# Interoperability in Virtual Organisations

*PhD kursus i "Handlingsrationeller i interorganisatoriske organisationer"*

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# Interoperability in Virtual Organisations.

## PhD kursus i ”Handlingsrationeller i interorganisatoriske organisationer"

Per Christiansson

# Handlingsrationaler i interorganisatoriske relationer Ph.d. specialkursus

Studiegruppens hovedproblemstilling er handlingsrationaler i interorganisatoriske relationer. I et abduktivt samspil mellem teori og empiri undersøges dominerende handlingsrationaler indenfor specielt fire områder, der er afgrænset med udgangspunkt i de respektive ph.d.-projekter, nemlig:

1. Partnering,
2. Virtuelle bygningsmodeller/digitalisering
3. Svigt
4. Best Practices indenfor digitalisering i byggeriet

Aktørforståelse
Udvikle strategier for forandring
Læreprocesser

# Interoperability in Virtual Organizations

| | |
|---|---|
| WHY | efficiency, effectivity, (competence collaboration, synergy, ...) |
| WHO | persons, teams, projects, companies - boarders are getting blurred |
| WHAT | is going to be interchanged, and on what levels (technical, business..)? |
| WHERE | will this happen? In a broad scale and/or in narrow domains? In physical and/or virtual surroundings. |
| HOW | need for ontologies, innovation, user participation, needs, functional systems, organizational change, short-long term, attitudes/values, trust, competences… |
| WHEN | active during/between projects. What is a project? Formal activity setting with a goal to produce/achieve something. |

# CONTENT

- The whole picture
- Real world - systems - models - ICT systems - User Environment
- Companies - projects - communities
- Knowledge managament, collaboration, and communication
- Conceptual models and ontologies
- (Data representations)
- Business and technological service levels
- The Future

NIST U.S. Department of Commerce
Technology Administration
National Institute of Standards and Technology

Advanced Technology Program
Information Technology and Electronics Office
Gaithersburg, Maryland 20899

## Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry

Michael P. Gallaher, Alan C. O'Connor, John L. Dettbarn, Jr., and Linda T. Gilday

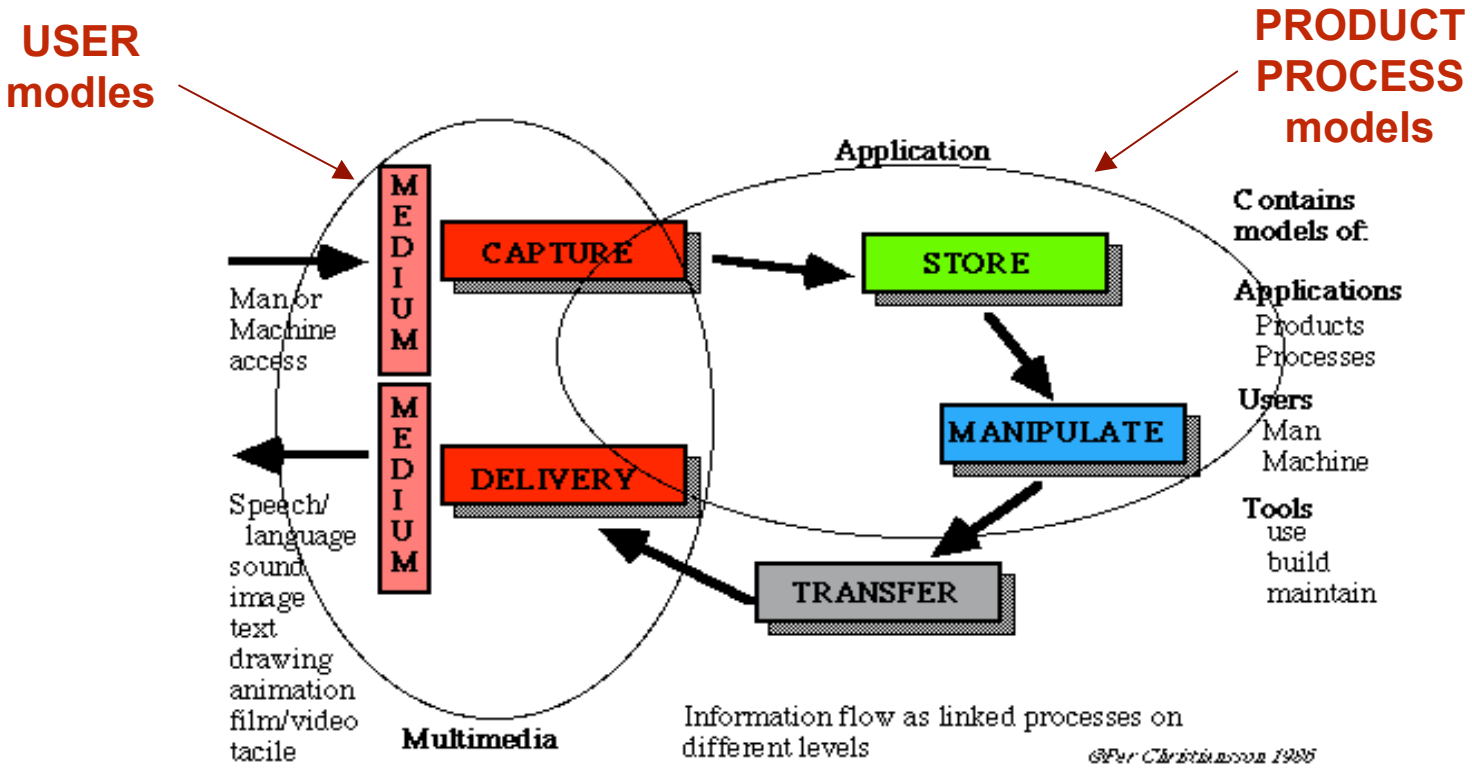

"Inadequate interoperability increases the cost burden of construction industry stakeholders and results in missed opportunities that could create significant benefits for the construction industry and the public at large.

……

This report, prepared for NIST by RTI International and the Logistic Management Institute, estimates the cost of inadequate interoperability in the U.S. capital facilities industry to be $15.8 billion per year. The intended audiences are owners and operators of capital facilities; design, construction, operation and maintenance, and other providers of professional services in the capital facilities industry; and public- and private-sector research organizations engaged in developing interoperability solutions. "

15.8''' --> 1.8 milliarder DKK adjusted for population

# ICT and Models of Reality




ICT (Information and Communication Technology) may be defined as the technologies to support capture, storage, manipulation, communication and delivery of information on different application levels (from macro to micro scale) and in different contexts such as technological, organisational, and cultural.

# Future ICT Tools

*Wireless* networks with fibre based backbone
*Portable/ubiquitous* units (computers, service/communication units)
*Many* (flat panel/glasses/..) *communication units* (offices, building sites, homes)
*Embedded* intelligence (installation components etc.) with Internet connectivity
*Peer-to-peer* societies/interest-groups/'global' villages
Family/personal *servers* (personal storage of information/knowledge within physical reach)
Manifold of parallel personalised/team/project *market* and *service* places
XML tagged communication standards and *Semantic Web*.
*All* information ('good' and 'bad') accessible through dynamic logical containers
*Virtual spaces* for communication and learning
Personal global *positioning* units

# Changing Paradigm

*Changing paradigm* for information handling (information containers dynamically composed, everything stored in a wide range of formats).

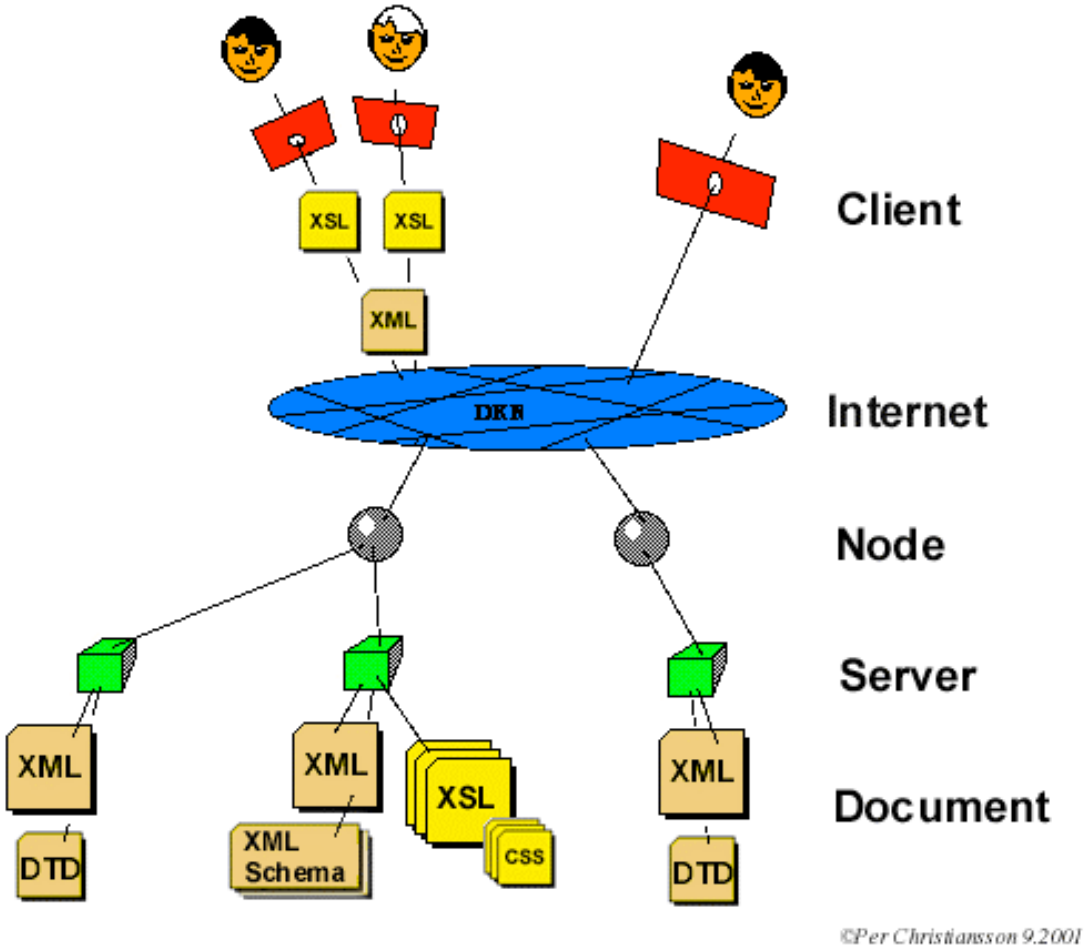
Separation of information *content* and *access* mechanisms.

