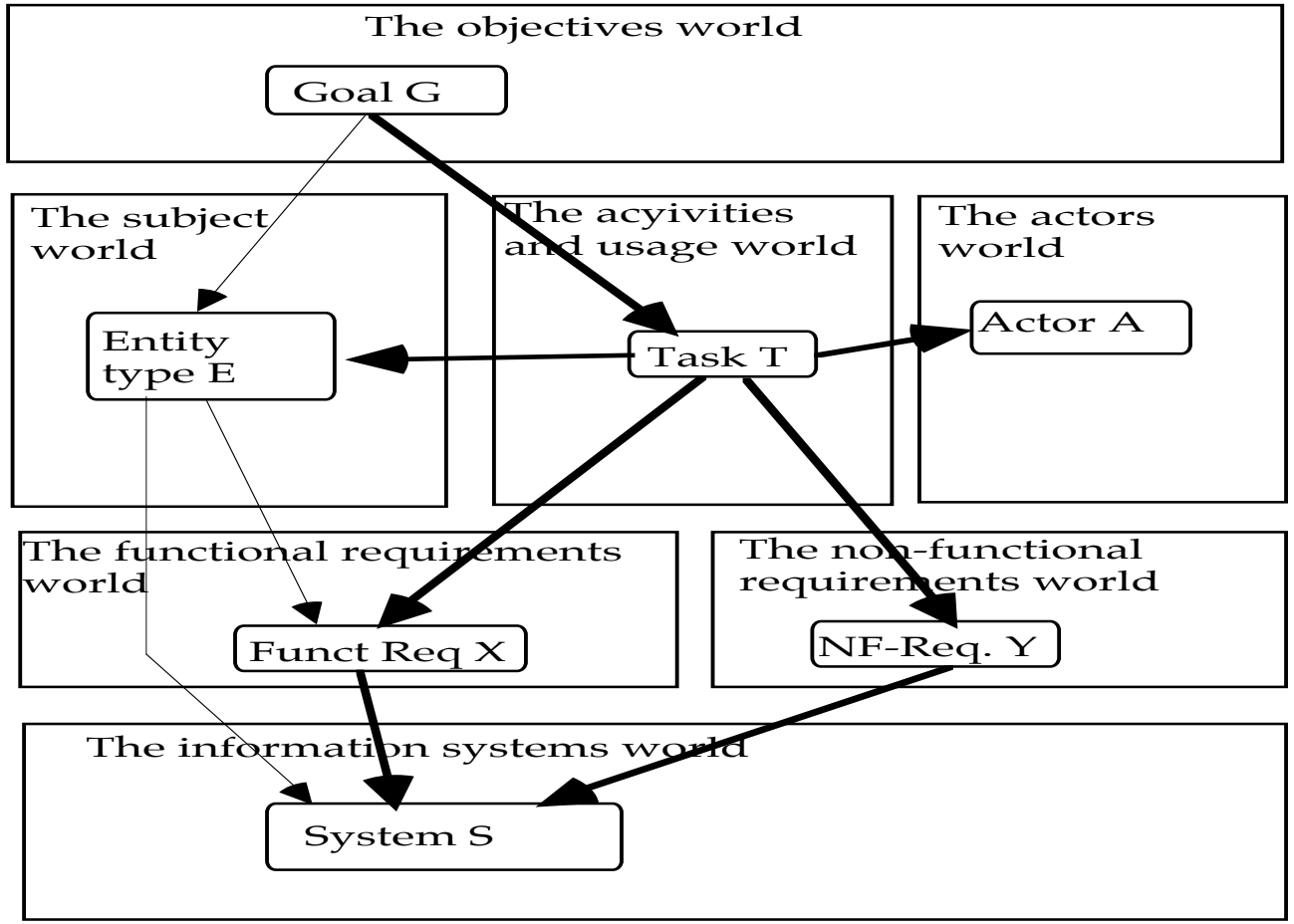
- **Enterprise Requirements**
  - **Modelling the enterprise objectives, activities, actors, resources**
- **Functional Requirements**
  - **Modelling the behaviour of the intended system**
- **Non-Functional Requirements**
  - **Modelling the constraints that the intended system should obey**

