AALBORG UNIVERSITY

Informationsteknologi i byggeriet og intelligente bygninger

Smart Energy Grids netværksmøde
BraínsBusiness ICT NORTH DENMARK.

RTX Telecom, 20 maj 2010. 09.20 – 09.50

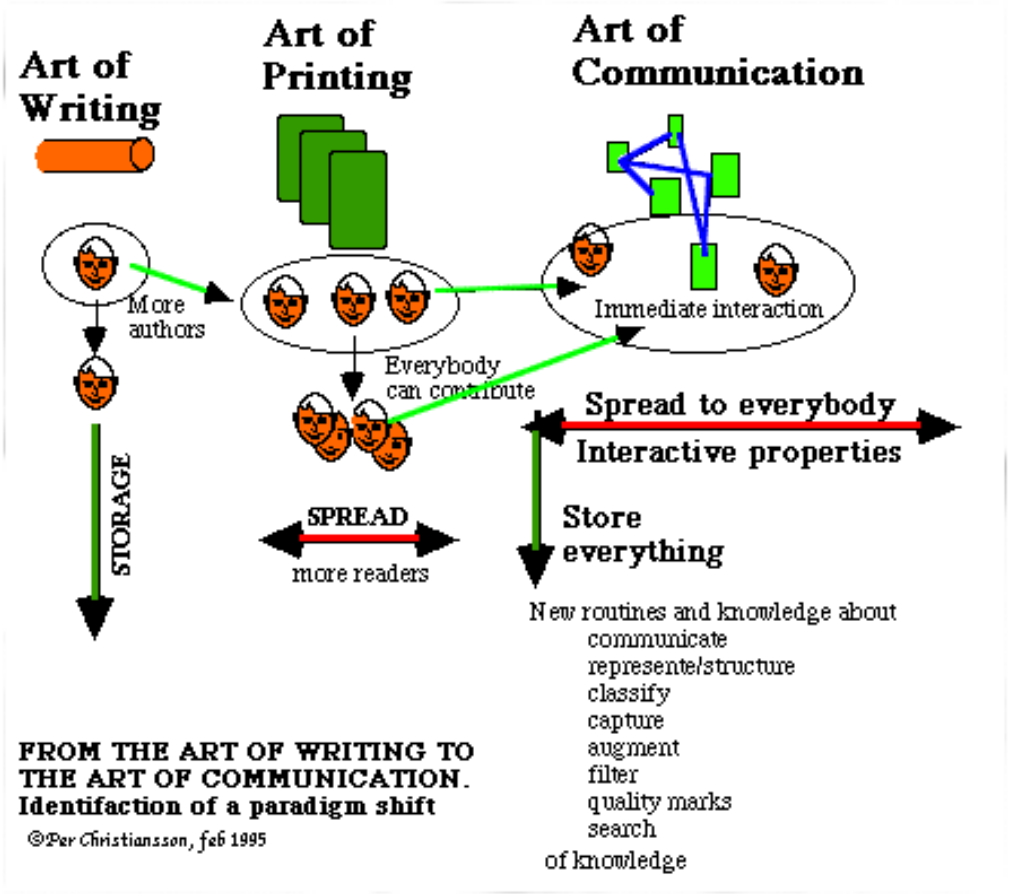
Per Christiansson
Aalborg University

CONTENT

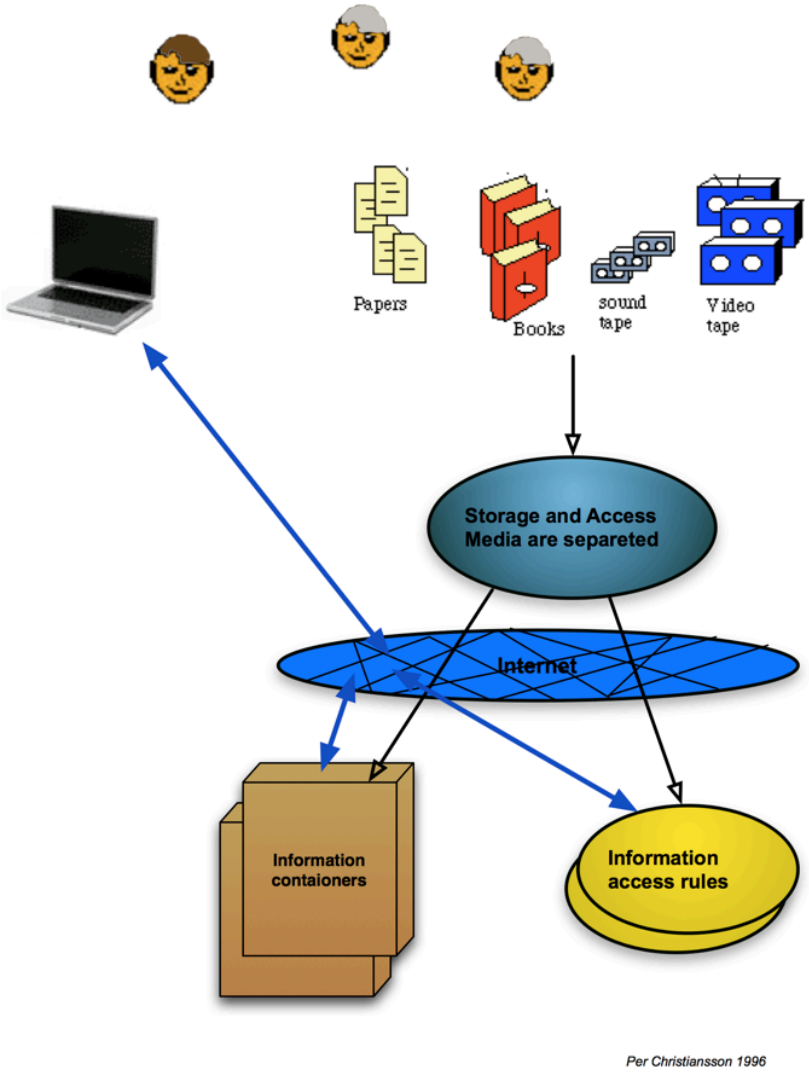
- The ongoing paradigm shift
- ICT in construction
- Intelligent building history
- New services in buildings/build environment
- Needs