*Digital models* (virtual buildings, users/team, processes, ICT tools, production systems) of our reality and also non-physical objects are accessed from adapted and advanced *user environments* (UE).

Web and html early 1990s. Now resources on the Internet, labelled by their *Uniform Resource Identifier* (URI), that can be described and reached through a common syntax and structure such as RDF (Resource Description Framework) and RDF Schema that give meaning to the web based information containers.

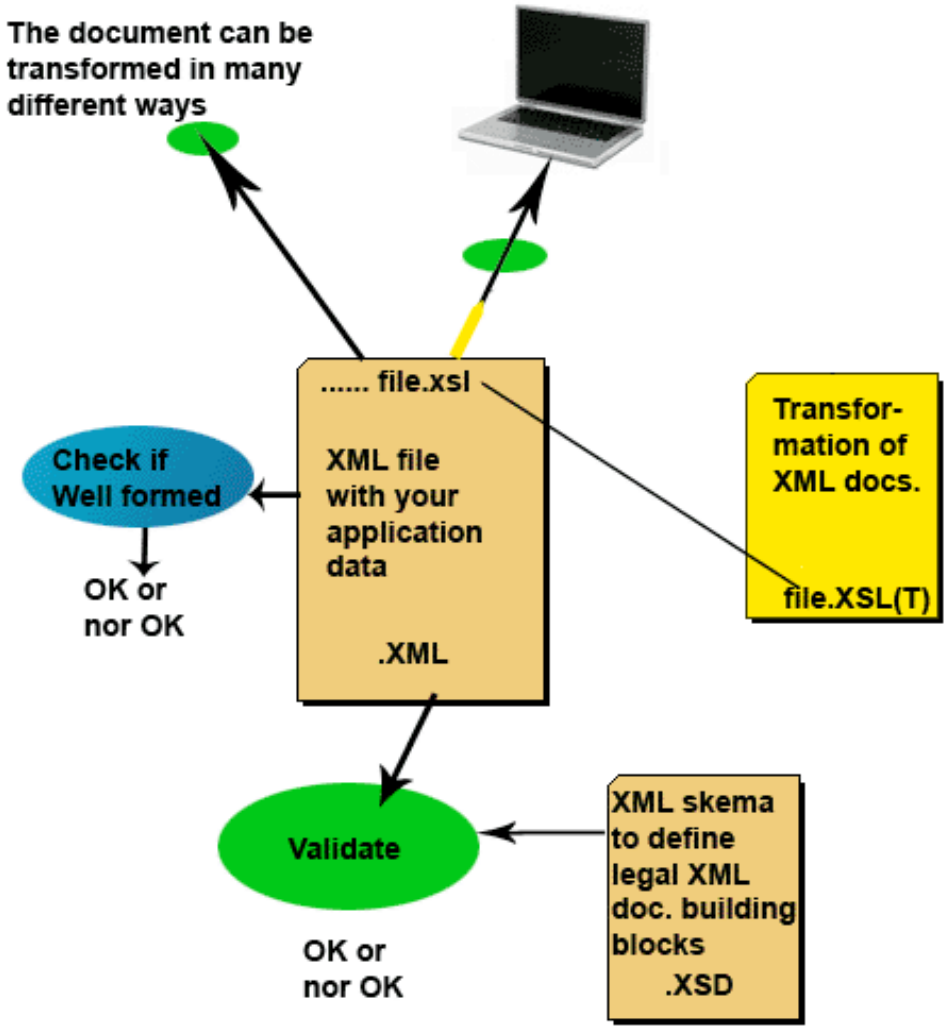
New *services* and new not yet designed *ICT tools*

# Storage and access media separation




Separating content from presentation. Efficient communication and web-services.

# XML, XSD, XSLT




Further clarification of the relation between XML file containing application data and model, skema file, and transformation file.

Through the introduction of the RDF (Resource Description Framework) an emerging standard for handling *metadata* on the World Wide Web was introduced 1997.

RDF will provide a *framework* for metadata *interoperability* across different Internet based resource description communities with focus on semantics rather than meta data syntax and structure.

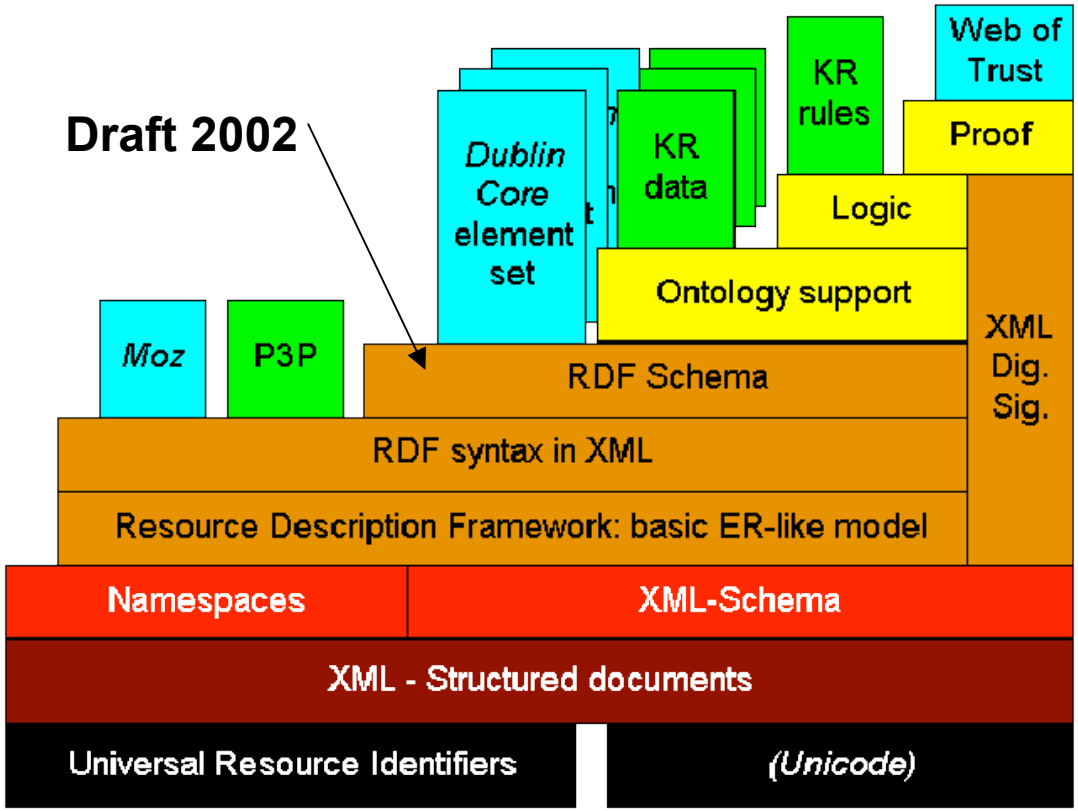
The semantic web will use *XML*, *RDF*, and *Ontologies* (with taxonomy and a set of inference rules) as basic building substances.

RDF is a way to express *relations between objects*, something XML does not allow you to do, "RDF provides a general model for describing resources. Resources in RDF are any objects that can be uniquely identified by a Uniform Resource Identifier (URI).

The RDF data model can be represented as a set of *triples*
{Property Type, Node/Resource, Node or Property Value} or Attribute(Object,Value)

'RDF Vocabulary Description Language 1.0: *RDF Schema'* was presented as a W3C Working Draft 12 November 2002,

# The Semantic Web




Tim Berners Lee, http://www.w3.org/2000/Talks/1206-xml2k-tbl/slide10-0.html

**The next generation World Wide Web**

# Virtual spaces

A Virtual Space (VS) may be defined as a mixed reality environment optionally involving many physical spaces and many virtual spaces.

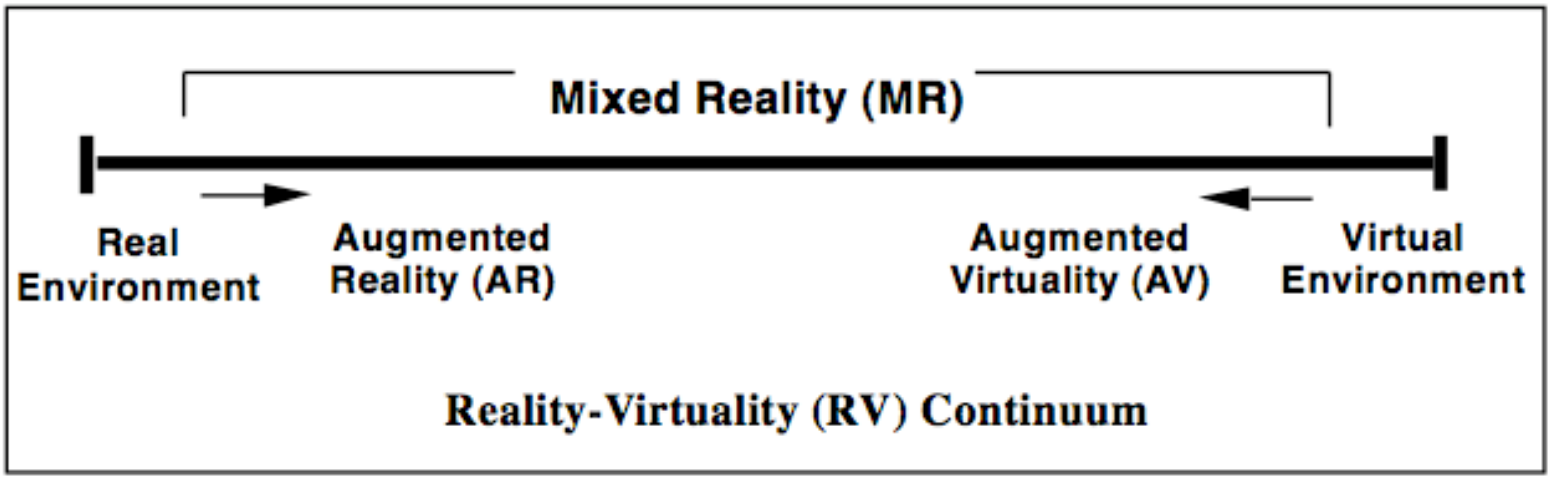
A VS may be set-up within *one* building or *many* buildings placed in the local community or on the other side of the world.