Requirements modelling worlds

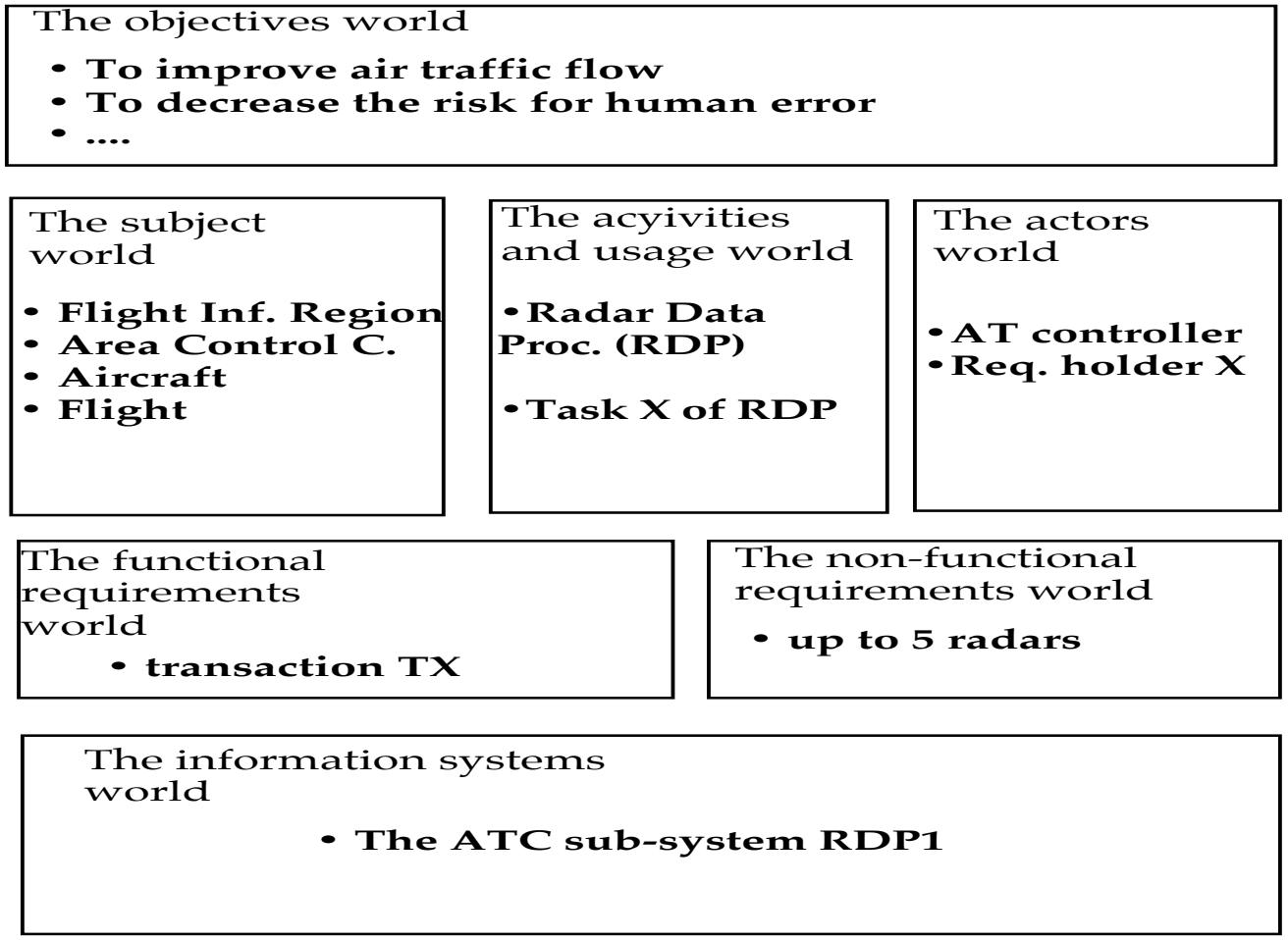


ESPRIT Project 6612, F-cube

