Universität Rostock Traditio et Innovatio

WIRTSCHAFTSINFORMATIK
UNIVERSITÄT ROSTOCK

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Seminar on

Knowledge Reuse

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- **10 faculties**
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- **Life, Light & Matter**
- **Maritime Systems**
- **Aging Science and Humanities**
- **Knowledge – Culture – Transformation**

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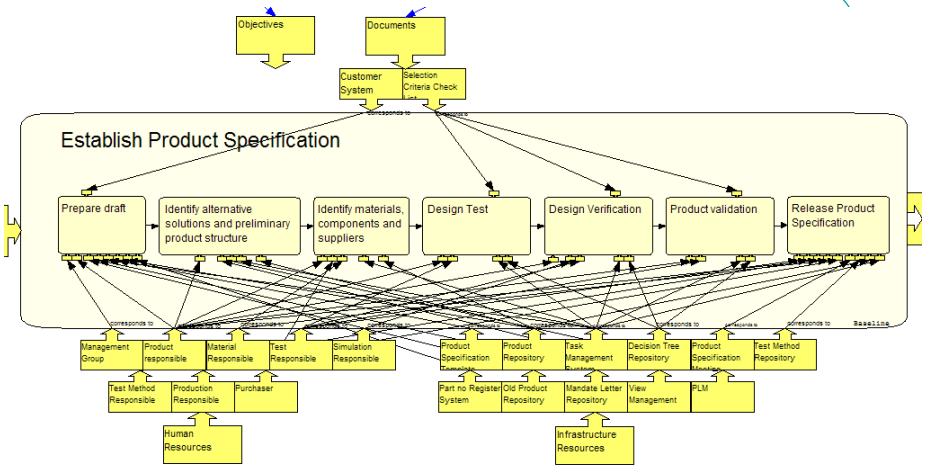
Institute of Computer Science: Konrad-Zuse Building

Research Area

Industrial Organisation
- Enterprise modelling languages
- Methods for enterprise modelling
- Enterprise Engineering
- Best practices
- Tools for enterprise modelling and architectures
- etc.

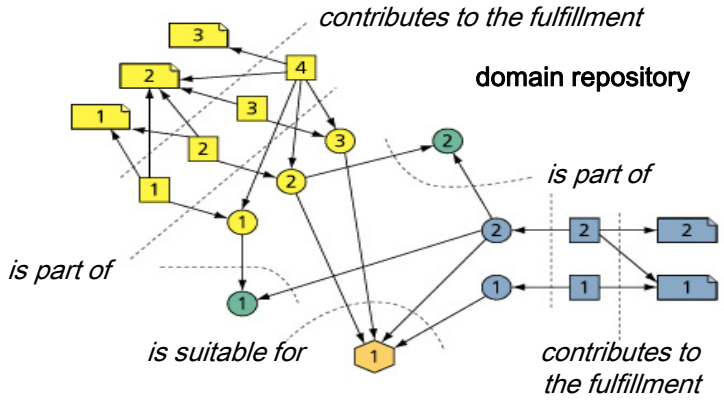
Organisational Knowledge

Computer Science
- Knowledge representation techniques
- Ontology Engineering
- Development of knowledge-based applications
- Methods and best practices
- Tools for ontology construction
- etc.



Enterprise Model

Enterprise Ontology



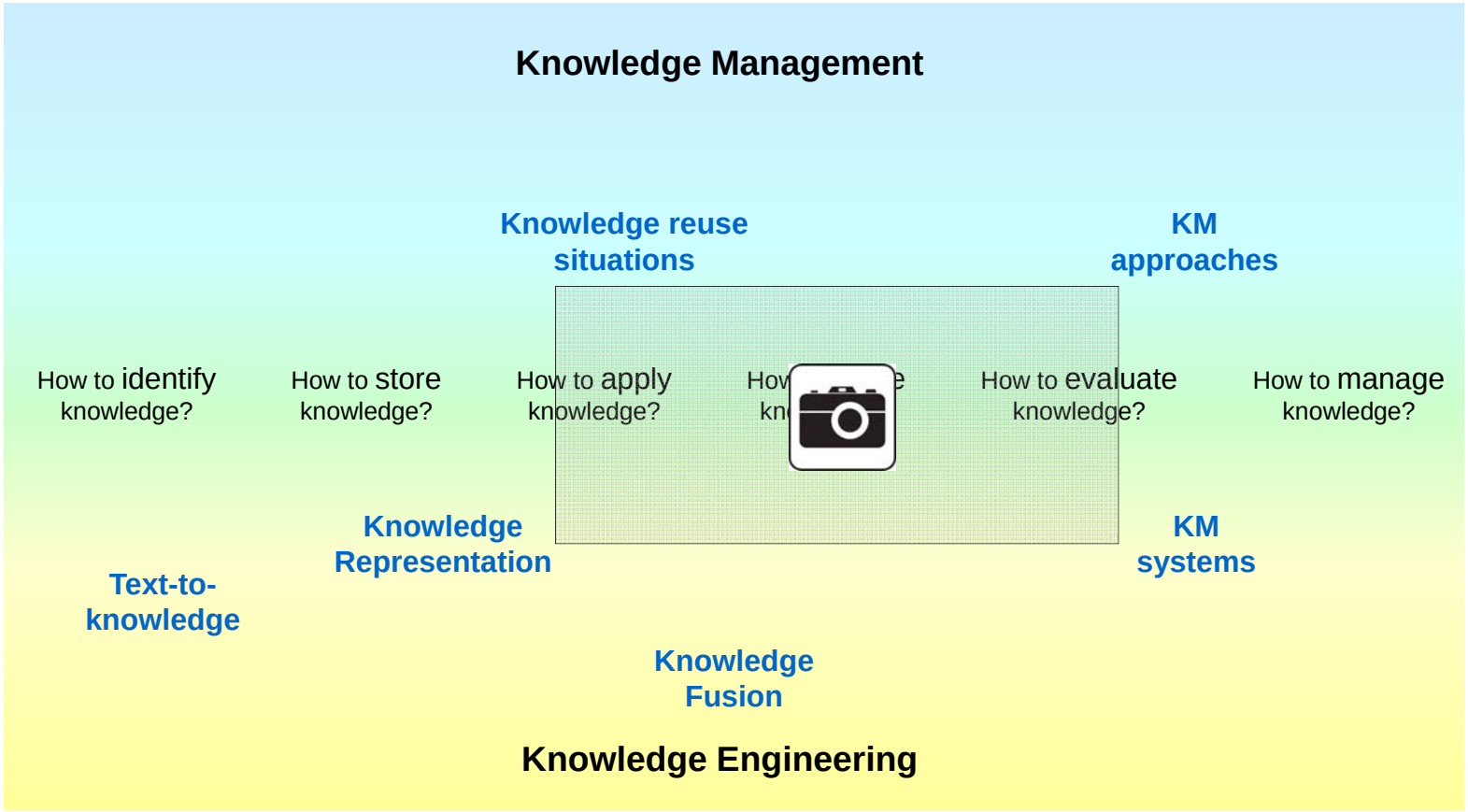
Knowledge Reuse

Warm-up

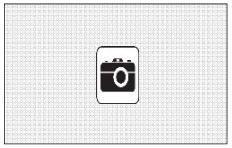
What is knowledge and knowledge reuse?

What is knowledge reuse from your understanding?
Please give an example for a knowledge reuse approach!

Knowledge Reuse: The „Big Picture“



Knowledge Reuse: The „Big Picture“



Knowledge Management

Economics

Knowledge reuse situations

Knowledge Management approaches

Knowledge Reuse Approaches

Business Information Systems

Knowledge Representation

KM systems

Computer Science

Knowledge Engineering

Content and Learning Objectives

Content

- The seminar investigates different approaches for knowledge reuse from computer science and business information systems. Starting from a discussion of fundamentals of knowledge reuse, different ways of reuse and their characteristics are introduced and compared.