A VS do *not* have to be *stationary* but can e.g. follow a person defined as the immediate surrounding of that person. In this latter case wireless connection to the space is a necessity and maybe a complication in interaction with stationary spaces.

A virtual space may provide service to support *many* kinds of activities.
We may define virtual workspaces supporting collaboration, home health care space with access to distant doctors, different communities of interest or practice, virtual city space for service discovery and access etc.

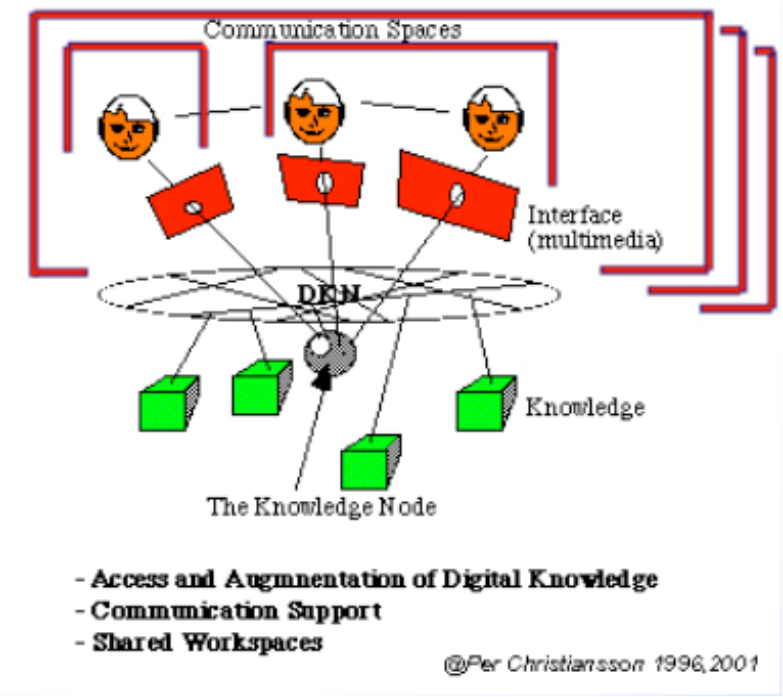
The *impact* on social behaviour, economics, and personal values due to virtual spaces introduction should continuously be monitored and taken into account.

# The Mixed Reality




"Simplified representation of a RV Continuum." (Milgram et.al., 1994)

# Collaboration Context




- ***Participants***; number of, type (persons, agents)
- ***Collaboration subject/context & Form of interaction***; design, reviews, purchase, learning, brainstorm, negotiation, discussion,
- ***Communication content*** to support interaction; e.g. speech, sound, images, music, video, whisper, body language, 3D objects, control information;…..
- ***Meeting spaces*** and room definitions; physical, virtual, static, dynamic, mobile and combinations.
- ***Time*** (synchrounous-asynchrounous meetings)
- ***Collaboration artefacts***;
- communication channels,
- control and access mechanisms
- user applications, and information containers (Cad, DataWarehouse, simulation..

# Collaboration ICT-systemss

## Centralised project collaboration

-*Groupware*

- *Projectwebs*

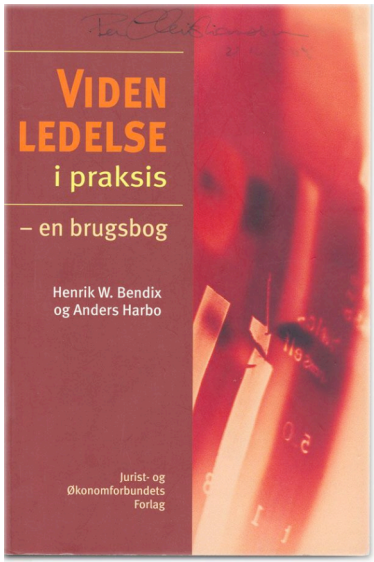
- *EAI Portals* (Enterprise Application Integration)

## Decentralised project collaboration

-*P2P* (network of client/servers)

-*Grids* (network of servers).

# Videnledelse i praksis

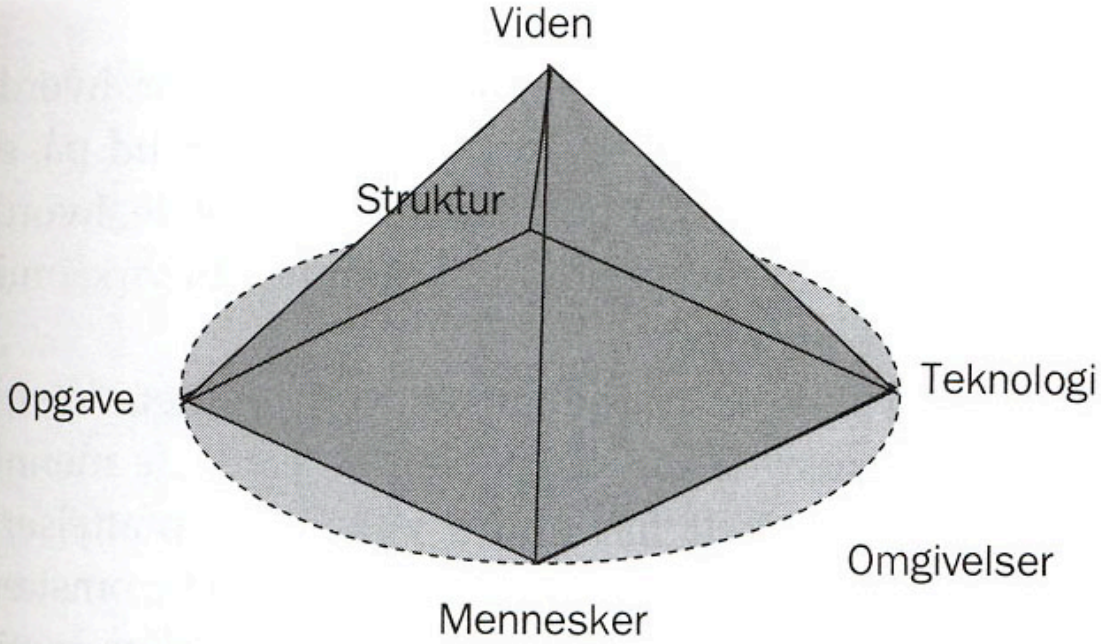



Henrik Bendix, Anders Harbo

1. Viden+ledelse = videnledelse? (s17)
2. Virksomheden som et system af videnprocesser (s27)
3. Når viden bliver levende - de forretningskritiske videnprocesser (s39)
4. (Videnmedarbejdere har også brug for ledelse) (s63)
5. Kommunikation og videndeling - at tale ordentligt om det væsentlige (s89)
6. Komptenceudvikling - et personligt projekt (s115)
7. Innovation - viden bliver hurtigt forældet (s143)
8. Optimering af videnprocesser - den korteste vej mellem to punkter (s169)
9. Hvis nu man arbejder med og ikke imod naturen - incitamenter og barrierer (s193)
10. Målinger - kan man sætte tal på det uhåndgripelige (s215)
11. Internet og intranet for ikke-entusiaster (s237)
12. Lugten i bageriet - kultur i videnorganisationer (s253)

# Videnledelse i praksis

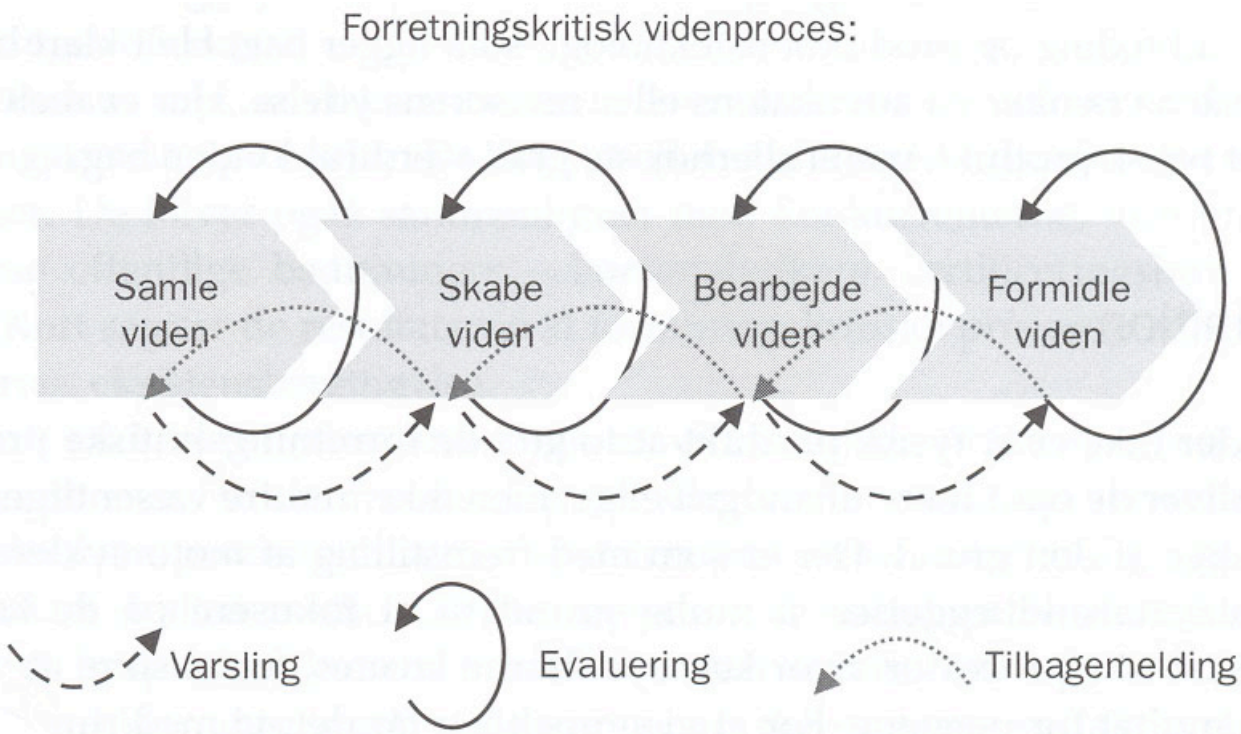
Henrik Bendix
Anders Harbo




Figur 2.2: Pyramiden symboliserer hvordan videnprocesserne er en del af de organisatoriske dynamikker