THE ONGOING PARADIGMSHIFT

The Ongoing Paradigm Shift

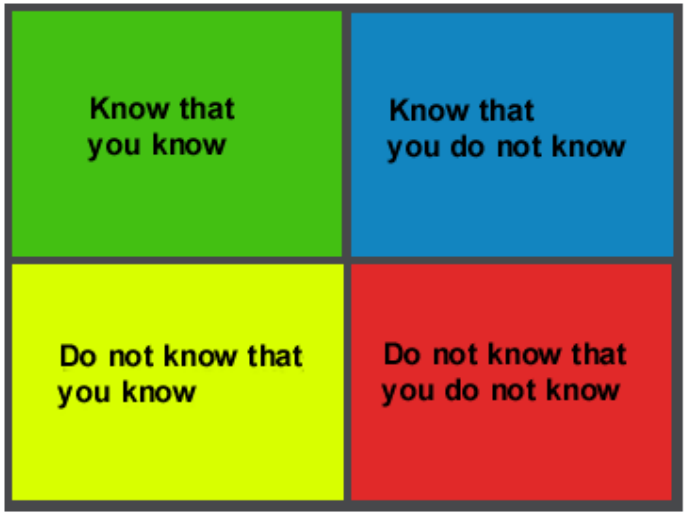


Separation of Storage and Access Media

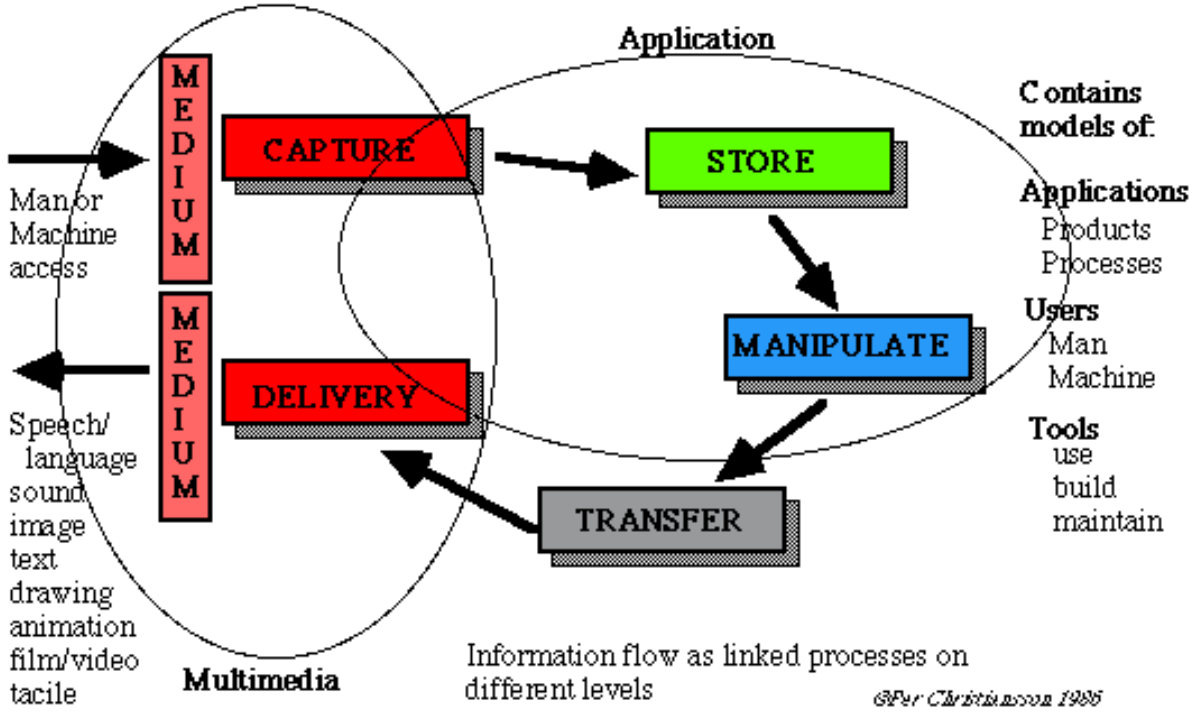


The Ongoing Paradigm Shift

- The globe is shrinking.
- Knowledge/experience spread.
- De-facto standards formed
- Creative/innovative ideas circulated
- Knowledge is a crucial development driving force



ICT Definition



IT or ICT (Information and Communication Technology) is the collective term for technology that caputure, store, manipulates, transfer and deliver information. The process may involve machines and humans in any combinations and on all abstraction levels.

Driving forces and trends

The technology driving force has been significant in development of the Intelligent and Responsive Buildings and Intelligent Cities. Such as

- Moore's law
- Spread and standardisation of Internet,
- Increased bandwidth within Internet,
- Communication standards development,
- Embedded intelligence with sensors and actuators connection, Internet of Things
- New network services and service-oriented architectures (SOAP, WDSL, ..) OGSA,..)

Virtual building (VB) models access is getting more standardised through use of the IFC standard, and will thereby be easier to integrate as a resource in IB service systems. ('BIM models')

ICT in Construction

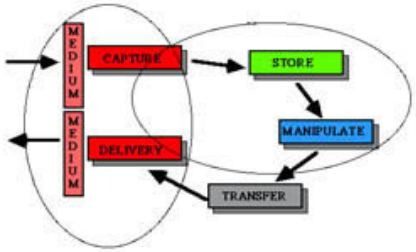
Building Informatics, AAU, teaching domains

User Environment (UE) design
- User needs capture
- Requirements specs
- Contextual design
- Usability/evaluation

Knowledge Management (KM)
- Intranet/extranet specifications
- ICT and change strategy
- Knowledge and experiences discovery, capture, storage and transfer
- Information QA

Intelligent Buildings (IB)
- IB design
- Services and systems
- Networks
- Facility management
- Intelligent city

Computer Supported Collaborative Working (CSCW)
- Virtual workspaces
- Sync/async communication
- Distributed collaboration
- Storytelling



Building simulations
- Building systems simulations
- Building systems integration

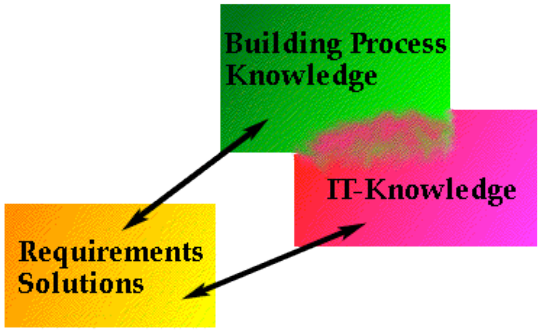
Virtual Buildings (VB)
- CAD
- Product and process models and modelling
- Classification
- Conceptual modelling
- 3D geometric modelling

Human Computer Interaction/ Multimedia (HCI/MM)
- HCI design
- Multimodal interfaces
- MM formats
- Computer graphics
- Virtual Reality