Learning Objectives

- Ability to define and explain the term knowledge reuse and challenges involved
- Knowledge about contemporary developments in knowledge reuse
- Ability to compare different approaches for knowledge reuse

Time Plan, Material

- Rough time plan
  - 9 – 10:30: lecture on knowledge reuse
  - 10:30 – 11: coffee break
  - 11 – 11:45: “hands-on” – analyze approaches for knowledge reuse
  - 11:45 – 12:30: discussion of the results of the analysis

- Material
  - Lecture slides
  - Scientific papers
- Upcoming
  - Documentation in eBISS lecture notes

The Context for

Knowledge Reuse Techniques

What is knowledge?

One of many definitions:

"Knowledge is the result of a process of understanding, accomplished by the classification of information in a certain context based on individual experiences" (T.H. Davenport)

Types of Knowledge

Explicit Knowledge

- knowledge that was acquired, validated, structured, and saved

Tacit Knowledge (implicit knowledge)

- knowledge that is not stored but carried by a person
- can possibly be acquired using special tools

Declarative knowledge

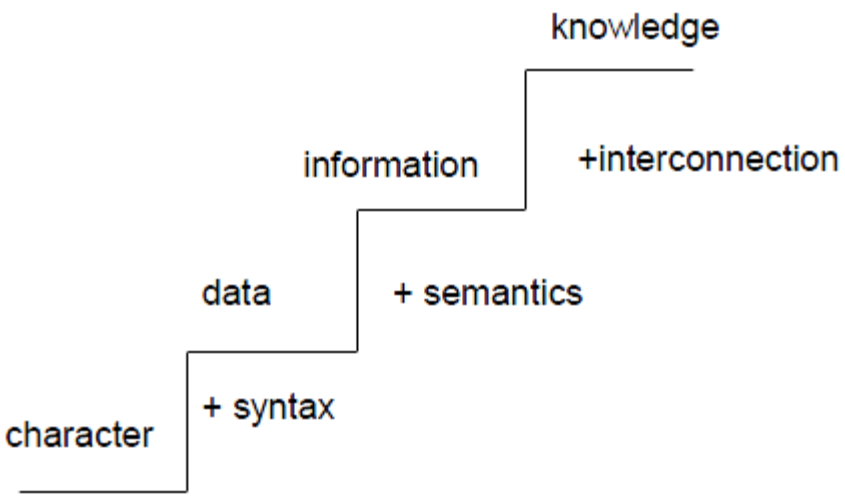
- knowing that something is true or false
- can be represented with knowledge representation languages

Procedural knowledge

- knowing how to do something
- can be represented with programming languages

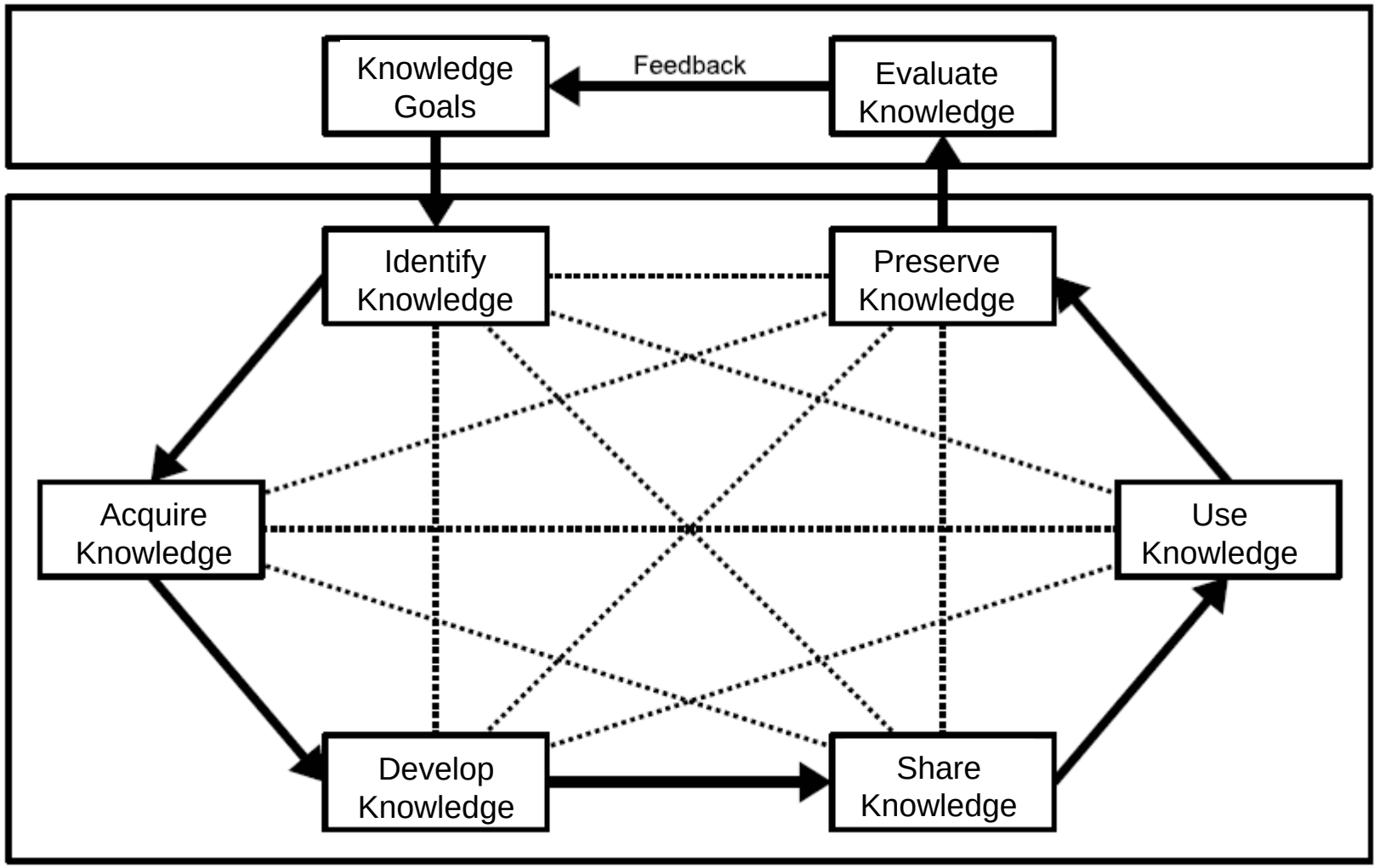
What is knowledge?