# Videnledelse i praksis

Henrik Bendix
Anders Harbo




Figur 3.1: Videnprocesserne udgør en vekselvirkning mellem faserne at *samle*, *skabe*, *bearbejde* og *formidle* viden på den ene side og løbende varslinger, evalueringer og tilbagemeldinger på den anden

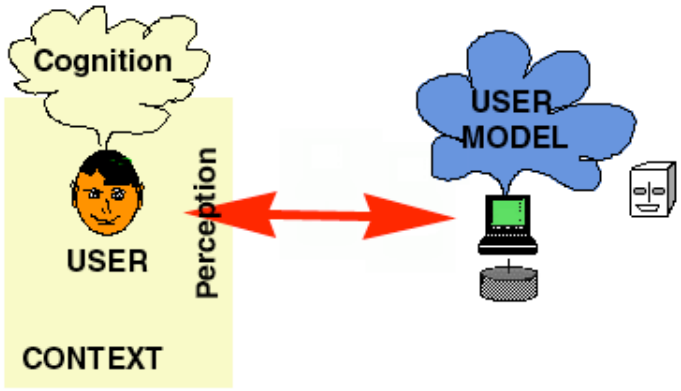
# Videnledelse i praksis

Henrik Bendix
Anders Harbo

| | |
|---|---|
| *Skabelse af ny viden* | Tid brugt på forskning og udvikling belønnes<br>Synliggørelse af nye resultater<br>Tildeling af ressourcer til forskning og udvikling<br>Eksperimenter som positiv værdi |
| *Indsamling* | At være opsøgende (deltagelse i kongresser, faglige netværk m.v.) som positiv værdi<br>Let tilgængelighed (Internetadgang, abonnement på tidsskrifter o.l.)<br>Tildeling af ressourcer<br>Belønning af tidsforbrug |
| *Dokumentation* | Velfungerende Intranet<br>Aktiviteter, hvor dokumenteret viden synligt genbruges (intern undervisning, erfaringsudveksling)<br>Tid brugt på dokumentation belønnes<br>Ressourcer tildeles |
| *Formidling* | Tid brugt på formidling belønnes<br>Måling og belønning af publikationer, optræden på konferencer o.l.<br>Ressourcer tildeles (hjælpemidler, m.v.)<br>Synlig anerkendelse af indsatsen<br>Træning, erfaringsudveksling på området formidling |
| *Tilegnelse af viden* | Tid brugt på kompetenceudvikling belønnes<br>Kvalifikationsløn<br>Ressourcer tildeles (kursusmidler m.v.)<br>Ledelse signalerer med egen adfærd at tilegnelse af ny viden er en positiv værdi |

**Check:** Hvordan opfattes det enkelte tiltag af størstedelen af medarbejderne, som udsættes for det? Som incitament eller barriere?

# User Models




The computer contains a more or less explicitly described user model.

Merriam Webster:

* Cognition = the act or process of knowing including both awareness and judgement;
  from co- + gnoscere to come to know
* Perception = act of perceiving; awareness of the elements of environment through physical sensation
  (Percieving = to become aware of through the senses)

# Videnledelse i praksis

Henrik Bendix
Anders Harbo

| | |
|---|---|
| **Faglige kompetencer** | »Min unikke viden ... « |
| **Personlige kompetencer** | »Min måde at fungere på ... « |
| **Sociale kompetencer** | »Vores sociale samspil ... « |
| **Systemkompetencer** | »Måden vi gør tingene på her ... « |
| **Helhedskompetencer** | »Vores overordnede opgave ... « |

Tabel 6.1: Videnmedarbejderen skal udvikle sine kompetencer på alle 5 områder

| | **Værdiskabelse**<br>**Krav »udefra«** | **Ambitioner**<br>**Ønsker »indefra«** |
|---|---|---|
| **På kort sigt** | Løs opgaven<br>Lær det fornødne<br>**Træning** | Vælg spændende opgaver<br>Undersøg mulighederne<br>**Opdagelse** |
| **På langt sigt** | Stå til rådighed<br>Test egen formåen<br>**Afprøvning** | Skab et fagligt project<br>Udvikl det til et »professorat«<br>**Studium** |

Figur 6.2: Fire tilgange til kompetenceudviklingen

# Communities of Practice

Henrik Bendix
Anders Harbo

**Praksisfællesskaber**
Det typiske praksisfællesskab er kendetegnet ved:

- En *fælles, bred interesse* for et eller andet, som f.eks. bestemte behandlingsformer, programmeringssprog og teknologier
- Et *fællesskab*, hvor individerne mødes og knytter sig til hinanden på kryds og tværs, som f.eks. til internationale gigant-kongresser, hvor man nemt kan blive væk, i mindre grupper på fælles projekter osv.
- En *fælles praksis*, en klar oplevelse af at bidrage til gavn for et eller andet konkret mål og til gavn for medlemmerne. Gratis hjælp, når man skal løse konkrete opgaver er ikke dårligt.

Praksisfællesskaber kan udvikles inden for virksomheden alene eller kan udbredes til at omfatte virksomheden og dens kunder/brugere, leverandører osv. Eller praksisfællesskabet kan eksistere på tværs af virksomhederne eller helt uden for dem.

Praksisfællesskaber bidrager til virksomhedens evne til videndeling, både med omverdenen og internt. For at få gavn af dette, er det nødvendigt at forstå de særegne træk ved praksisfællesskabet i modsætning til andre organisationsformer. Skemaet her sammenligner praksisfællesskabet som organisationsform med den etablerede organisation, afdelingen og med den midlertidige, projektgruppen.

| Organisation | Afdeling | Praksisfællesskab | Projektgruppe |
|---|---|---|---|
| *Mål* | Bredt, stabilt | Vagt, mere interesse end mål | Kortsigtet, konkret |
| *Varighed* | Så længe organisationen består | Så længe der er aktivitet, dvs. interesse | Afsluttes når opgaven er løst |
| *Kommunikation* | Fastlagt gennem procedurer og sædvaner | Åben, mangfoldig, sædvanebetonet | Etableret til lejligheden. Fokus på opgaveløsningen |
| *Ledelse* | Etableret, en del af organisationen og dermed med fast ledelsesstruktur | Ingen ledelse, men »ildsjæle« Uden for ledelsens rækkevidde | Udpeget projektleder mens projektet foregår Styring via styregruppe eller projektejer |
| *Produkt* | Stabile leverancer af fastlagte ydelser | Konkrete løsninger, fællesskab, videndeling | Konkret løsning af specifik opgave |
| *Kompetencer* | Baseres på job- og uddannelsesstrukturer Udvikles over lang tid og i formaliserede rammer | Interessebaseret på tværs af formelle fag. Gensidig udvikling baseres på individuelt engagement | Sammensætning af projektgruppe afspejler behov for kompetencer. Kompetencer udvikles uden for projektet |
| *Tid og sted* | Inden for fastlagte rammer – både hvad angår tid og sted | Virtuelt i både tid og sted Frivilligt | Uden for organisationens normale rum, men med klare aftaler om tid og sted |

Praksisfællesskaber kan specielt bidrage til virksomheden på tre forskellige måder:

- Skabe løsninger på tværs af normale organisatoriske grænser
- Forvalte og udvikle viden som er kritisk for virksomheden
- Understøtte fælles faglighed og identitet.

# Communities of Practice

Henrik Bendix
Anders Harbo

*Praksis*

Fællesskabet skal skabe værdi, for både virksomheden og deltagerne selv. Alle erfaringer viser, at fællesskabet skal have konkrete opgaver at løse, for at det kan virke over længere tid. Deltagerne skal som noget af det første beskæftige sig med at definere den værdi, de ønsker at skabe – den praksis som de ønsker at koncentrere sig om:

- Skal den dreje sig om at løse konkrete problemer for hinanden?
- Skal den primært bestå i at forvalte og udvikle den fælles viden?
- Skal den være »missionerende« og udbrede et særligt videnbudskab til virksomhedens øvrige ansatte?
- Skal den bygge bro mellem virksomheden og centrale videnmiljøer uden for virksomheden?
- Skal den være et læringsfællesskab?

# Communities of Practice

## What are communities of practice?

Communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavor: a tribe learning to survive, a band of artists seeking new forms of expression, a group of engineers working on similar problems, a clique of pupils defining their identity in the school, a network of surgeons exploring novel techniques, a gathering of first-time managers helping each other cope. In a nutshell:

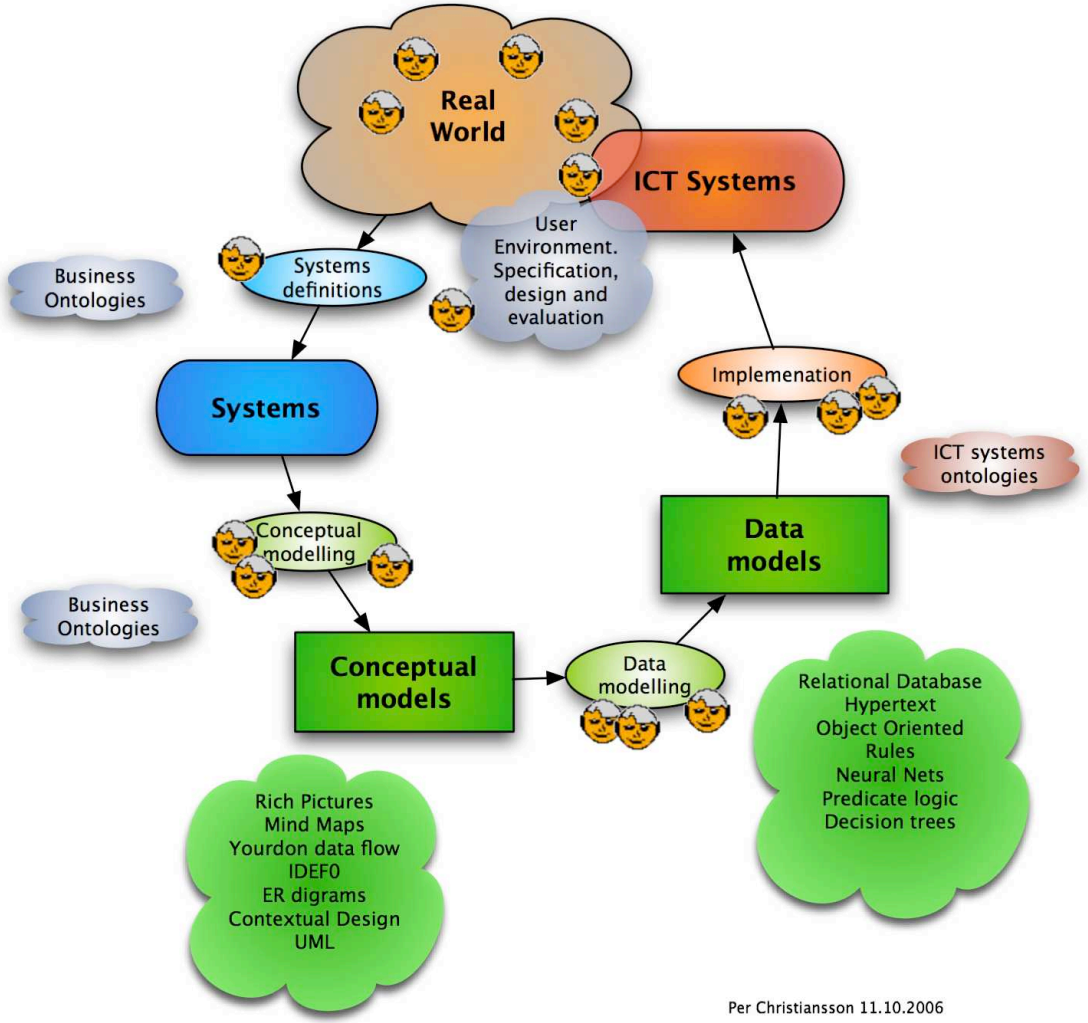
> Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.

Communities of practice are not called that in all organizations. They are known under various names, such as learning networks, thematic groups, or tech clubs.

*Etienne Wenger*

http://www.ewenger.com/

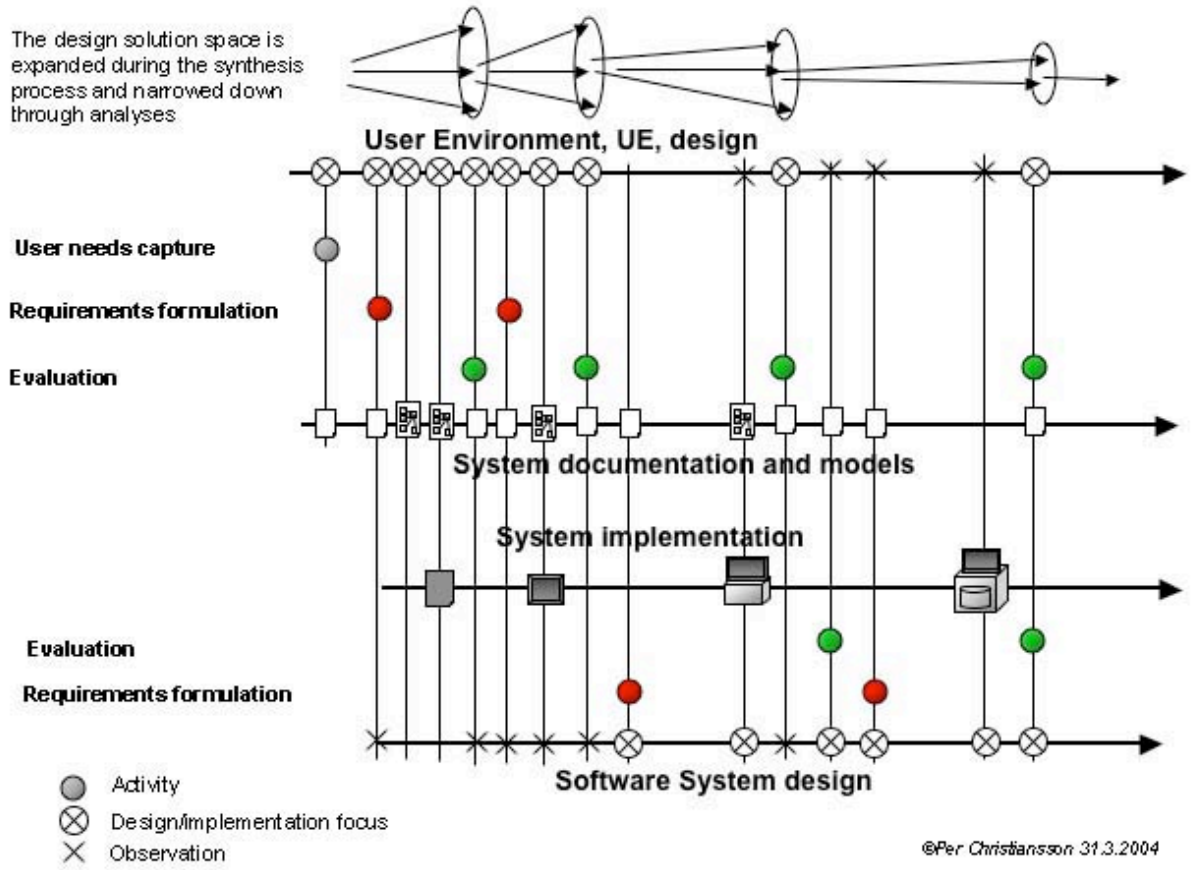
# Real world and systems




In the *real world* we identify activities, things, processes, context, and persons.

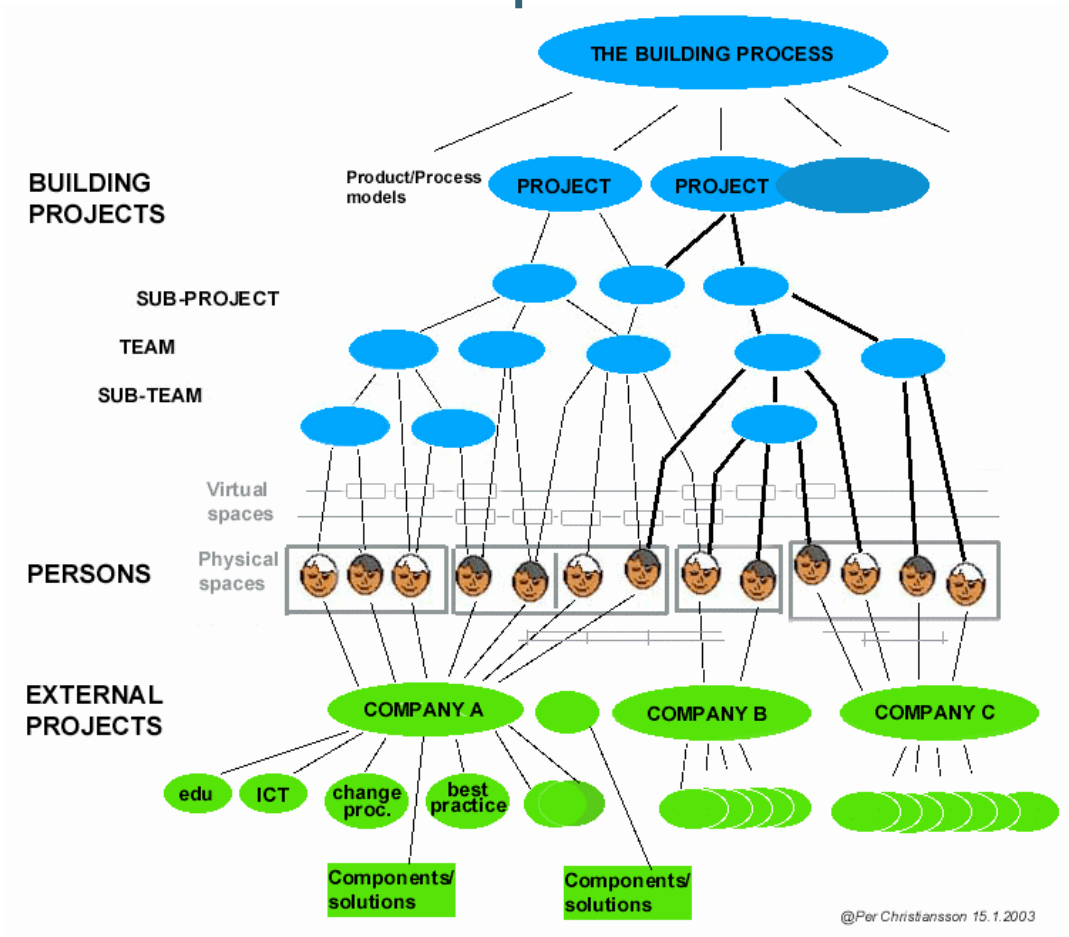
The real world can be described as (interrelated) *systems* (no de-facto structure is available today) to accomplish different *functions* e.g. a comfort system to provide personal living and working quality, personal transport system, load carrying building system, escape system, and communication systems (collaboration, knowledge transfer, mediation, virtual meeting).

# User involvement in system design




The design process focuses on user environment, UE, design/implementation and software development/implementation. The UE design including user needs capture and user requirements formulations can be supported by contextual design methodology. Different evaluation paradigms can be used as design/implementation progresses

# Oganisational impact 1/2




Organisational view on internal and external building project actors, activities and attached information containers.

Christiansson, P, 2003, "Next Generation Knowledge Management Systems for the Construction Industry". Auckland, New Zealand, April 23-25, 2003. CIB W78 Proceedings 'Construction IT Bridging the Distance. CIB Publication 284. ISBN 0-908689-71-3. (494 pages). (pp. 80-87).