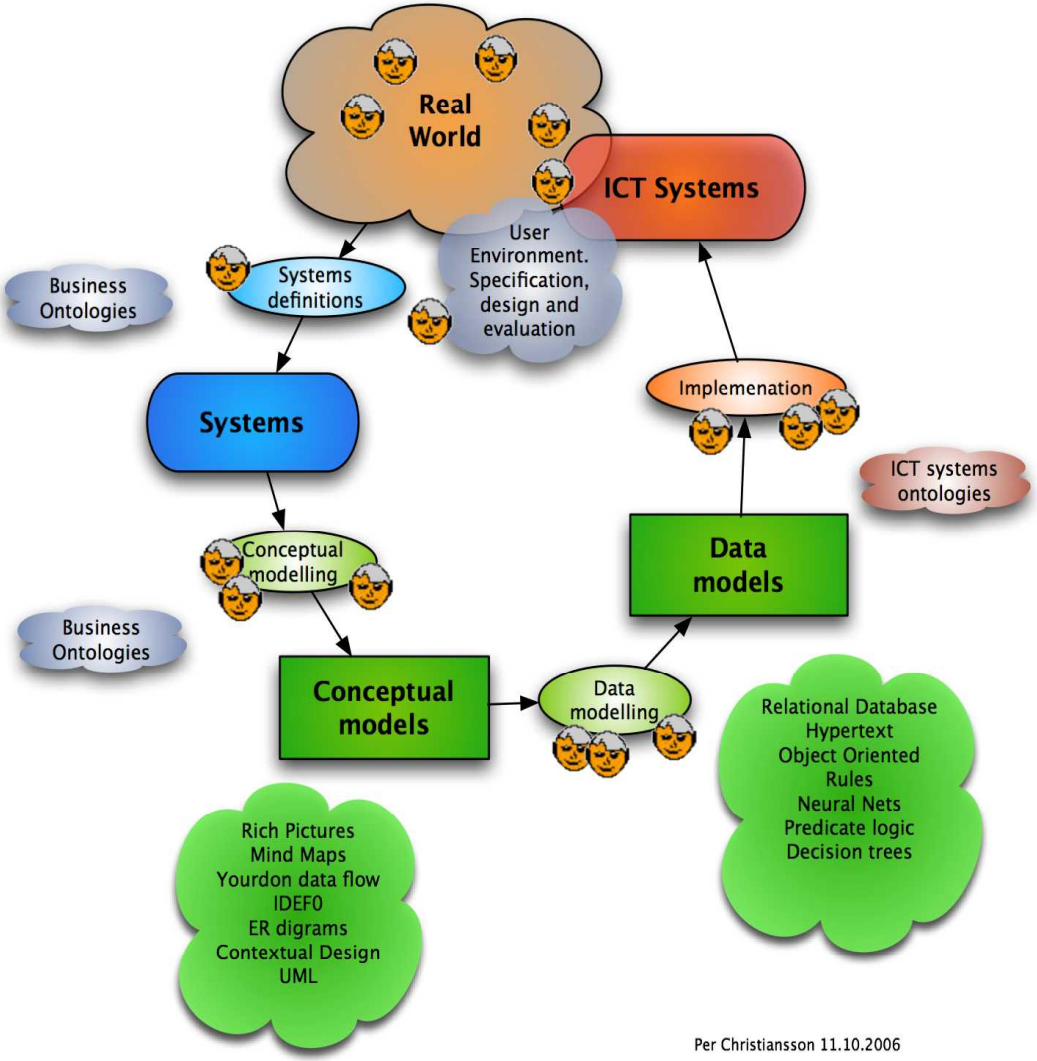
Knowledge Representations (KR)
- Relational databases
- Object Oriented
- Logic
- HyperText
- XML
- Semantic Web

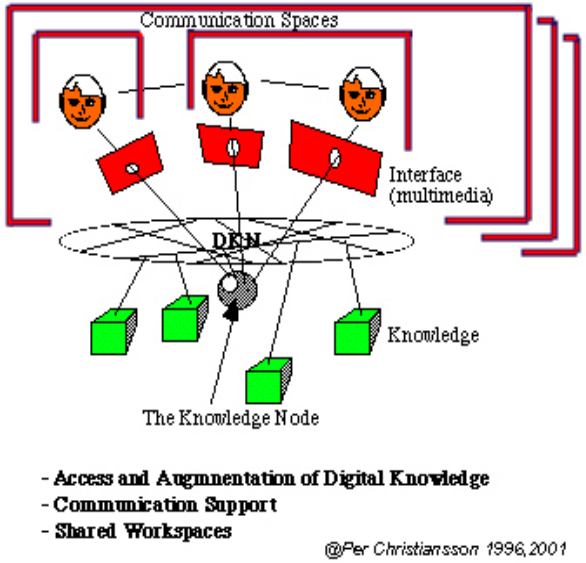
Building informatics related areas. http://it.civil.aau.dk/it/education.

See also the Building Informatics education at Aalborg University where students come out with a combined Building and ICT competence.