Knowledge Staircase



By K. North

Knowledge Management Building Blocks [Probst et al., 2000]



Knowledge Reuse Situations (1) [Markus, 2001]

Shared work procedures

- People working together on a team, either homogeneous or cross-functional
- producers of knowledge for their own later reuse

Typical purposes knowledge reuse

- Keep track of current status and things needing attention
- Recall reasons for decisions need to be revisited or when there is turnover among team members
- Learn how the team can perform better on the next project

Shared work practitioners

- People doing similar work in different settings
- producers of knowledge for each other‘s reuse

Typical purpose of knowledge reuse

- Acquire new knowledge that other have generated (e.g. how to handle a particular problem)
- Get advice how to handle in particularly challenging or unusual situation that is new to the team
- Gain access to observations that spur innovation

Knowledge Reuse Situations (2) [Markus, 2001]

Expertise-seeking novices

- people with an occasional need for expert knowledge that they do not possess and do not need to acquire themselves because they need it rarely

Typical purpose of knowledge reuse

- Answer an arcane question or solve an ad hoc problem
- Apporximate the performance of experts
- Minimize the need for experts

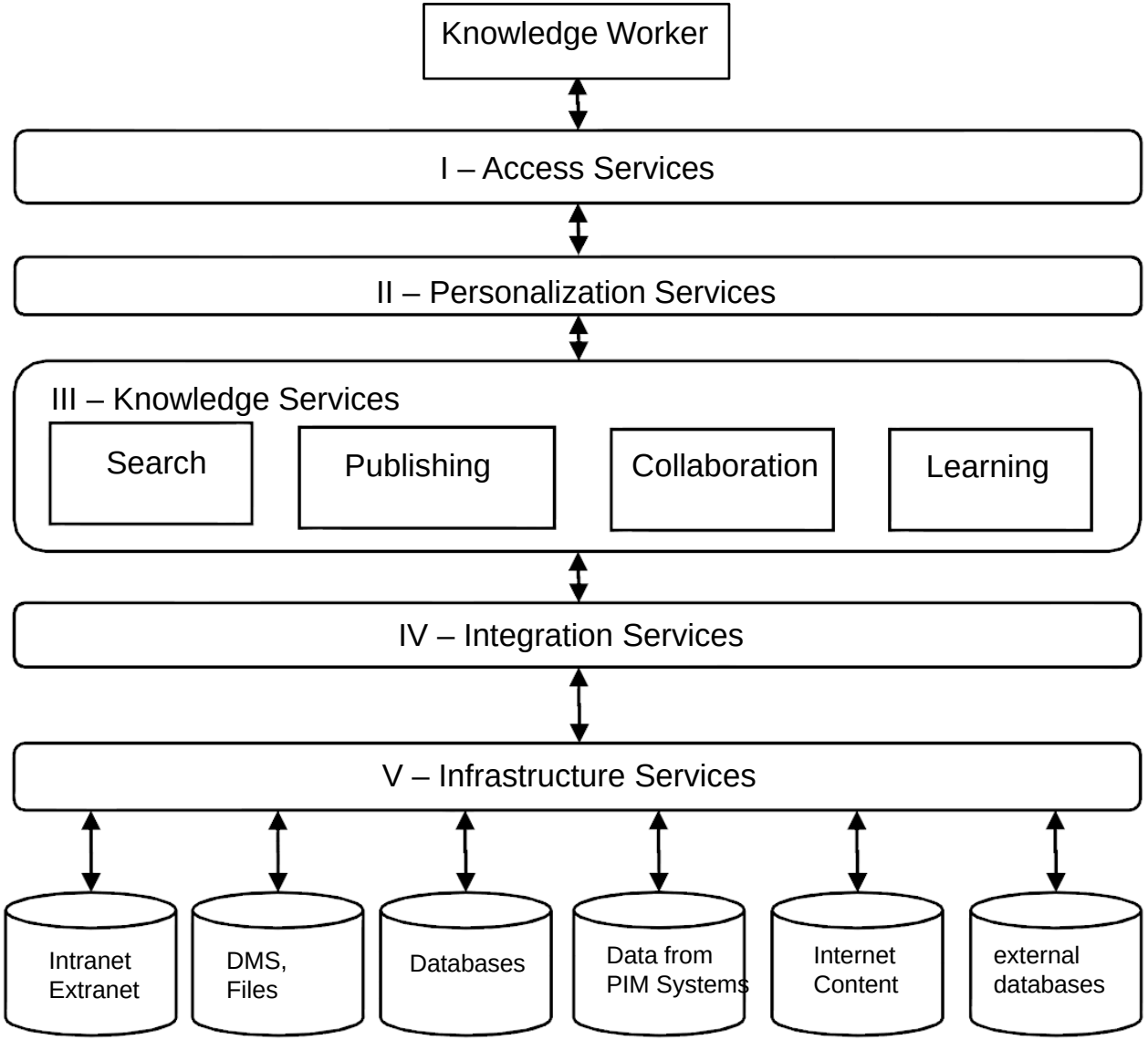
Secondary knowledge miners

- People who seek to answer new questions or develop new knowledge through analysis of records produced by other people for different purposes

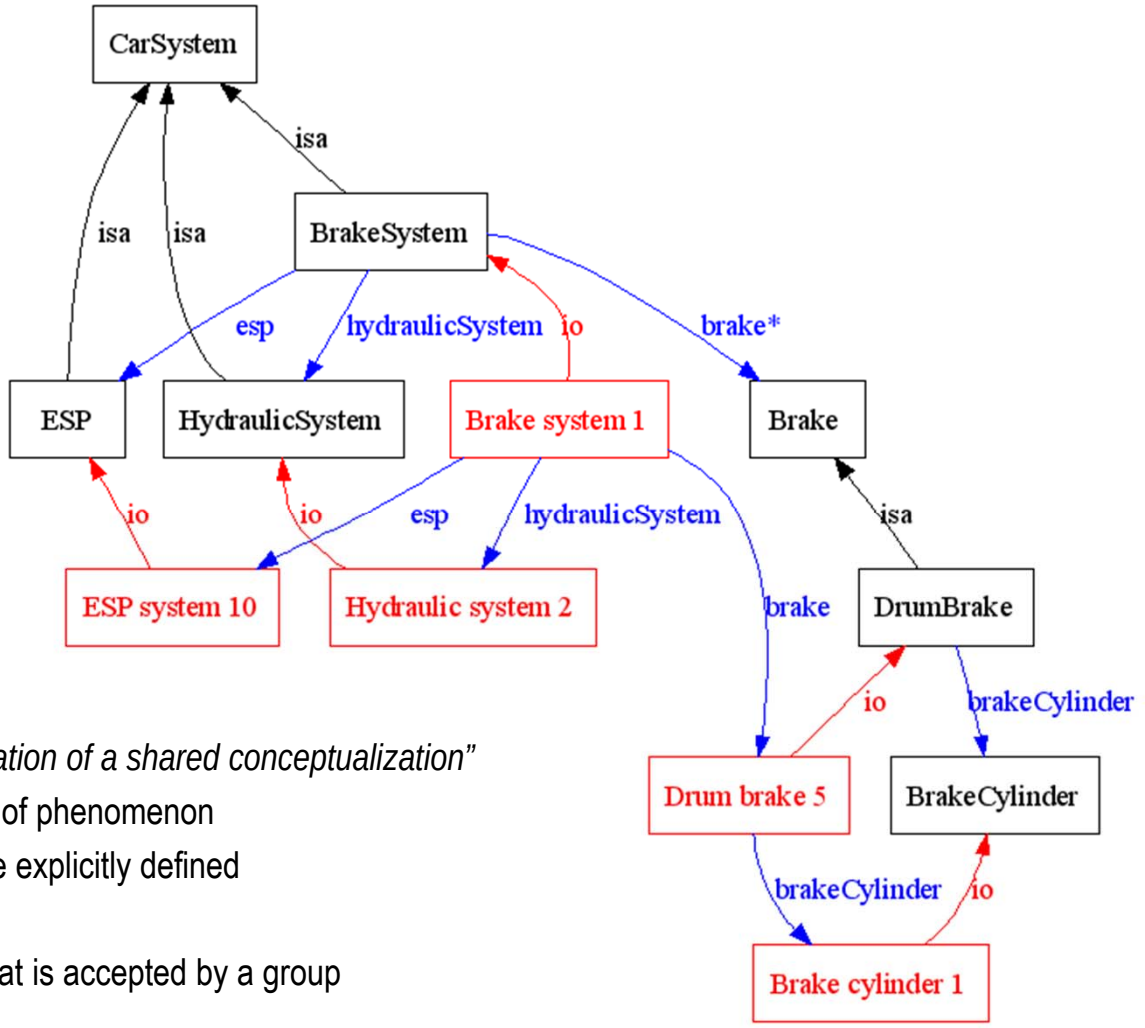
Typical purpose of knowledge reuse

- Seek answers to new questions or create new knowledge

Knowledge Services [Maier, 2010]



Knowledge Representation: Ontology



Studer et al.