# Oganisational impact 2/2

- Mix of *physical and virtual workspaces* (80/20 to 20/80, physical meetings will *remain* very important especially during non-routine activities).
- New procedures (new companies?) to provide *knowledge management support* (e.g. long-term project information storage end experience transfer, company/building project education services).
- Greater possibilities to back-up digital knowledge resources in the companies due to *efficient capture and re-use of experiences* and ideas.
- Efficient handling of *unstructured and partly redundant information*. (The building process will for a foreseeable future contain semi-structured data together with information containers with highly formalised non-redundant data models).
- *Meta data* in models containing non-redundant data on high abstraction levels will glue together domain specific more specialised application models.
- Disconnection of *building application semantics* from underlying information containers will facilitate system interoperability and build-up of user specific search in and interrogation of underlying information containers.
- Higher flexibility in *creating project teams* composed of persons from different companies ( the old 'building master').
- Flexible *collaboration* patterns between and within teams.

(Christiansson, P, 2003)

# Virtual Organisations

According to the ICH Glossary:
Interoperability is “the ability of information systems to operate in conjunction with each other encompassing hardware, communication protocols, applications, and data compatibility layers” (ICH, 2004). (Inteligrid D11.2)

- syntactical, (XML…)
- structural (RDF, SOAP, WSDL, …)
-semantic interoperability ( RDFS, OWL,…)

- Experiences transfer between VOs (different ontologies developed)
etc.

# Virtual Organistions



| The (traditional) "Real" VO | Grid for VO |
|---|---|
| Organisations are the nodes | Organisational ICT systems are the nodes |
| Competence sharing | Capacity sharing (computing, storage, resources) |
| Distributed team work and collaboration | Distributed parallel computing and processing |
| Information & contract flows not necessarily aligned | Information flows based on "resource" availability contract |
| Common (shared) repositories and services (VO environment) | Distributed objects and applications (Grid "spider web") |
| Interfaces to standards and proprietary applications | Grid middleware is the interface to everything! |
| Functional solution to a business need | Technical packaging of technical solutions |

*Figure 6: Different Perspectives of a VO: Traditional vs. Grid Views*

Experiences transfer beween VOs (but different ontologies developed)

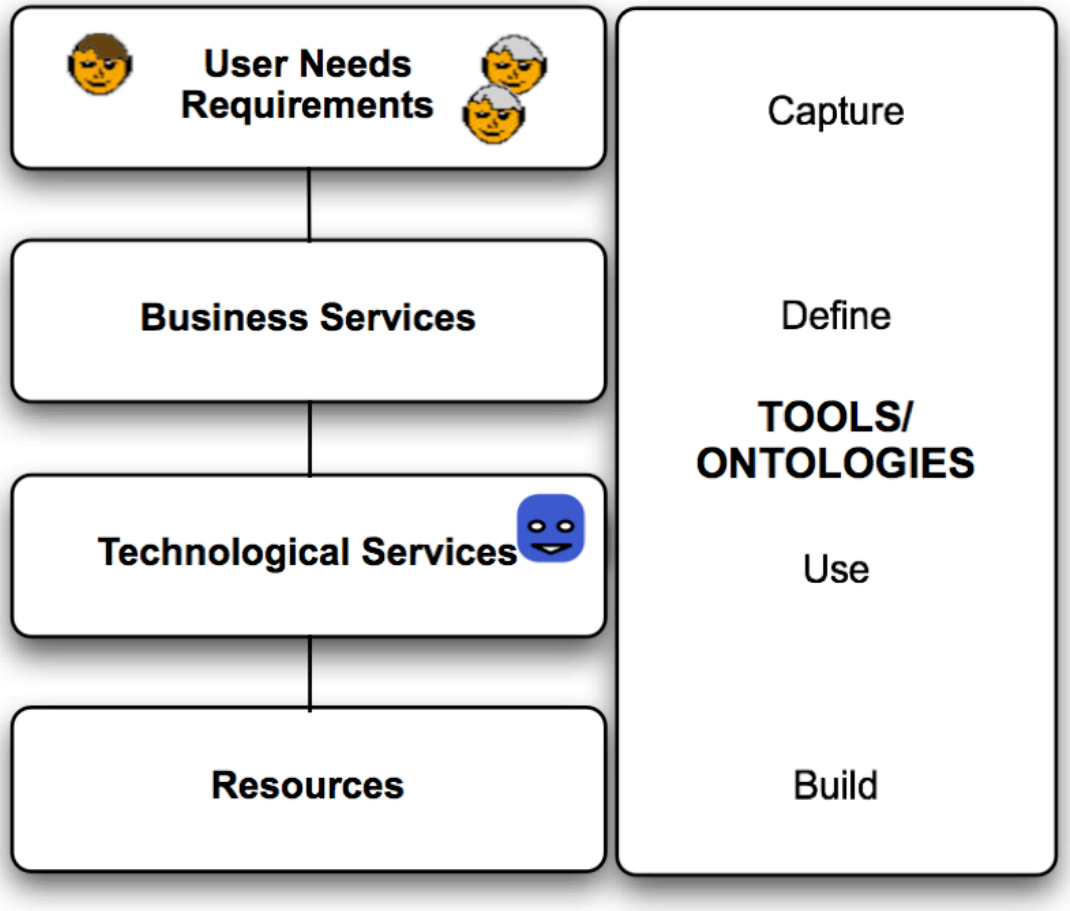
# Ontologies

ONTOLOGY
- the branch of metaphysics dealing with the nature of being
- An explicit formal specification of how to represent the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them.

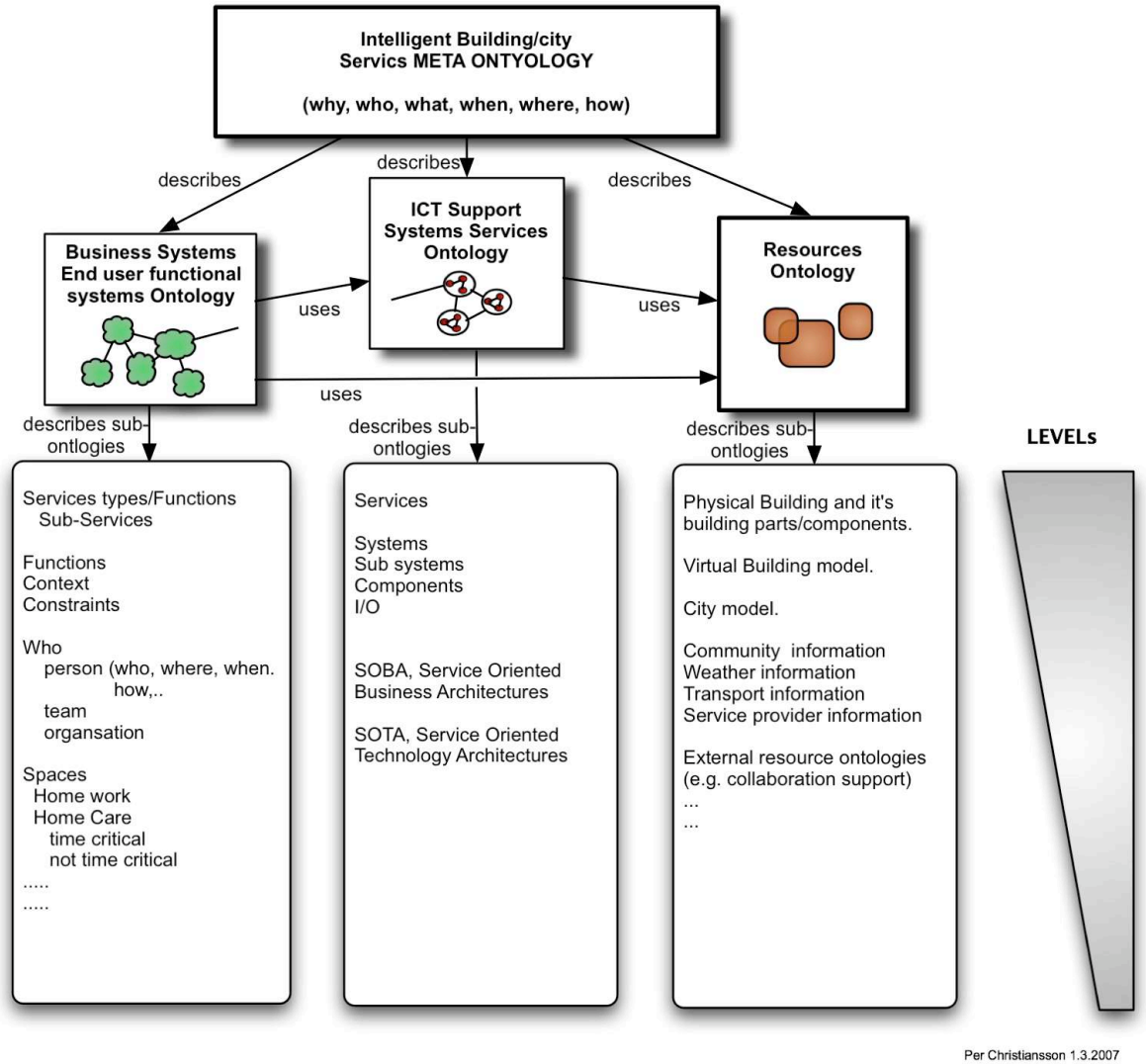
DICTIONARY
- a book that lists the words of a language in alphabetic order and gives their meaning, or that gives equivalent words in different language.

CLASSIFICATION
- The action or process of classifying something according to shared qualities or characteristics

# Needs - Services - Resources



# Services Ontologies




An ontology is an explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them.

A service request may generate alternative support system actions depending on context and/or other parallel services requests. Worse case is that a critical service will invoke temporary close down of other services.

From Christiansson P. (2007) "ICT Enhanced Buildings Potentials", Proceedings 24th CIB W78 Conference "Bringing ICT knowledge to work". June 26 - 29 2007, Maribor, Slovenia. ISBN 978-961-248-033-2. (pp. 373-378). http://it.civil.aau.dk/it/reports/2007_06_w78_maribor_pc2.pdf

# Inteligrid

”InteliGrid's basic assumption is that software not only has to model the real world, but it also has to model the technical resources that this software is using, especially because these resources are becoming increasingly complex in a networked or grid environment. The InteliGrid framework architecture therefore includes four layers:

(a) Real world (or problem domain) layer,
(b) Conceptual layer which includes various conceptual models and ontologies,
(c) Software layer which includes applications and services,
(d) Basic resource layer which includes various basic hardware and software resources,

whereby both (c) and (d) are to some extent also modelled in (b).”