Instances of modelling worlds

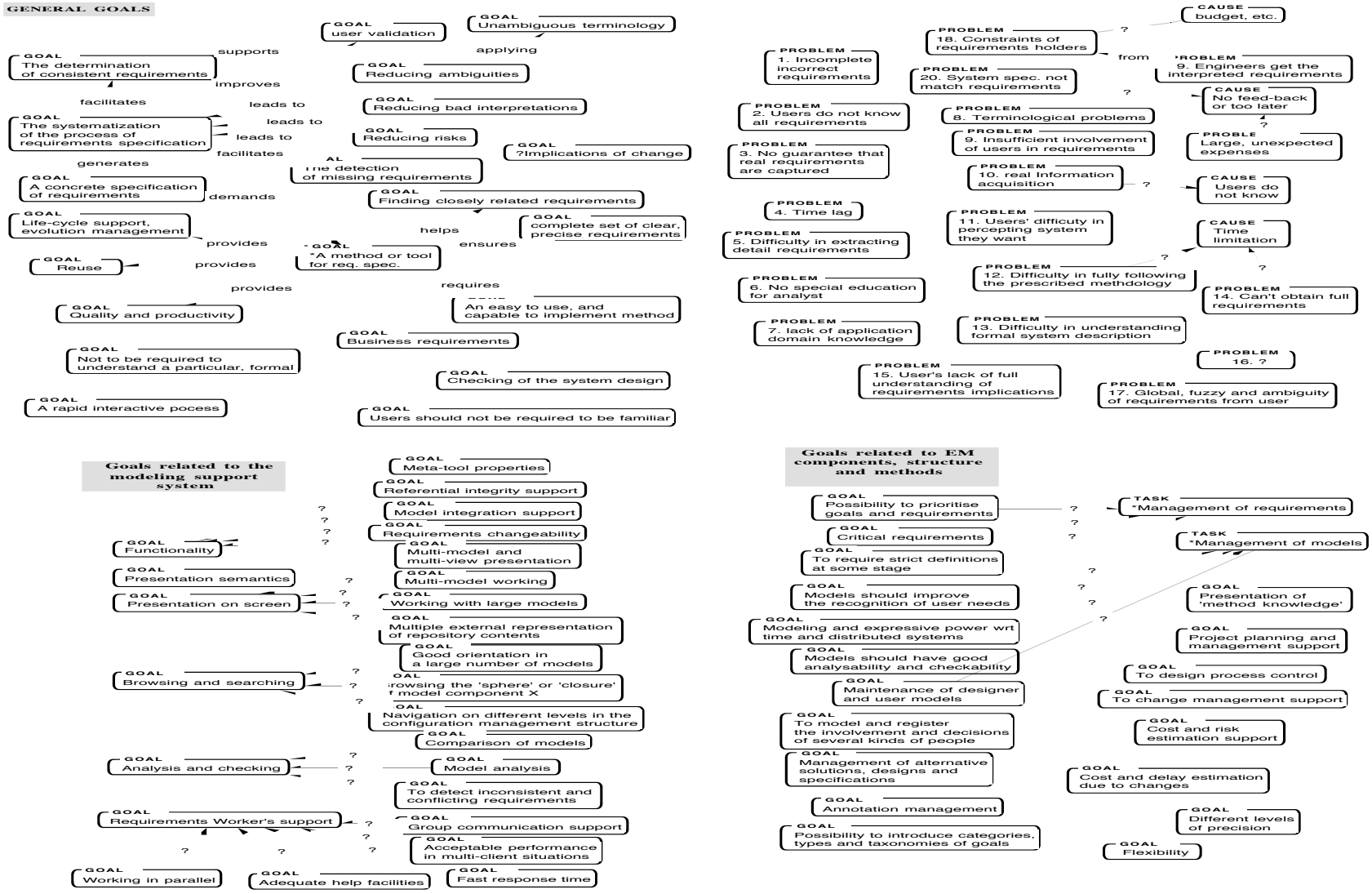


Air Traffic Control System Requirements