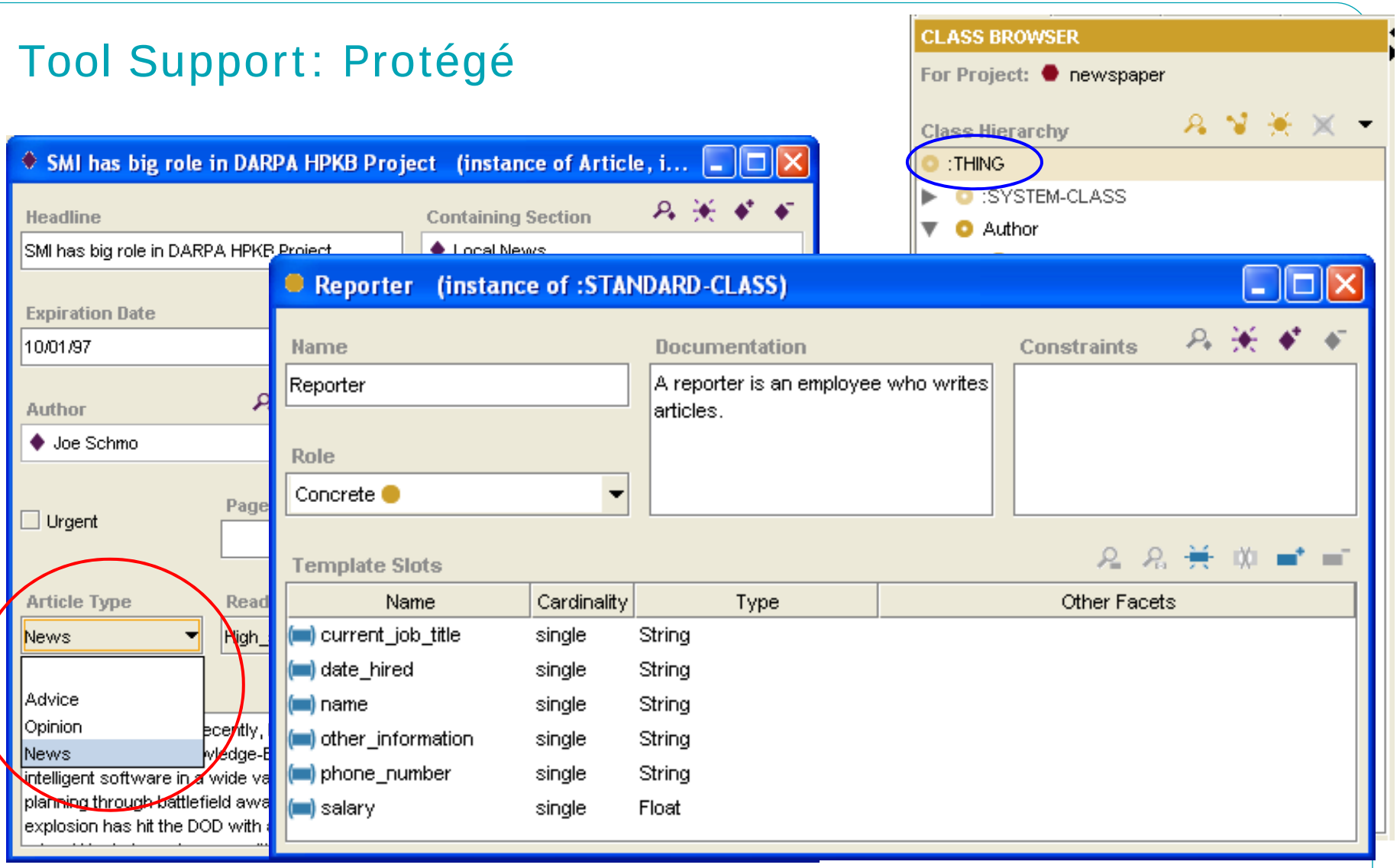
- *"An ontology is a formal, explicit specification of a shared conceptualization"*
  - Conceptualization: abstract model of phenomenon
  - Explicit: concepts & constraints are explicitly defined
  - Formal: Machine-readable
  - Shared: Consensual knowledge that is accepted by a group

Seven Steps to Create an Ontology [Noy + McGuinness, 2001]

Ontology Development 101: A Guide to Creating Your First Ontology

Step 1. Determine the domain and scope of the ontology
Step 2. Consider reusing existing ontologies
Step 3. Enumerate important terms in the ontology
Step 4. Define the classes and the class hierarchy
Step 5. Define the properties of classes – slots
Step 6. Define the facets of the slots
Step 7. Create instances

Tool Support: Protégé



Knowledge Reuse Techniques

Overview

What is knowledge and knowledge reuse?

- Allen Newell's view
- Nonaka's and Takeuchi's view

What knowledge reuse approaches have been proposed?

  - How can these approaches be compared and characterized?

Some examples for knowledge reuse

- Patterns
- Reference models

Allen Newell (1982) [Newell, 1982]

Knowledge

- knowledge is that which an observer ascribes to an intelligent agent (human or machine) that allows the observer to construe the agent's behavior as rational (i.e. behavior that allows the agent to achieve its perceived goals)
- knowledge is an abstraction that cannot be written down