(D31, 2006)

# Inteligrid

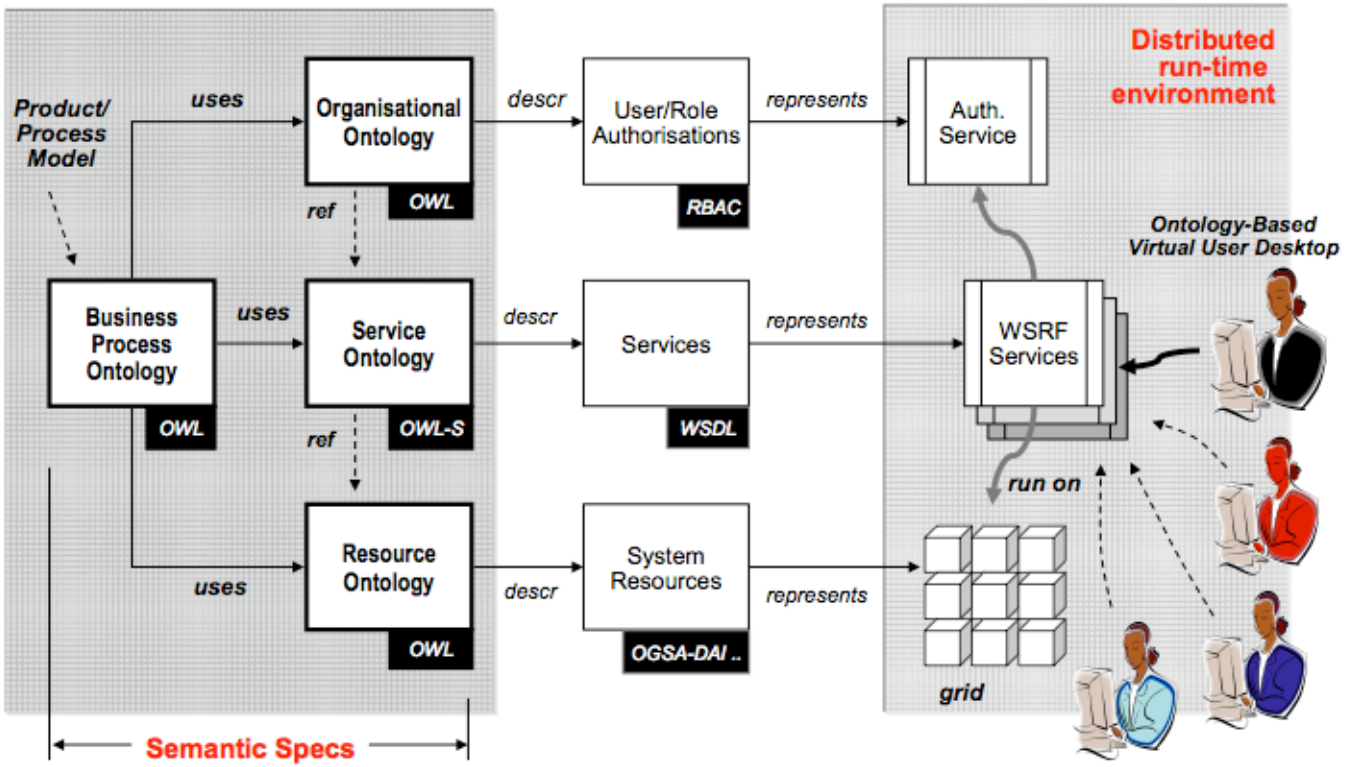



*Figure 7: Schematic presentation of the InteliGrid ontology approach.*

The objectives of the /Inteligrid ontology/ framework are:
- to enable consistent mapping of the conceptual layers to the technical implementation environment,
- to support scalable processing levels of varying complexity enabling flexible adjustment to the context of each specific project and use cases,
- to support modularity and extensibility, but also use of available standardised specifications,
- last but not least, to efficiently support business processes by means of conceptualised instantiable business process object templates.

(D31, 2006)

# Inteligrid

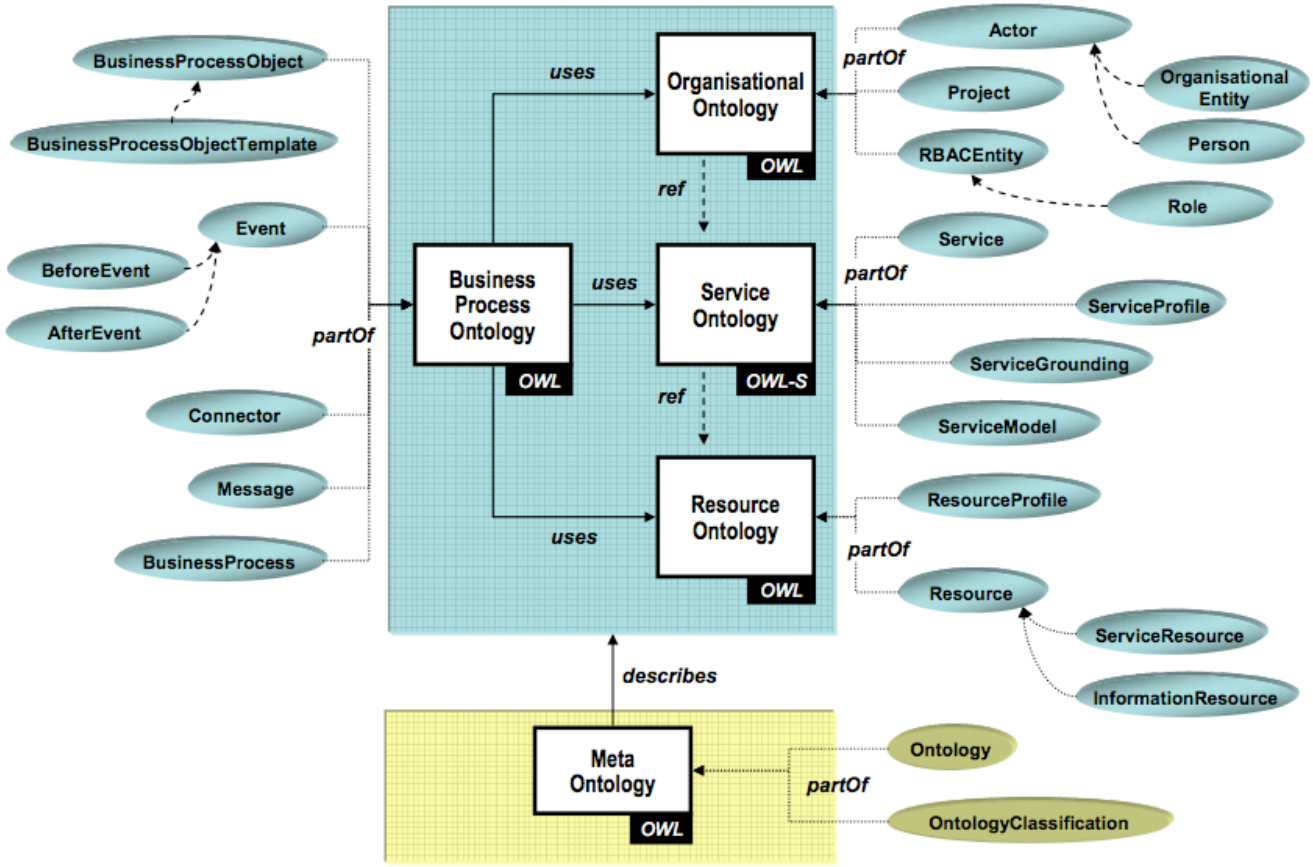
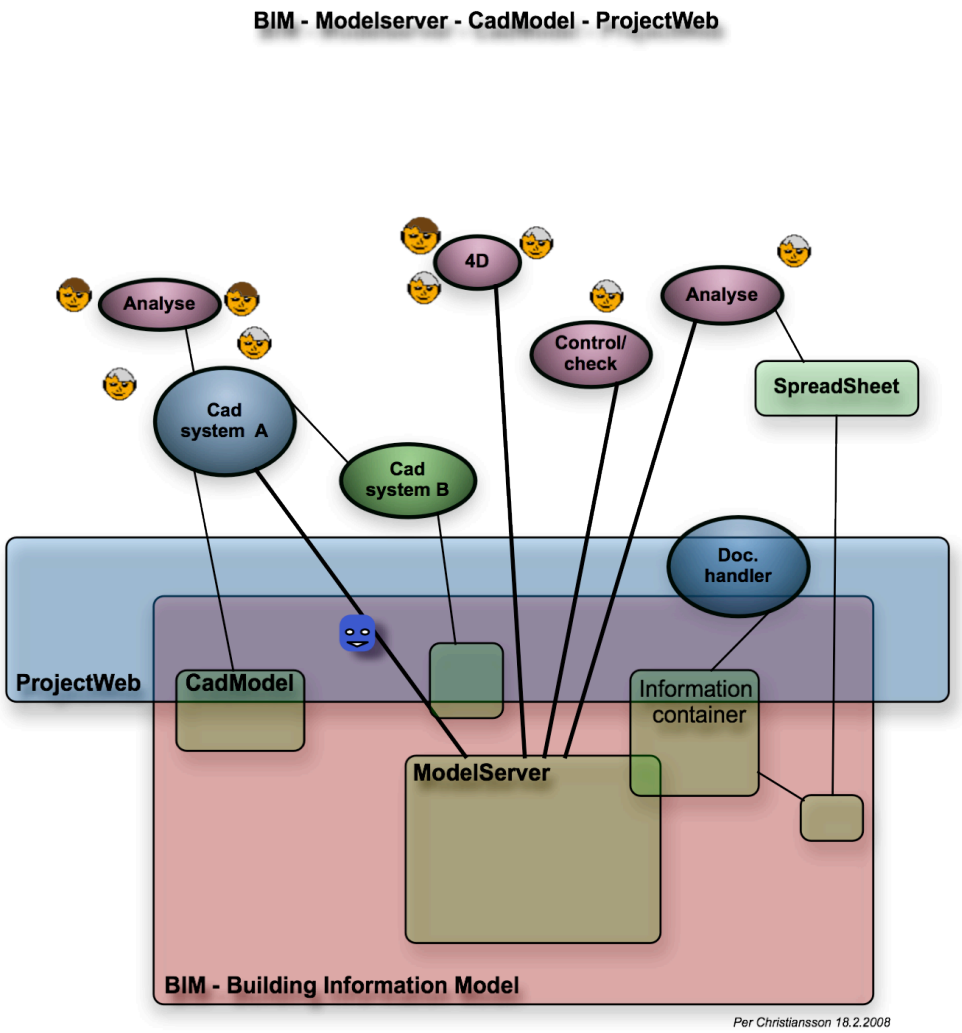