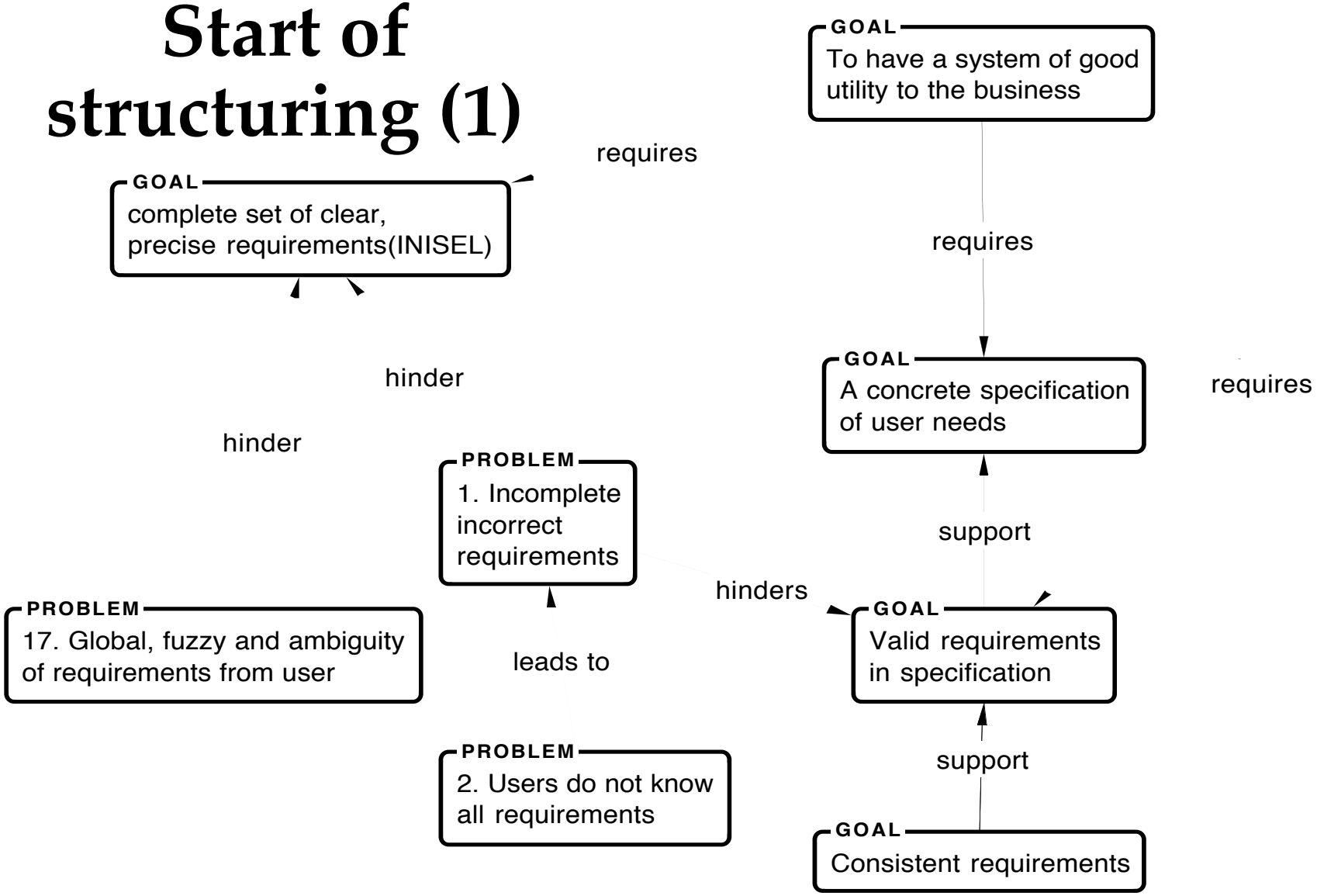


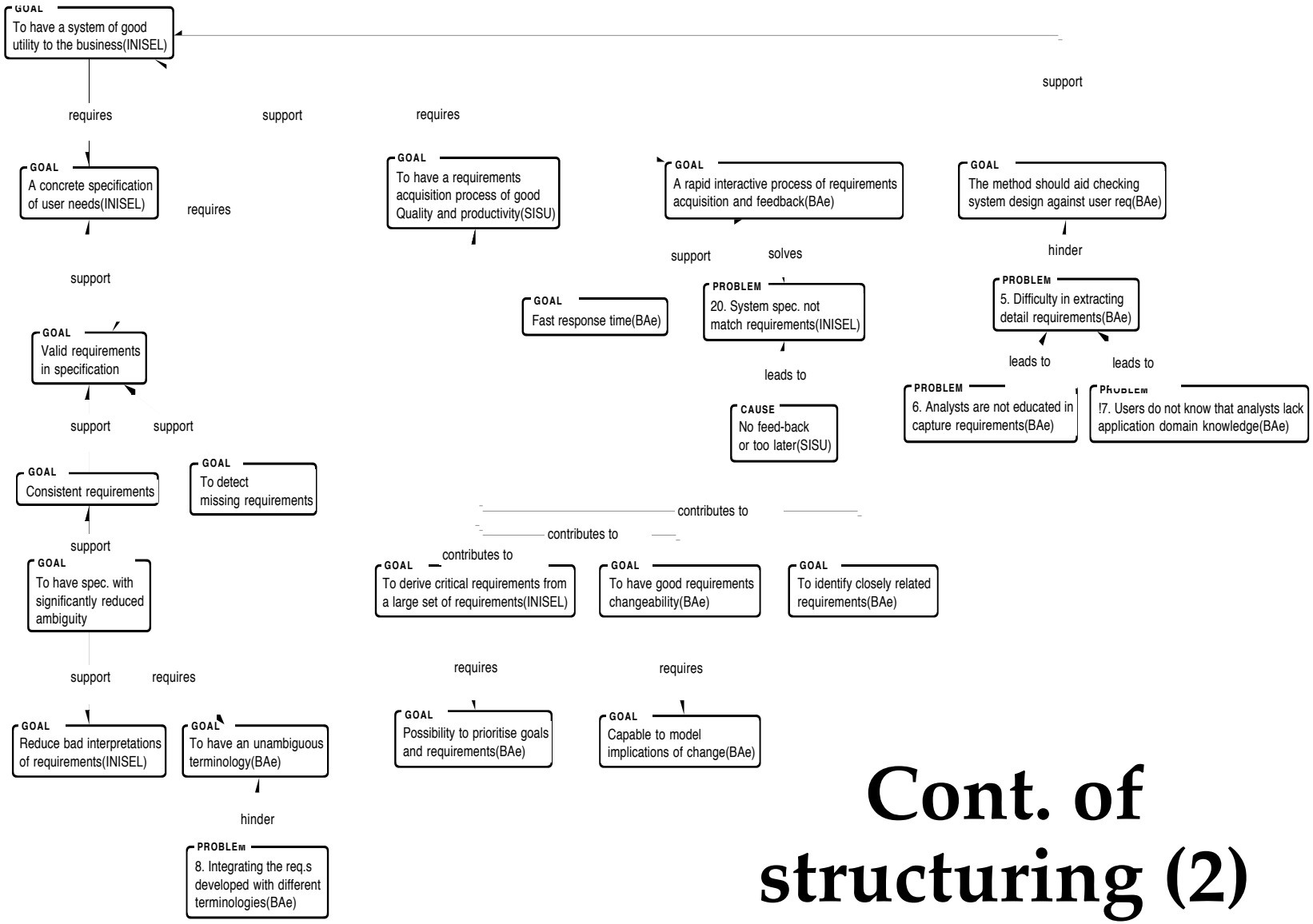
ESPRIT Project 6612, F-cube