Knowledge base

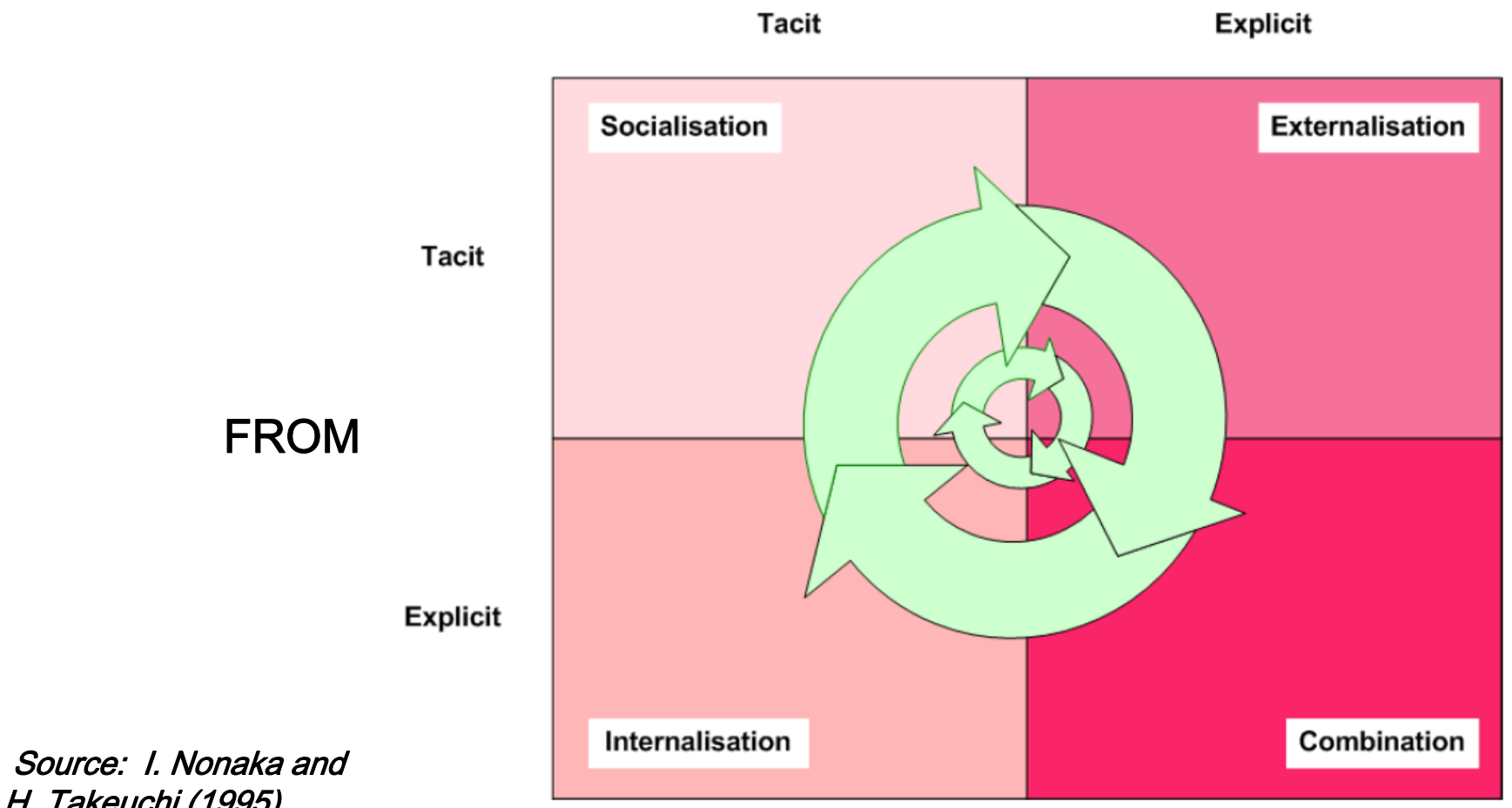
- data structures that we might use to encode knowledge in a computer knowledge base are not equivalent to the knowledge (the capacity for behavior) that those data structures represent
- we are able to use data structures (symbols) to represent knowledge, but those symbols cannot generate intelligent behavior - unless some process is applied to those symbols
- distinguish the symbols in a knowledge base (knowledge representation) from the knowledge (capacity for rational behavior) that the symbols can be used to generate

Allen Newell (1982) (ctd.)

Sharing and Reuse of Knowledge

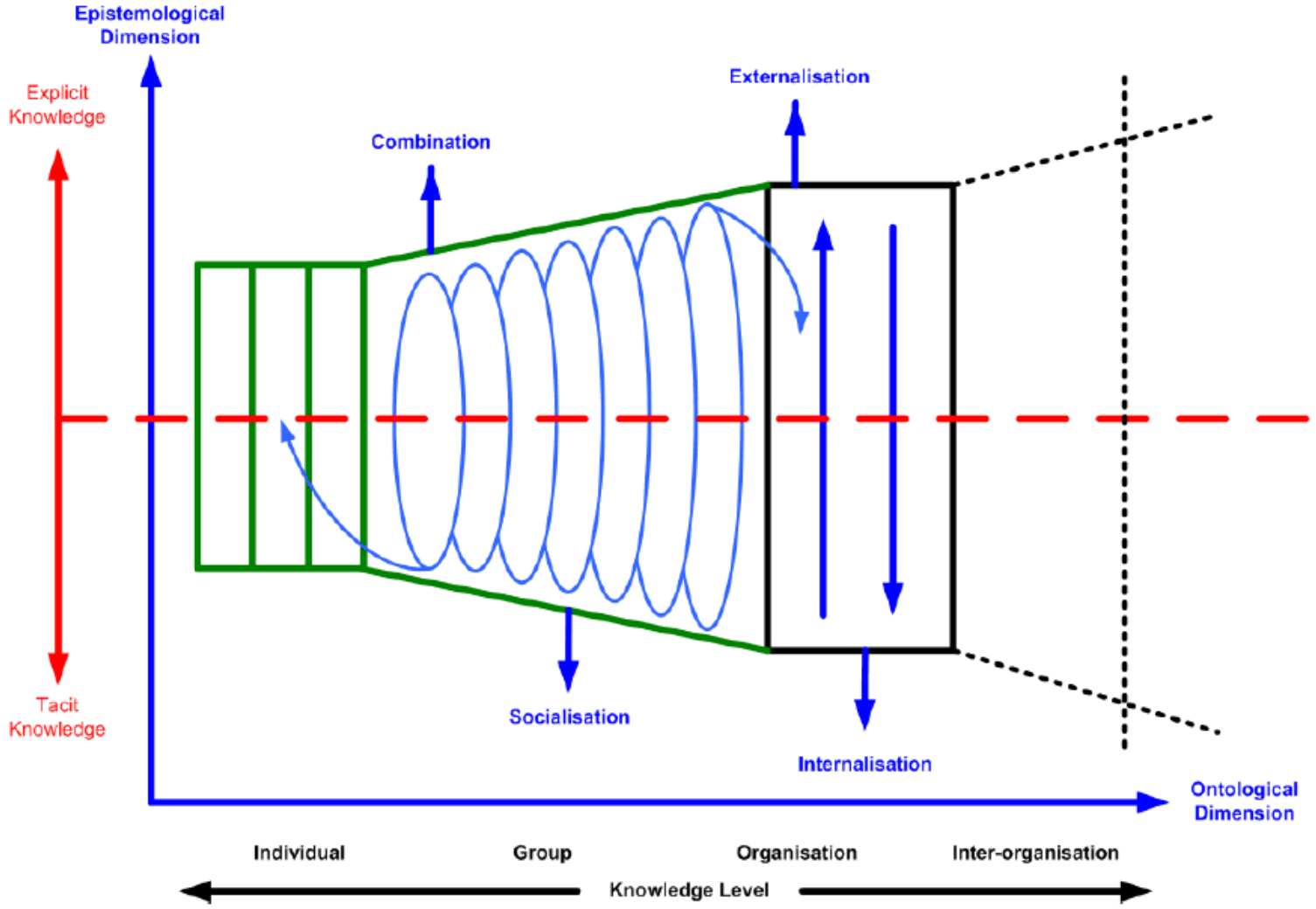
- knowledge bases have meaning only when they are processed by some interpreter - either by a computer program or by our own minds)
- We cannot share and reuse knowledge bases if we do not also share and reuse the inference engines (or mental processes) that bring our knowledge bases to life
- although we may speak of transferring “knowledge” from one site to another, we can at best transfer knowledge bases. We design our knowledge bases so that they can be processed to produce intelligent behavior.

SECI Spiral Model [Nonaka, 1994]



Source: I. Nonaka and H. Takeuchi (1995)

SECI Spiral Model



Source: I. Nonaka and H. Takeuchi (1995)

Observations: Newell vs. Nonaka/Takeuchi

- Newell‘s and Nonaka/Takeuchi‘s views are not conflicting
  - common ground: knowledge is more than what can be captured in knowledge representations / explicit knowledge
- Emphasis on different viewpoints
  - Knowledge representation / interpreter vs. transition between tacit and explicit knowledge
- Indicate many different options how to support reuse
  - Starting either from Newell‘s knowledge levels or from the SECI phases

Knowledge Reuse Techniques

– and how to compare them

Knowledge Reuse – Related Subjects in Literature

Some examples:

- Semantic patterns
- Knowledge patterns
- Ontology modules
- Ontology design patterns
- Task patterns
- Information demand patterns
- Knowledge architecture
- Enterprise knowledge reference models
- Ontology architetcure
- Knowledge formalization patterns
- Active Knowledge Architectures
- Active Knowledge Models
- Information Supply patterns
- Analysis Patterns
- Knowledge Transformation Patterns
- Workflow patterns
- … there is more …

Are all of them really supporting knowledge reuse?
What are the differences? How to compare?
What is the right approach for a specific purpose?