*Figure 8: Overview of the ontology framework.*

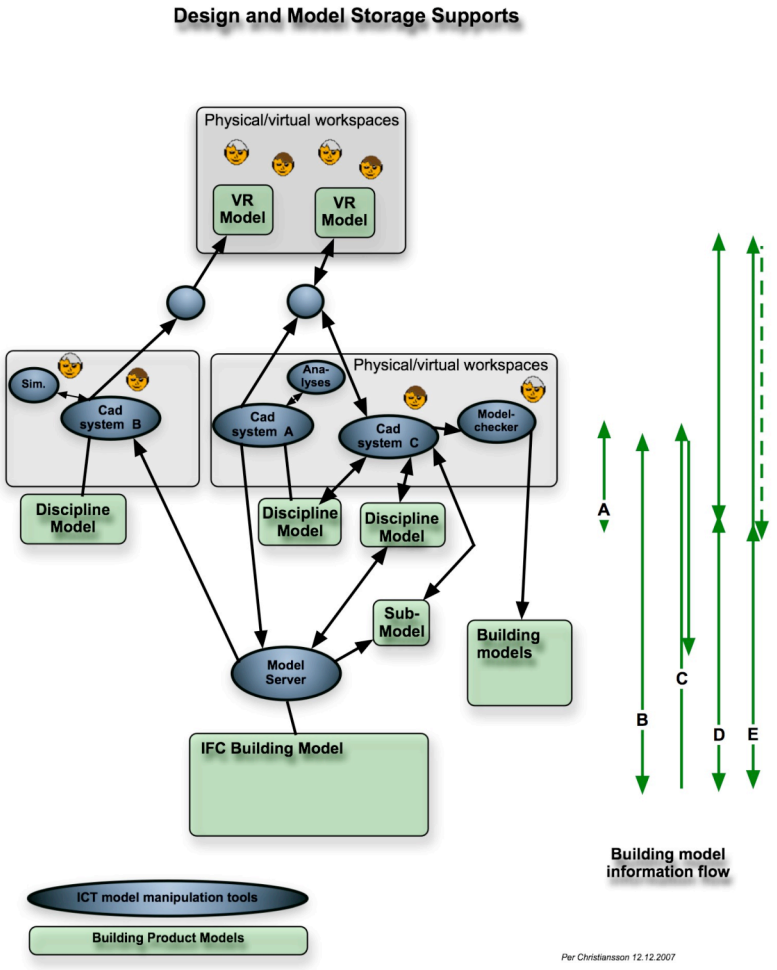
Further development of an AEC Business Process Ontology whilst not directly in the project's scope is sought in collaboration with BuildingSMART and the IDM project, to contribute to VO related standardisation in AEC/FM. (D31, 2006) p.46

# Design Support Tools and Containers



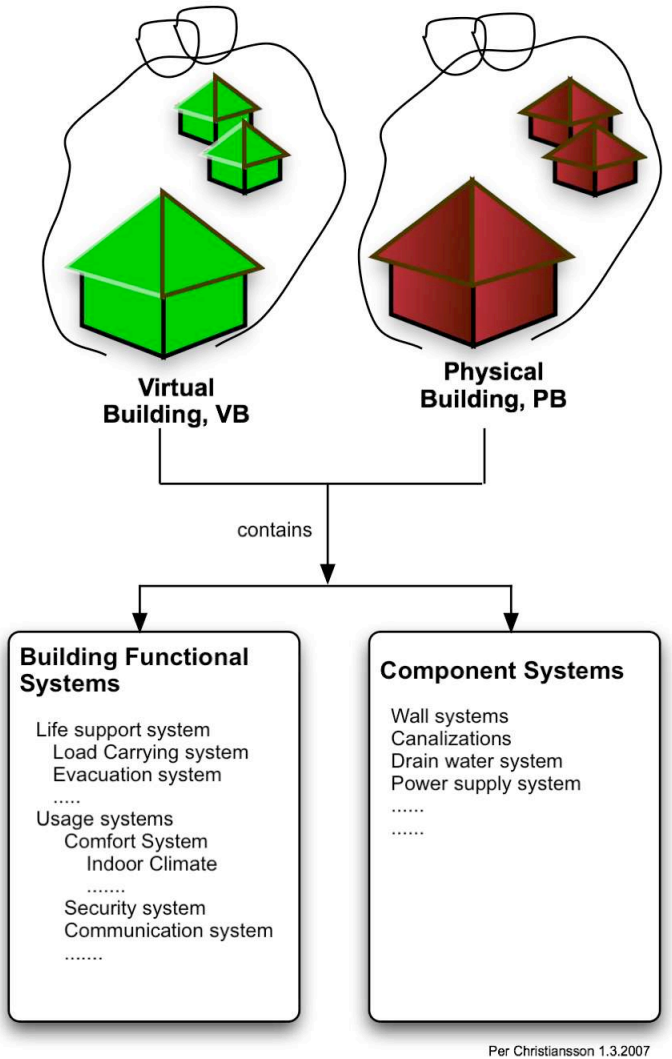

Information/model containers are accessed from analyses/simulation/control programs. Organization, collaboration, work methods, responsibilities are also influenced by and influencing ICT tools properties. (From workshop 17.9.2007 at the Nanotech building, Aalborg University)

# Design Support Interoperability




A) Today's storage in Cad systems
B) the ideal case where discipline models can be merged into the common IFC Building Model either direct (simultaneous work on he building model) or via model file transfer
C) Possible situation today where building sub-models are extracted from he model server, checked and stored locally by e.g. Solibri modelchecker,
D) A rare situation where even changes on simplified VR-models (often surface models) can be transferred back to discipline models in Cad systems and further to the IFC Model server for merging,
E) same as but updates has to be manually transferred from VR-model to discipline models

# The Building/City functional system view




The virtual building can be used as interactive documentation of the ready building to support different services such as O&M activities, location of resources and persons in the building, and for simulation and design of new services and user environments.

The building is more or less functionally integrated with other buildings, city areas, and optional global 'neighbourhoods'.

# Intelligent Building definition

In 2000 the author made the following *definition:*

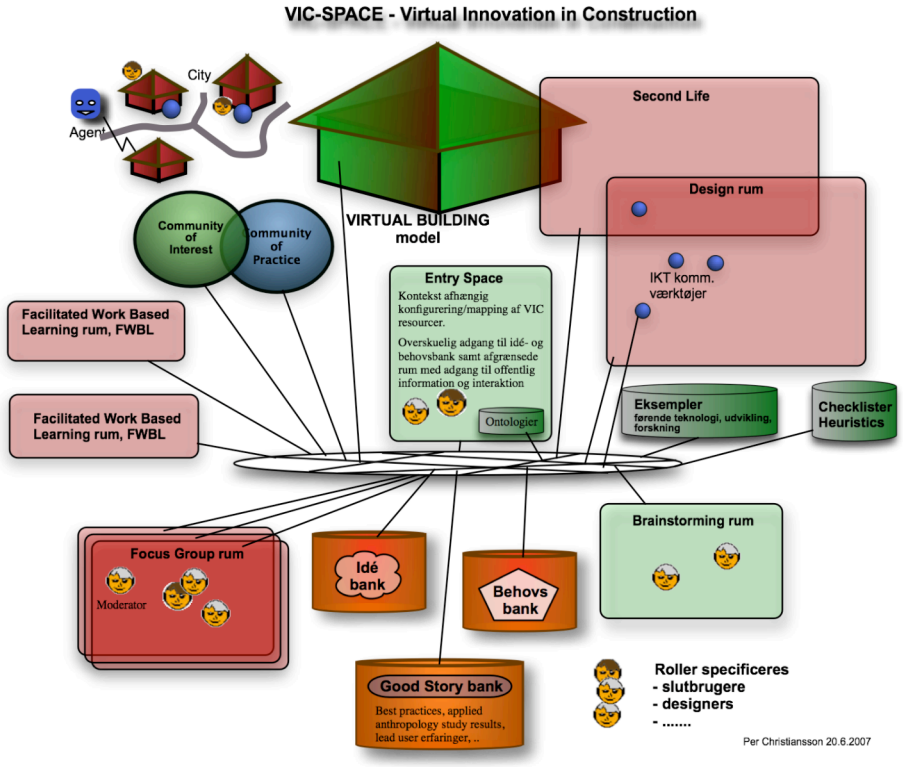
"Intelligent buildings are buildings that through their physical design and IT installations are responsive, flexible and adaptive to changing needs from its users and the organisations that inhabit the building during its life time. The building will supply services for its inhabitants, its administration and operation & maintenance. The intelligent building will accomplish transparent 'intelligent' behaviour, have state memory, support human and installation systems communication, and be equipped with sensors and actuators."

Some important characteristics in future Intelligent Buildings can be

- be *flexible* and *responsive* to different usage and environmental contexts
- be able to *change state* (with long and short term memory)
- contain tenant, O&M, and administration *service systems*
- support *human communication*
- accomplish *'intelligent' behaviour* and *transparent intelligence*
- *Integrate* different IB systems to form complex systems

# Virtual Innovation in Construction - VIC project

## Brugerinvolvering i Byggeproecessen




The project goal is to create an ICT supported methodology VIC - Virtual Innovation in Construction, to involve building end user in a creative innovation process together with building designers, to capture and formulate end-user needs and requirements on buildings and their functionality.

An open dynamic innovation space VIC SPACE is created with access from WWW.

Rambøll, Arkitema, AAU

*"Research is making knowledge out of money - innovation is making money out of research"*

Per Eriksson, Director for the Swedish Agency for Information Systems

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[pages 3, 19-28, 29-40, 55-63, 68-70]
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