Unstructured set of fuzzy goals & requirements



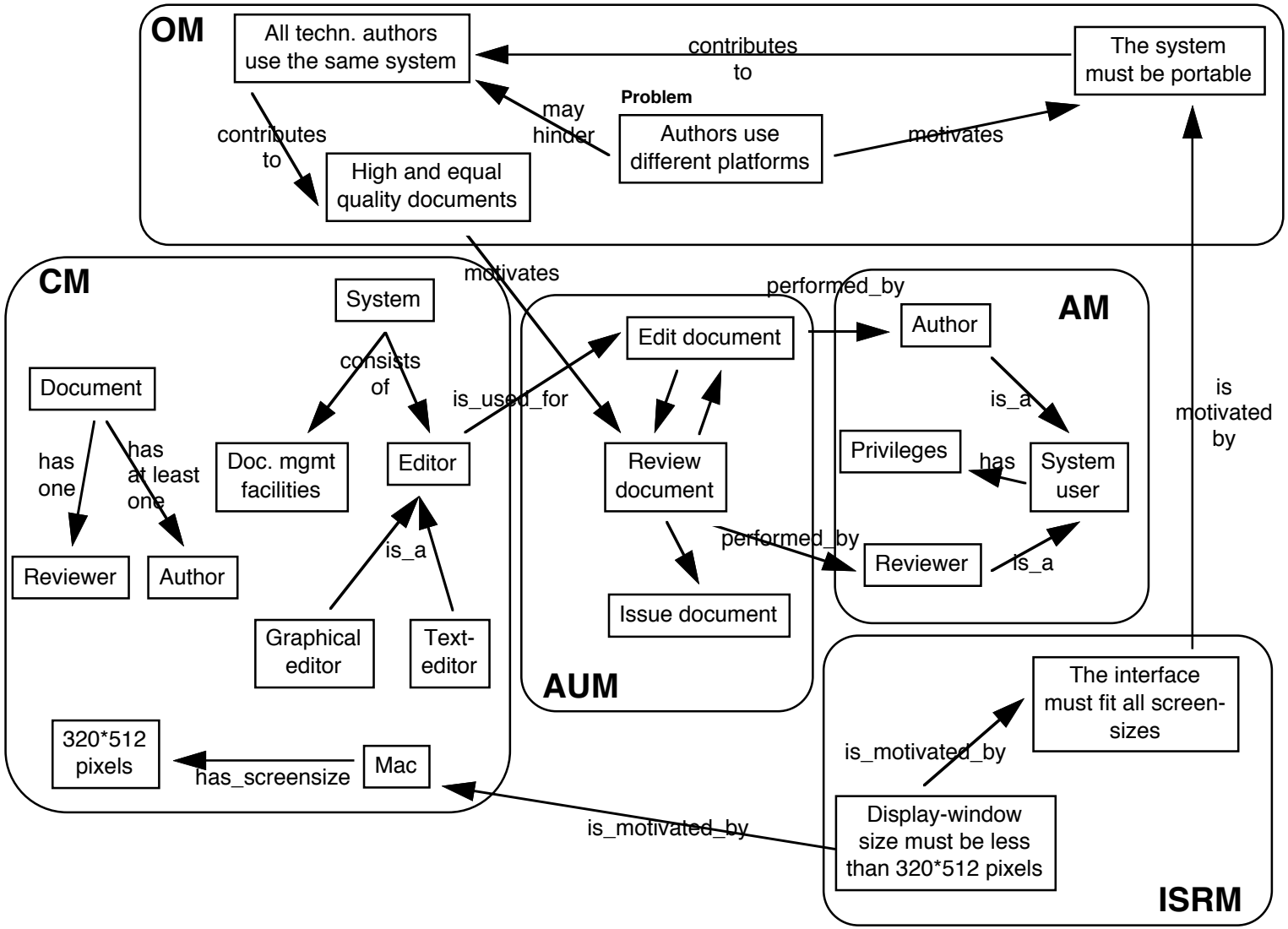
Start of structuring (1)