Some criteria for comparing knowledge reuse approaches

- Reuse techniques (from literature)
- Reuse situations (inspired by Markus)
- Capacity of knowledge representation (inspired by Newell)
- Addressee of knowledge (inspired by Nonaka/Takeuchi)
- Maturity (inspired by research validation approaches)
- Scope (from own experiences)
- Phase of solution development (from own experiences)

Some Reuse Approaches

Which reuse approach is used?

- Module: self-contained component of a solution with defined interfaces hiding the actual implementation
  - Use the module „as is“ and compose it with other modules to a solution
- Reference Model / Architecture: identifies the main building blocks of a system with their interfaces and dependencies
  - Knowledge reuse „in the large“
- Template: pattern or gauge to be used as a guide in making something accurately for a defined purpose
  - defines the structure but not the content; usually no behavioral aspects included
- Pattern: provides solution principles (and how to implement them) for a recurring problem in a specific context by abstracting from actual application
  - Exposes the core elements of the solution (structure and behavior) and consequences of using it

Reuse Situations (according to L. Markus)

Shared work procedures

- People working together on a team, either homogeneous or cross-functional
- producers of knowledge for their own later reuse

Shared work practitioners

- People doing similar work in different settings
- producers of knowledge for each other‘s reuse

Expertise-seeking novices

- People with an occasional need for expert knowledge that they do not possess and do not need to acquire themselves because they need it rarely

Secondary knowledge miners

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Capacity of the Knowledge Representation

Inspired by Newell's distinction between knowledge representation and interpreter (mental process / inference engine)

What is the capacity of the knowledge representation used?

- Knowledge representation format
- Reusable lexicon / shared vocabulary
- Shared conceptual model (classes of objects, characteristics of classes, relationships)
- Process reuse: process to be performed by interpreter is independent of knowledge representation format but dependent on interpreter
- Problem solving reuse: process to be performed by interpreter is independent of knowledge representation format and interpreter

Addressee of knowledge

Inspired by Nonaka/Takeuchi‘s spiral:

Who is the target group of the knowledge provided?

- Individual
- Group
- Organisation
- Inter-organisation

Scope of the knowledge

What is the main scope of the knowledge?

- Knowledge about a product or service
- Knowledge about an IT solution or artefact within the solution development process
- Knowledge about a process
- Knowledge about organizational structures

Phase of solution development

In which solution development phase is the knowledge supposed to be useful / applied?

- Analysis
- Specification
- Design
- Implementation
- Verification and Validation
- Operation
- Maintenance

Maturity: Which validation steps were completed for the reuse approach under consideration?

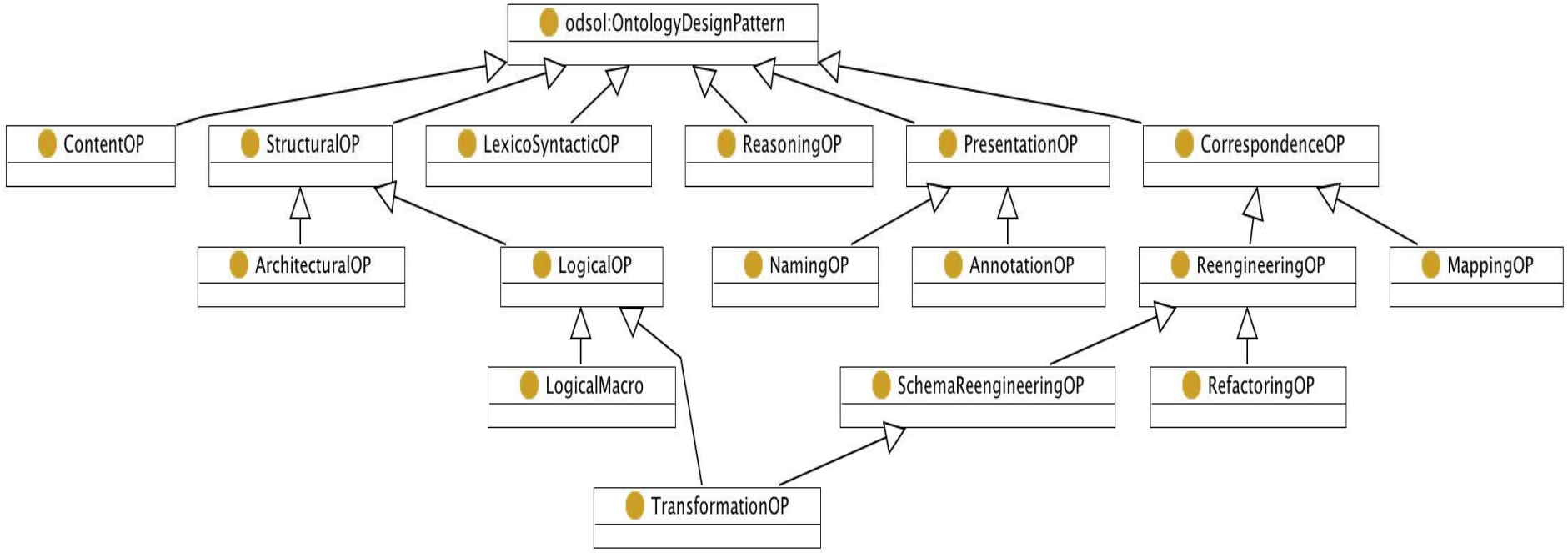
	Theory	Practice
Internal, development team	Validation against state of research, internal consistency checks	Prototype implementation for checking feasibility, test in lab environment
External, in validation context	Peer-review of publications describing approach and concepts, comparison to known best practices of the domain.	Case studies with application partners using the artifacts for evaluation purposes Application of the developed artifacts in cooperation / under instruction from developers
External, in application context	Development of extensions or enhancements of the concepts and approaches by external actors Application of the artifacts for creation of new theoretical knowledge Comparison with related approaches	Use of the artifacts developed (e.g. algorithms, methods, software components) for solutions