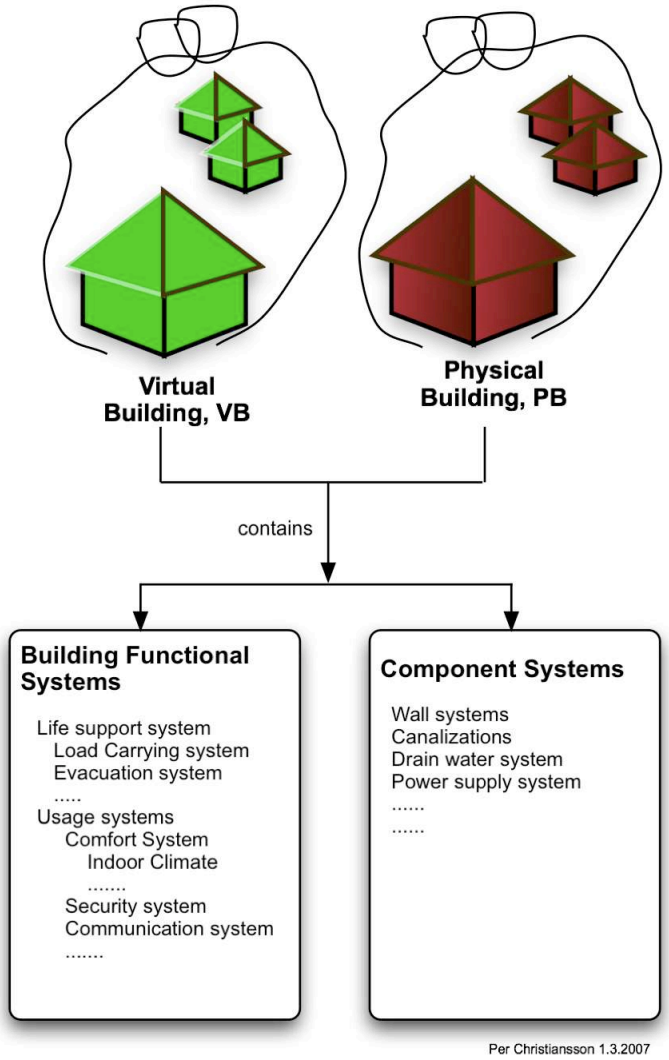
VICMET DESIGN SPACES





- **Real world** (activities, things, processes, context, persons)
- The real world can be described as (interrelated) **systems** to accomplish different **functions**
- The systems are **modelled** in context.
  - **Conceptual models** more or less formal (rich pictures, E-R diagrams, IDEF0,...)
  - **Data models** in formal representations (OO systems, relational db, hypertext,...) are designed
- **Implementation** of data models in physical **information handling systems**
- Evaluation of systems performance and **usability** testing

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'.

Sustainable Buildings

A sustainable building shall during its lifetime (50 years, 100 years,…) minimize its (global) energy consumption and maximise its yielded quality (i.e. It should form an effective, efficient and usable *system* from idea to recycling.

Buildings are most often not serial production things, though their parts often are.

Buildings can provide different services during its lifetime.

A building project team are most often unique for each project. The suppliers are most often not part of the team.

Merriam-Webster sustainable **1** : capable of being sustained.
2 a : of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged <sustainable techniques> <sustainable agriculture> **b** : of or relating to a lifestyle involving the use of sustainable methods <sustainable society>

User Involvement

The modern product end-user is participative, creative, self organizing and community oriented.

There is a great need to investigate and develop enhanced methods and work processes for end-user involvement in the building process to meet/formulate the future end-user needs and to produce better buildings.

Buildings are not ordinary products like mobile phones or cars.

There are great opportunities and challenges for innovation in an open environment but also challenges caused by the intra-organisational setting.

The virtual building (VB) plays a central role when we simulate, test, evaluate and refine services during building design.

Advanced ICT tools enhance our possibilities for effective, efficient and user-friendly collaboration in both physical and virtual environments.

End-user become a prosumer, producer and consumer.

PROJECT VIC Virtual Innovation in Construction

VIRTUAL INNOVATION IN CONSTRUCTION

Participants:
Arkitema K/S
Rambøll A/S
Aalborg Universitet

Project time August 2007 - May 2010.

Programme for User Driven Innovation.
Financed by
The Danish Enterprise and Construction Authority (EBST).