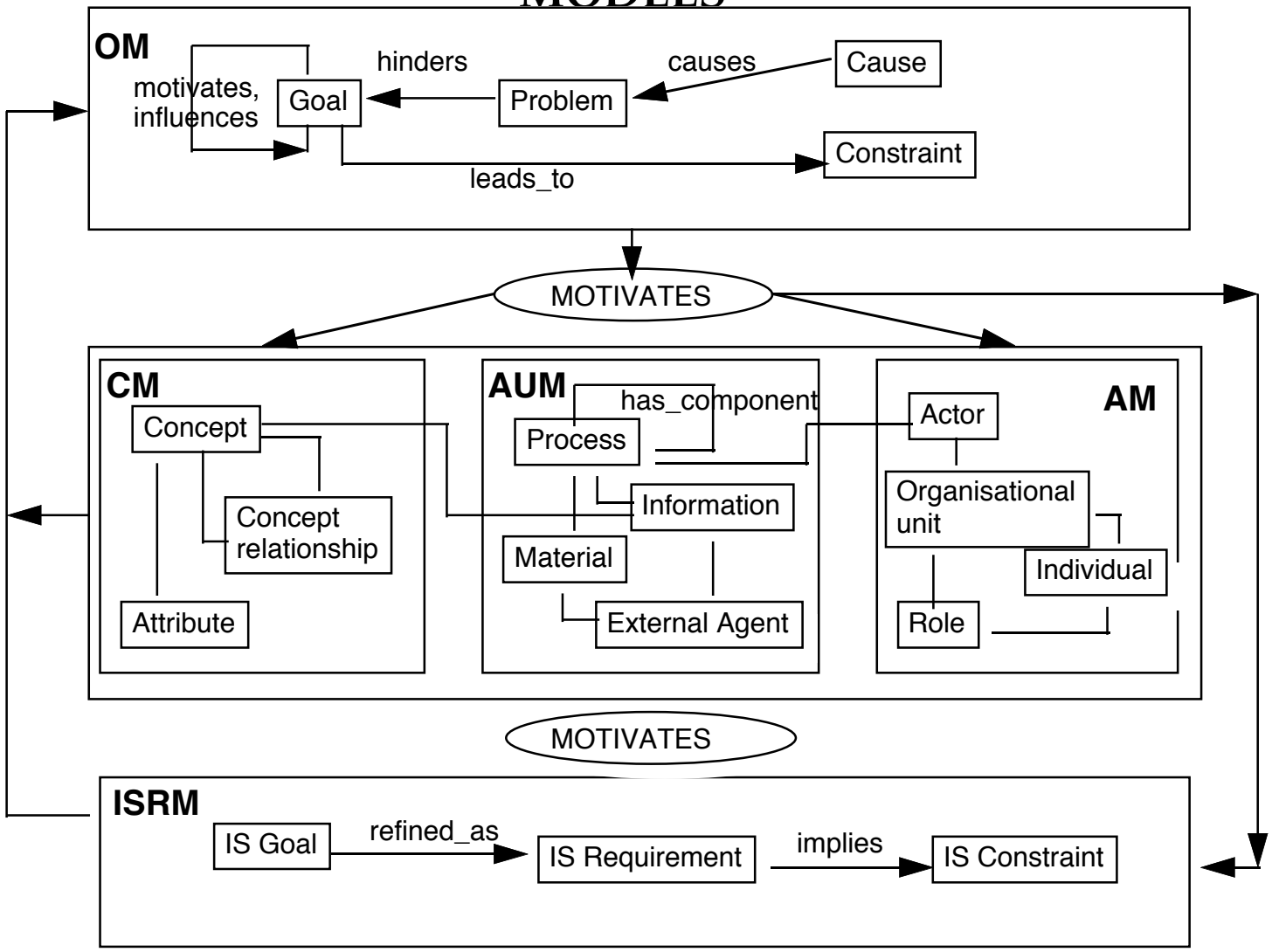


Cont. of structuring (2)