Inspired by Lincoln and Guba, „naturalistic inquiry“

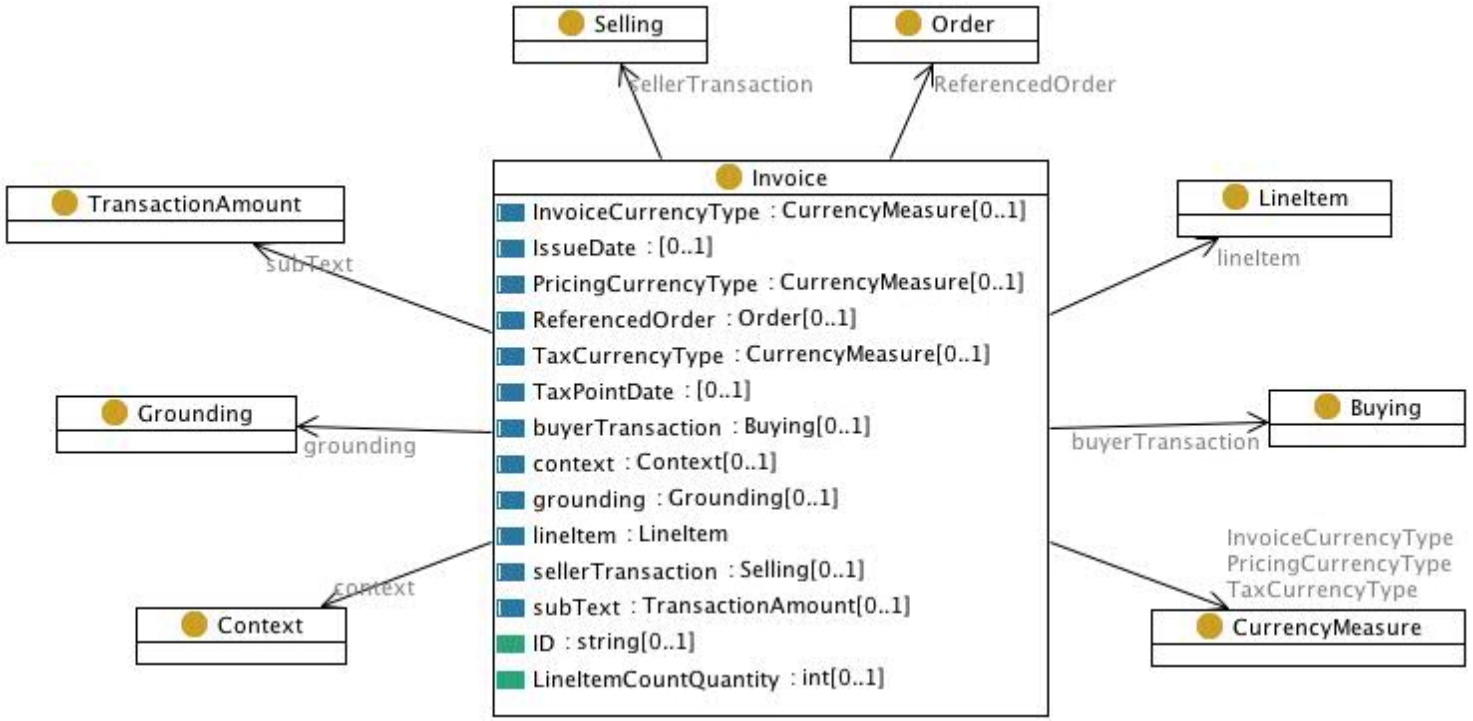
Ontology Design Patterns

Ontology Design Patterns

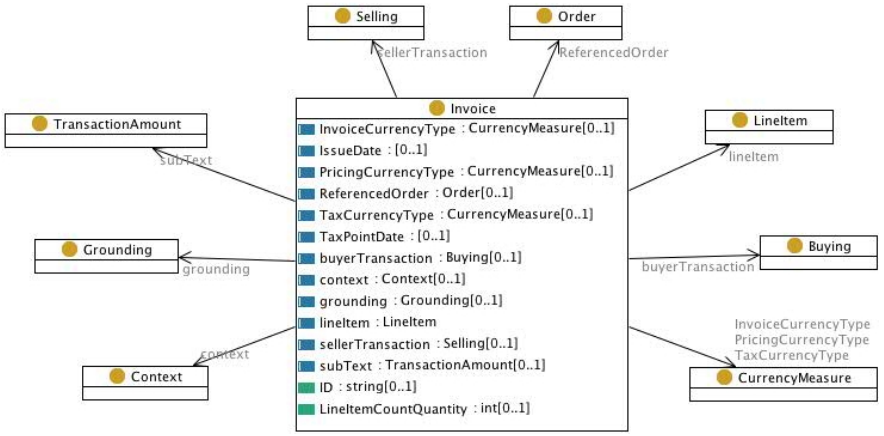
- Definition: *"a* set of ontological elements, structures or construction principles that intend to solve a specific engineering problem and that recur, either exactly replicated or in an adapted form, within some set of ontologies or is envisioned to recur within some future set of ontologies*".*



Ontology Design Pattern – Simple Example



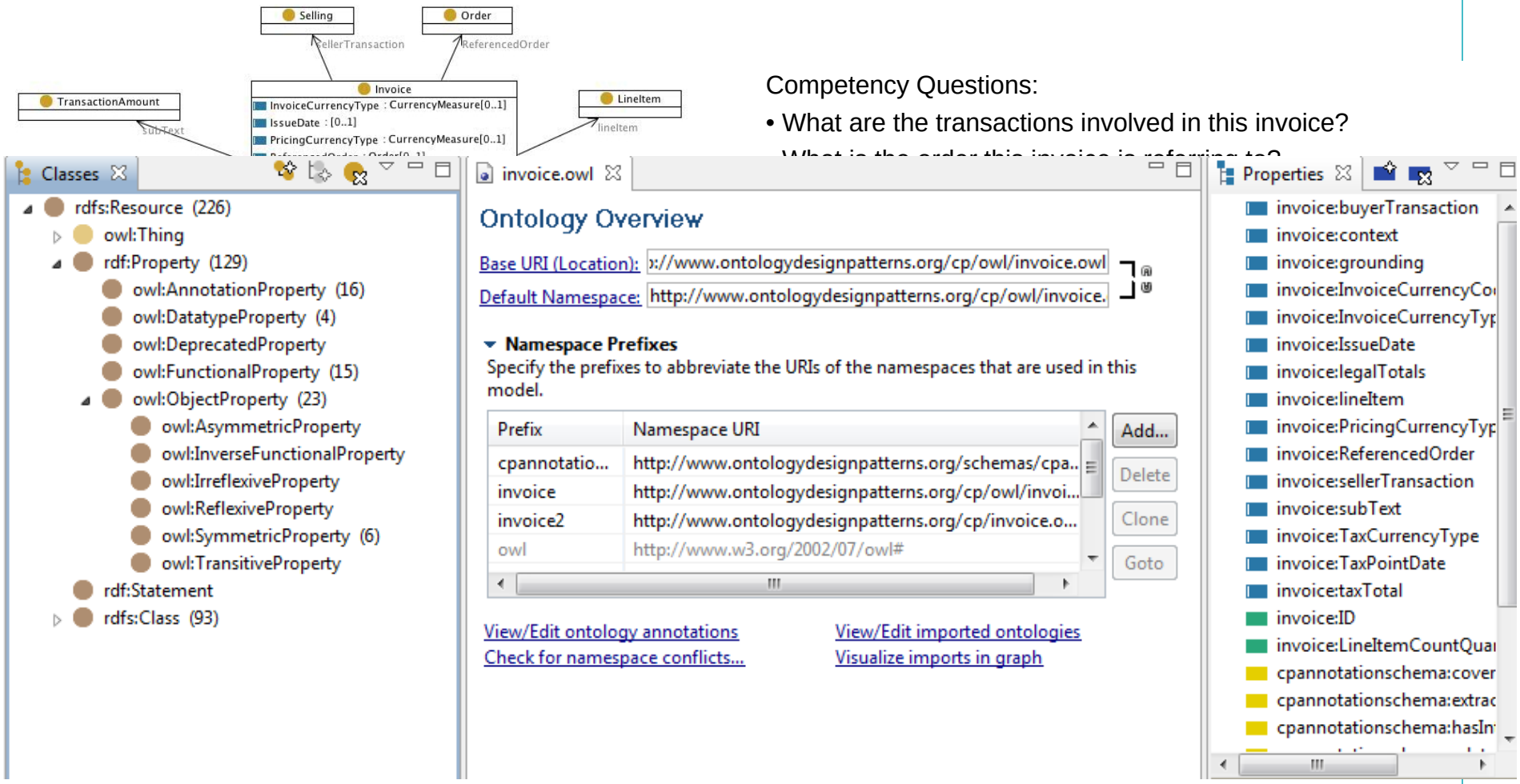
Ontology Design Pattern – Simple Example



Competency Questions:

- What are the transactions involved in this invoice?
- What is the order this invoice is referring to?
- What is the line item for this invoice?
- What is the amount of the transactions involved in this invoice?
- What currency is applied to this invoice?