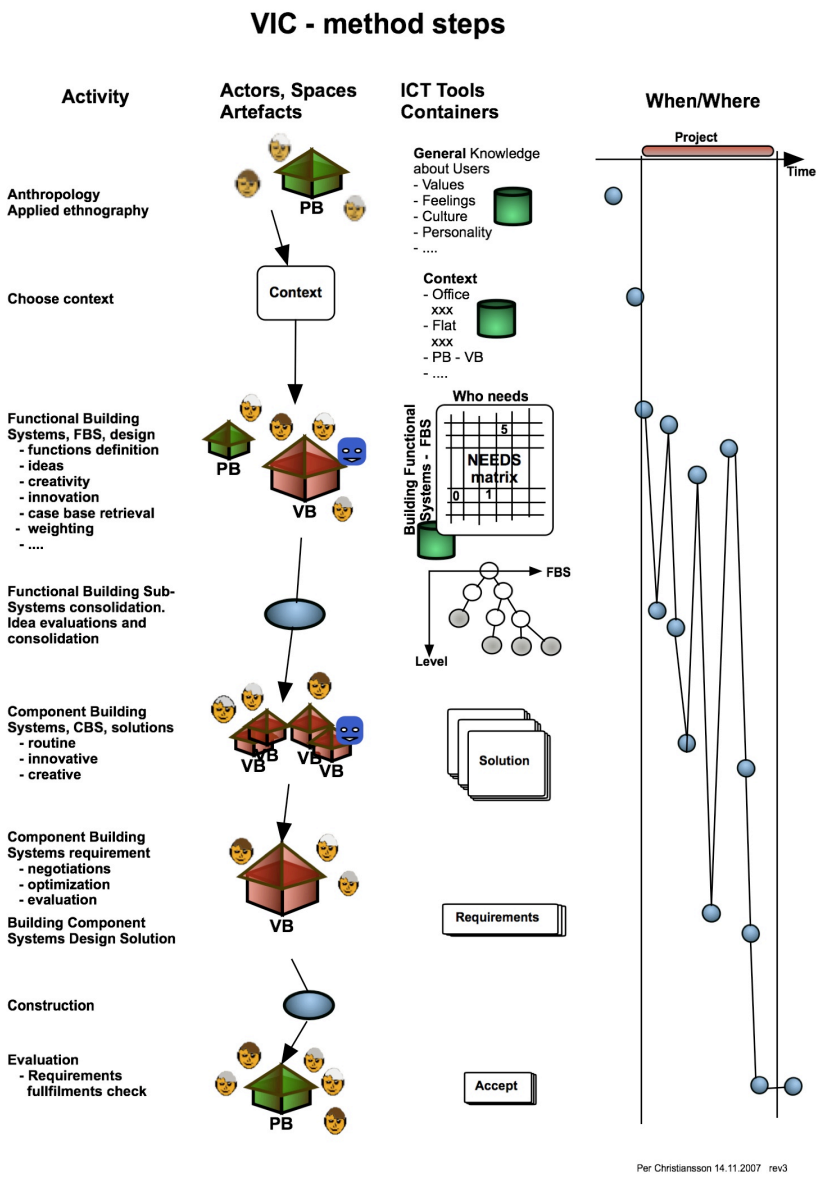
Project lead Aalborg University

http://www.vicspace.org

THE VIC METHOD

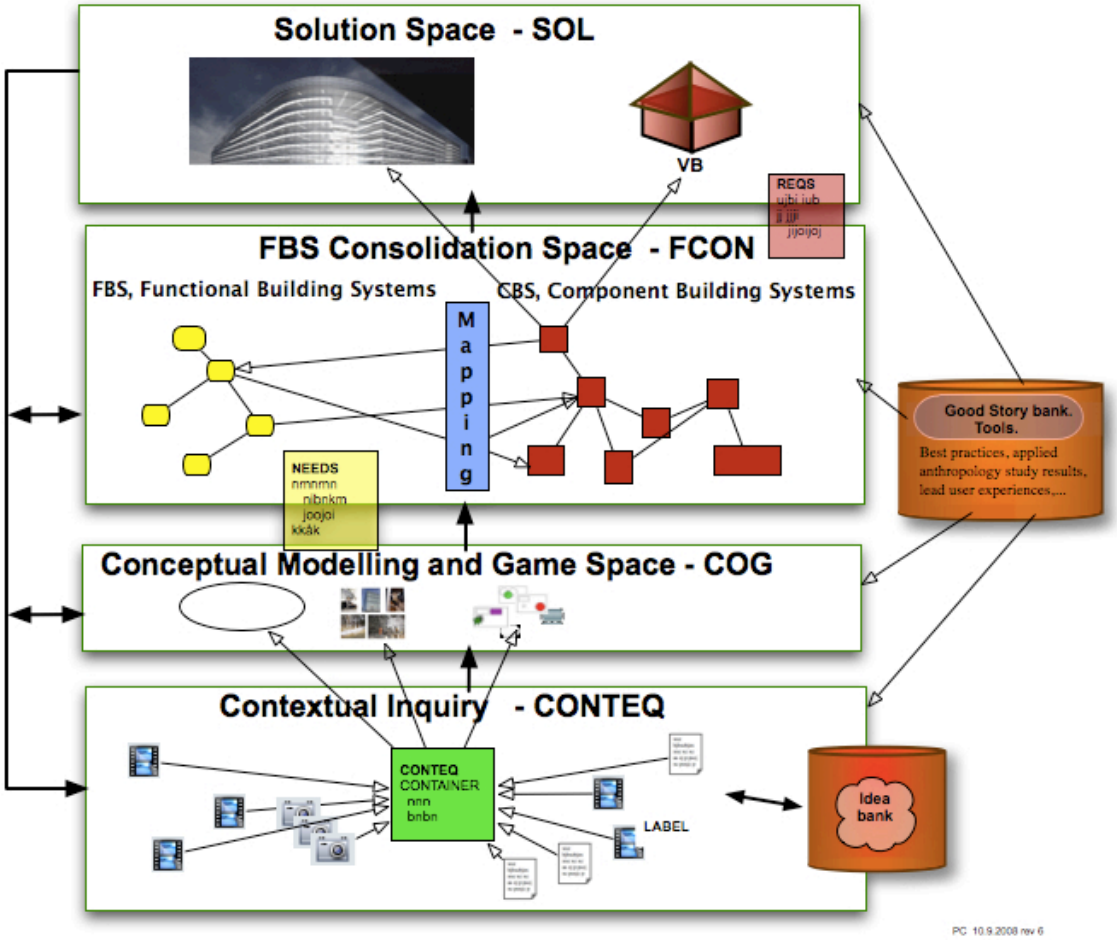
VICMET is open to support different business models and settings.