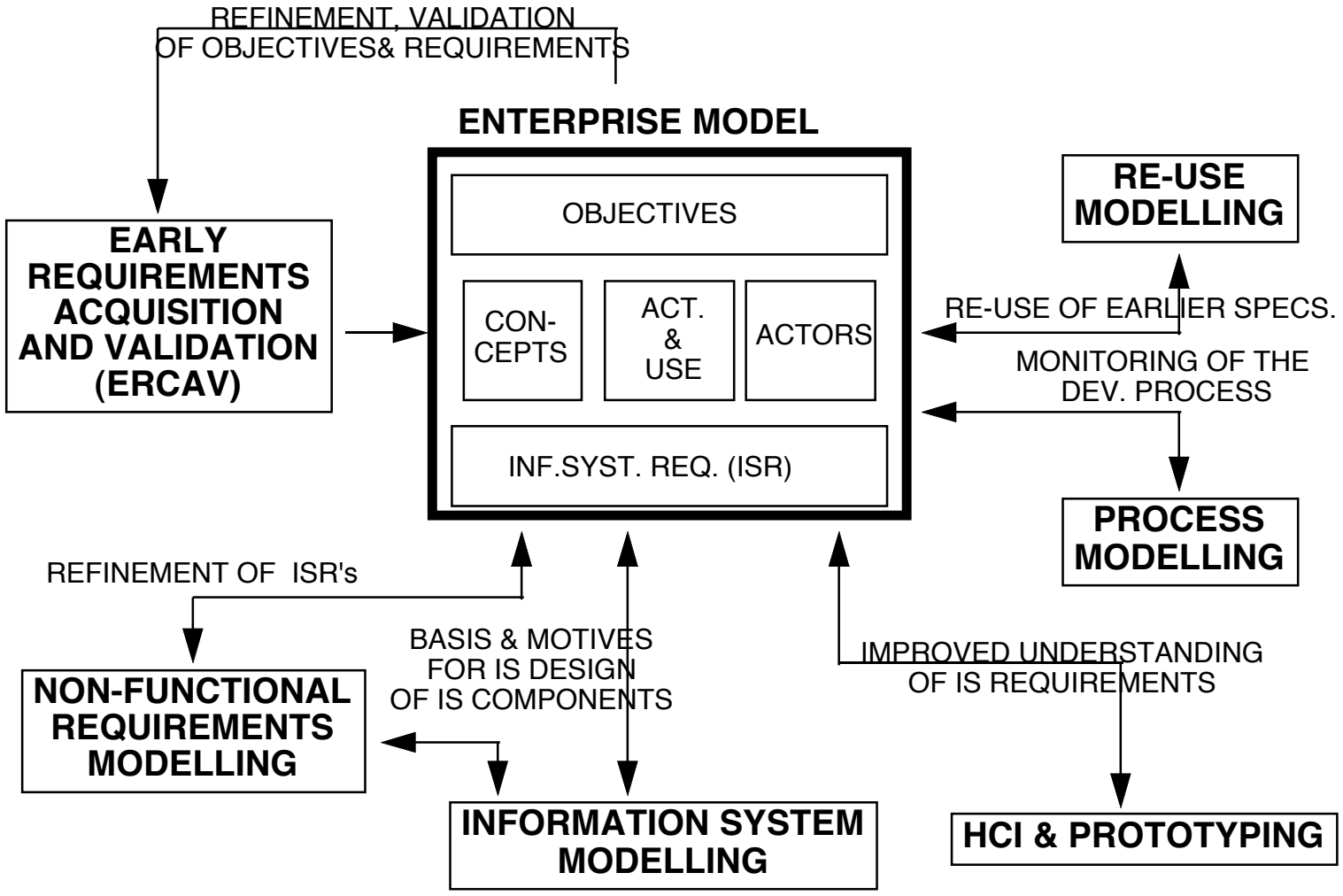
Enterprise Model: Example from BAe case study



THE ENTERPRISE MODEL AND ITS SUB-MODELS



RELATIONSHIPS TO OTHER F3 MODELS



HOW DOES ENTERPRISE MODELLING CONTRIBUTE TO REQUIREMENTS ENGINEERING?