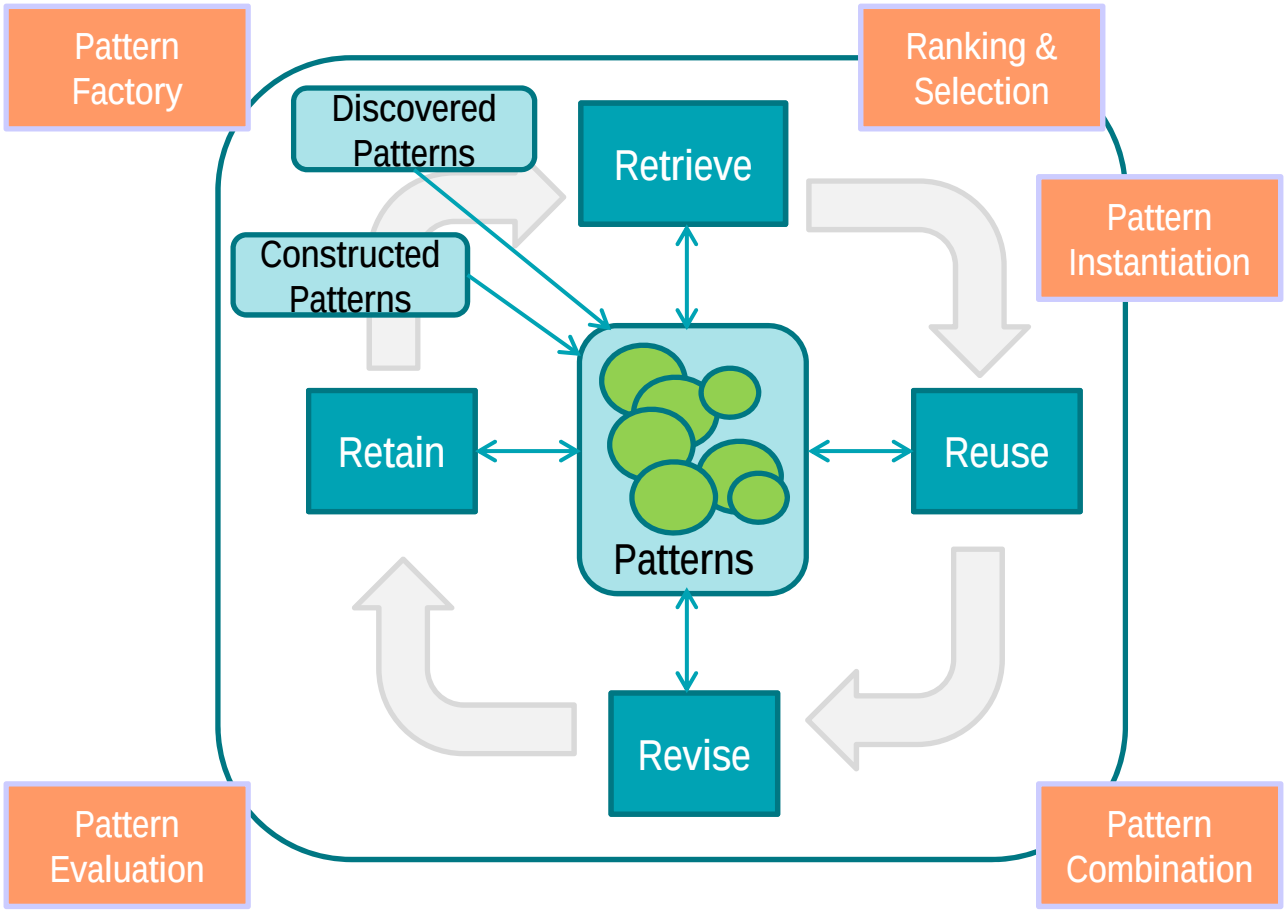
Ontology Design Pattern – Simple Example



Competency Questions:

- What are the transactions involved in this invoice?

Knowledge Reuse Lifecycle: Example of Ontology Patterns



Based on [Blomqvist, 2009]

Applying the criteria for ODP

- Reuse approaches: Pattern
- Reuse situation: "expertise-seeking novices" (aim) or "shared work practitioners" (current status)
- Capacity of knowledge representation: problem solving reuse (at least this is the aim)
- Addressee of knowledge: individual
- Maturity: unclear (external, in validation context ? Or already in application context?)
- Scope: Knowledge about an IT solution or artefact
- Phase of solution development: Design

Reference Models

Reference Model

Reference model is a general model for a class of issues with the following characteristics:

- On the basis of the model, specific models can be developed
- The general model can be used as an object for comparison with other models that are describing the similar issues

RM represent high-quality knowledge and best practices sharable by all stakeholders involved in a certain community and work area

RM components

- Main components of an RM are:
  - Basic model building blocks, structures, components, patameters, rules and services
  - Architecture of the entire RM and its modules with data and examples of practice
  - Description language that is used for a uniform display and for exchanging information between different actors
  - Rules and guidelines for applying the reference model to generate a specific model

RM example: ITIL

- The Information Technology Infrastructure Library (ITIL) is a set of concepts and practices for Information Technology Services Management (ITSM), Information Technology development and IT operations
- IT Service Management is concerned with delivering and supporting IT services that are appropriate to the business requirements of an organization.
  This improves efficiency and effectiveness and reduces the risks of managing IT services.
- ITIL gives detailed descriptions of a number of important IT practices and provides comprehensive checklists, tasks and procedures that any IT organization can tailor to its needs
- ITIL originates from UK, Office of Government Commerce (OGC, earlier CCTA)

ITIL Service Management (v3)

ITIL Service Management (v3)

Service Strategy	Service Design	Service Transition	Service Operation
• Strategy Management for IT Services	• Design Coordination	• Transition Planning and Support	• Event Management
• Business Relationship Management	• Service Catalogue Management	• Change Management	• Incident Management
• Financial Management for IT Services	• Service Level Management	• Service Asset and Configuration Management	• Request Fullfilment
• Service Portfolio Management	• Availability Management	• Release and Deployment Management	• Problem Management
• Demand Management	• Capacity Management	• Service Validation and Testing	• Access Management
	• Information Security Management	• Change Evaluation	
	• IT Service Continuity Management	• Knowledge Management	
	• Supplier Management		

Continual Service Improvement

ITIL V3: Service Strategy/Service Portfolio

ITIL V3 Processes are Decomposed into Nine Aspects

1. Purpose/Goal/Objective
2. Scope
3. Value to Business
4. Policies, Principles and Basic Concepts
5. Process Activities, Methods and Techniques
6. Triggers, Inputs, Outputs, and Interfaces
7. Information Management
8. Key Performance Indicators
9. Challenges, Critical Success Factors, and Risk

Applying the criteria for ITIL

- Reuse approaches: Reference Model
- Reuse situation: Shared work practitioners
- Capacity of knowledge representation: conceptual model
- Addressee of knowledge: organization
- Maturity: external, in application context
- Scope: Knowledge about an artefact , process and organization structures
- Phase of solution development: Analysis, Design

“Hands-on” Part

”Hands-on” Part

Work in groups of 2

Each group will receive one scientific papers about an approach to knowledge reuse

Your tasks:

- Read the article
- Prepare to present a short summary of the articles’ content for the seminar group
- Categorize / classify the approaches in the papers according to the features discussed in the lecture
- Reflect: Does the categorization work? Any features missing/superfluous/wrongly named in the categorizations? Any other categorization to be included?
- Present your findings in max. 5 minutes!

Papers for the ”Hands-on” Part

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- Probst, G., Raub, S., Romhardt, K. (2000) Managing Knowledge – Building Blocks for Success. John Wiley & Sons, Chichester, UK (2000).