All innovations in the designspace do not have to be part of the current design. They can also be stored as ideas or partly evaluated innovations stored with rationale, evaluations, and feedback views.

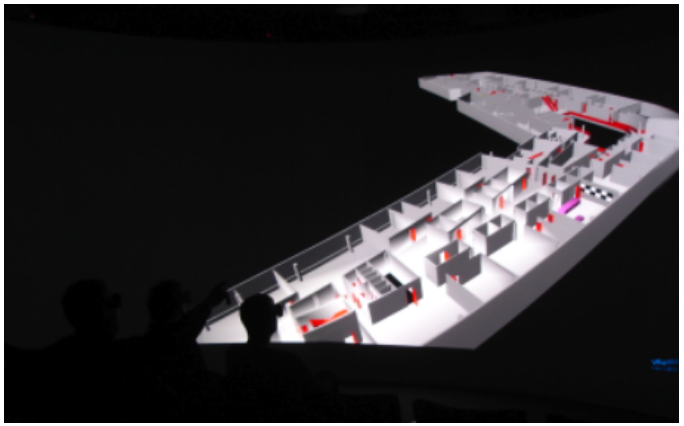


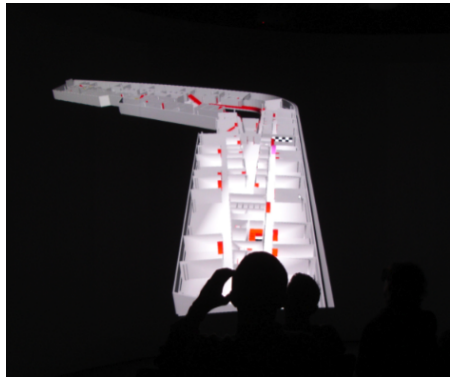
VICMET DESIGN SPACES

1. Formulate Design/Innovation domain
2. Set up design theme. Identify/allocate resources such as Idea bank, Best practice, Contextual Inquiry Bank
3. Contextual Inquiry (in **CONTEQ**)
   Where, how, who, when, methods support
4. Conceptual Modeling and Gaming (in **COG**)
   Modeling support (Contextual design methodology). Needs capture.
   Functional Building Systems specification.
   Creative/Innovative design.
5. Consolidation and Value formulation (in COG).
   Collaborative Story telling.
   Needs weighing and listing.
6. Component Building System (in **FCON**)
   CBS modeling. Functional Building Systems and Component Building Systems mapping.
7. Solution (in **SOL**). 3D virtual building modeling of (alternative) solutions.
8. Evaluation of solutions (in **SOL**)
9. goto 3