- EM extends the IEEE framework & guide to RS
- Improved re-use of Enterprise Knowledge
- Makes Requirements Engineering more systematic, precise, and "teachable"
- Reduces the risk for lost or misinterpreted requirements
- Improves, by user participation, the validity of the RS
- Makes the whole Requirements Specification mantainable during the system's life cycle and adaptabel to evolving business plans
- Improves RS completeness and quality leading to less re-work

Topics

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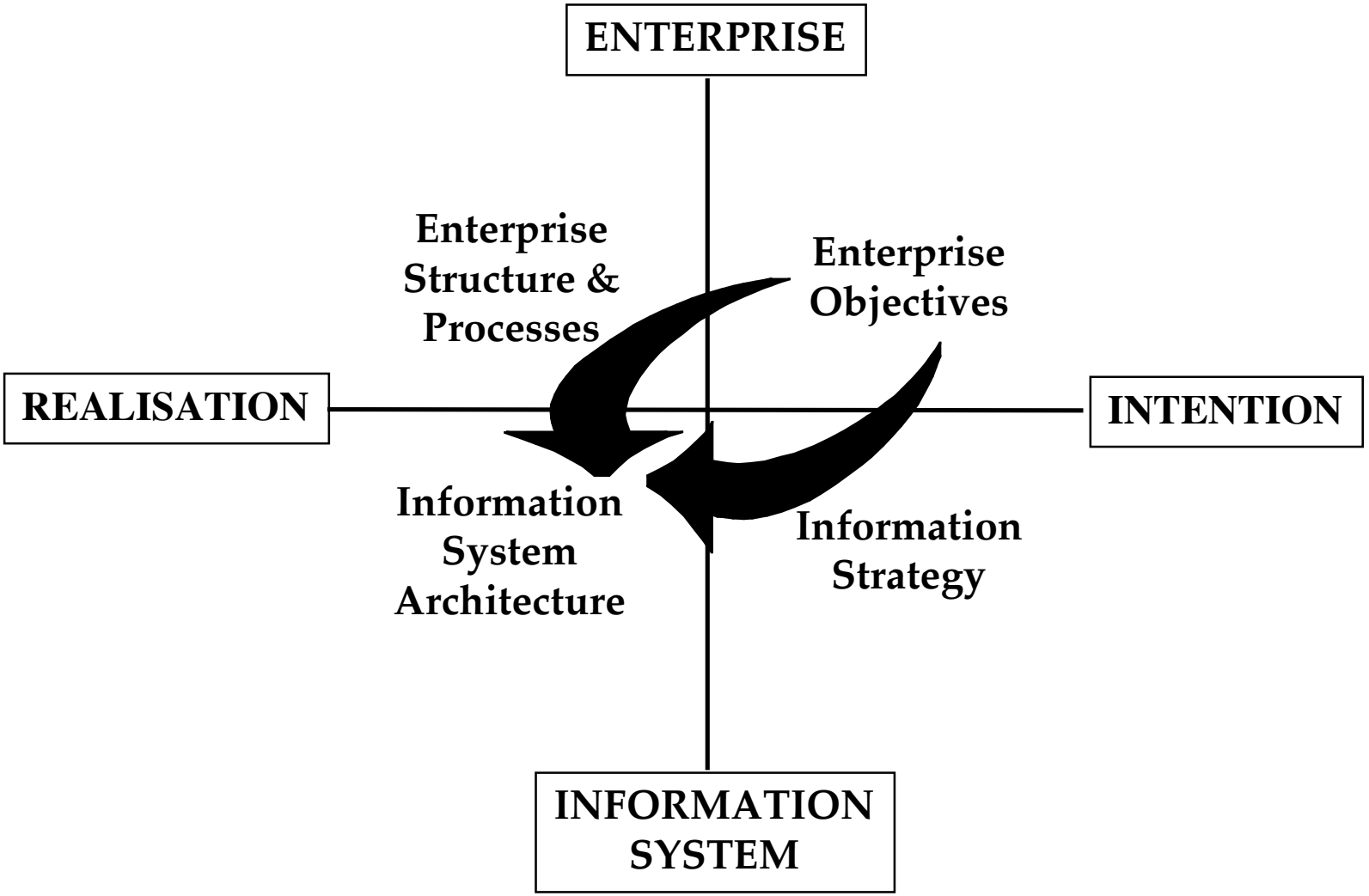
Coverage of Methods

Lifecycle stage / METHOD	Problem Definition	Analysis	Design	Implement-ation
Structured		X	X	X
Corporate Data Modelling		X	X	X
Real World Event Modelling		X	X	X
Object Oriented		X	X	X
Business Analysis	X	X		
Requirements Expression	X	X		
'Soft'	X			

Approaches to Implementation



Participants in R.E.