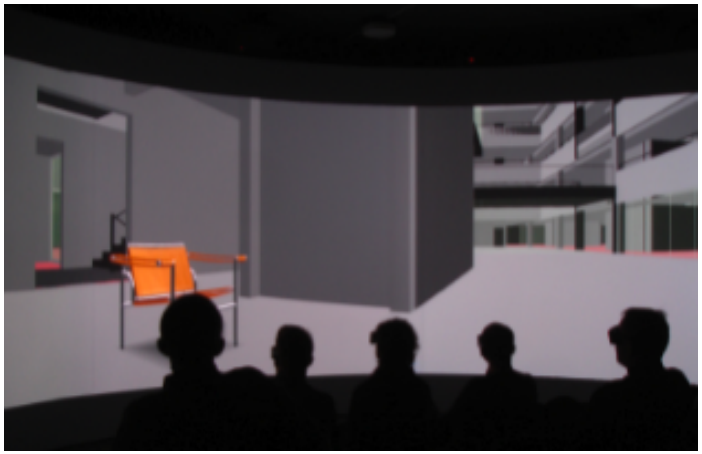


Bygningsmodeller

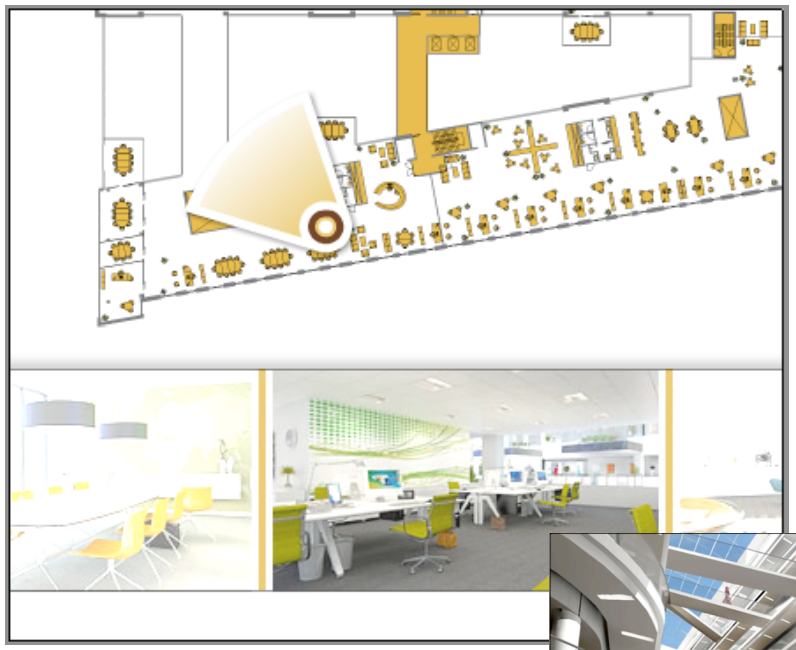




The Arkitema and Rambøll headquarters VIC cases



The VIC Method (Virtual Innovation in Construction)



The Arkitema and Rambøll headquarters VIC cases

Design Assessment (from the VIC project)


Taking notes


2 more workplaces


from opposite direction

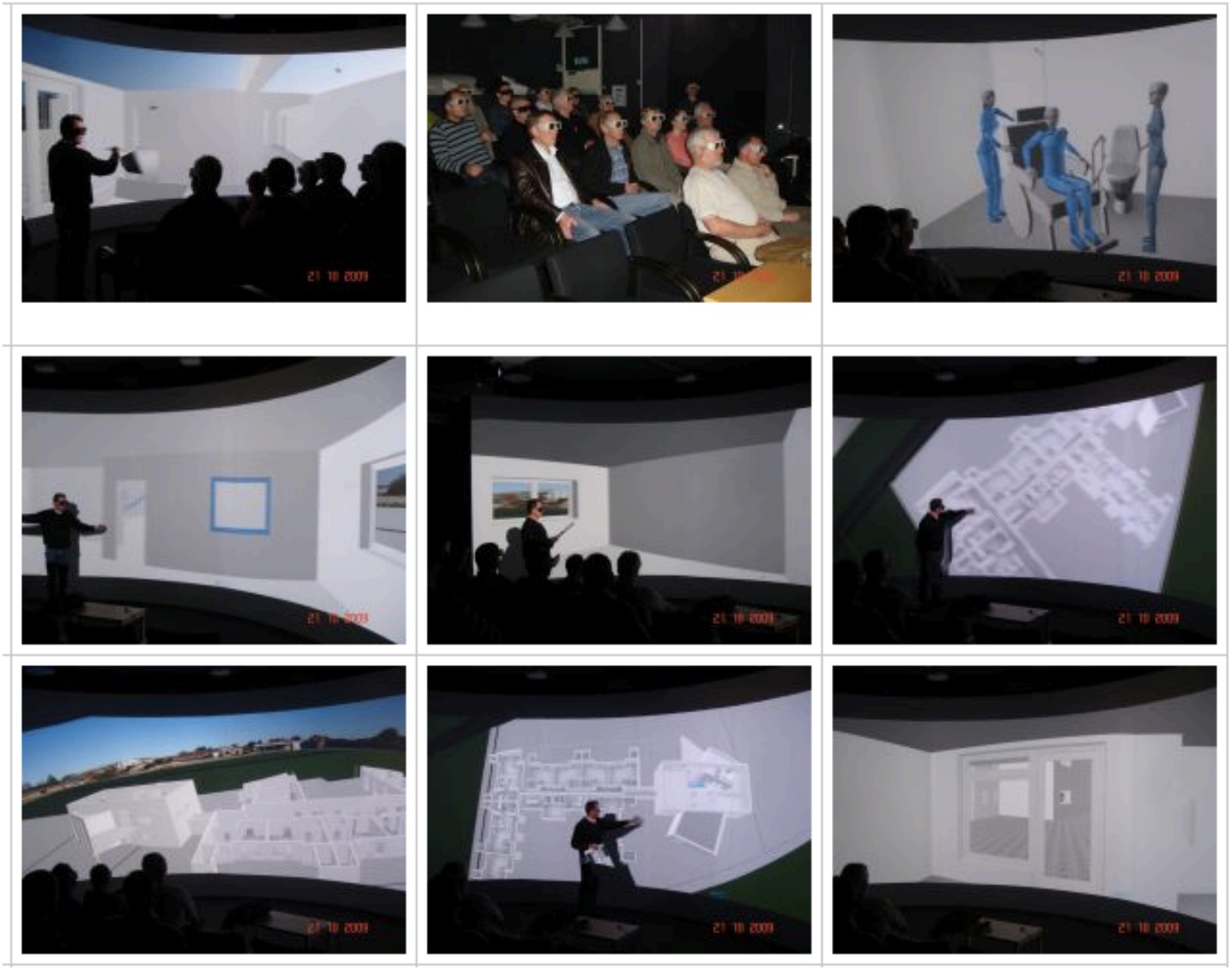

in the CAVE


In the Cave


atrium view

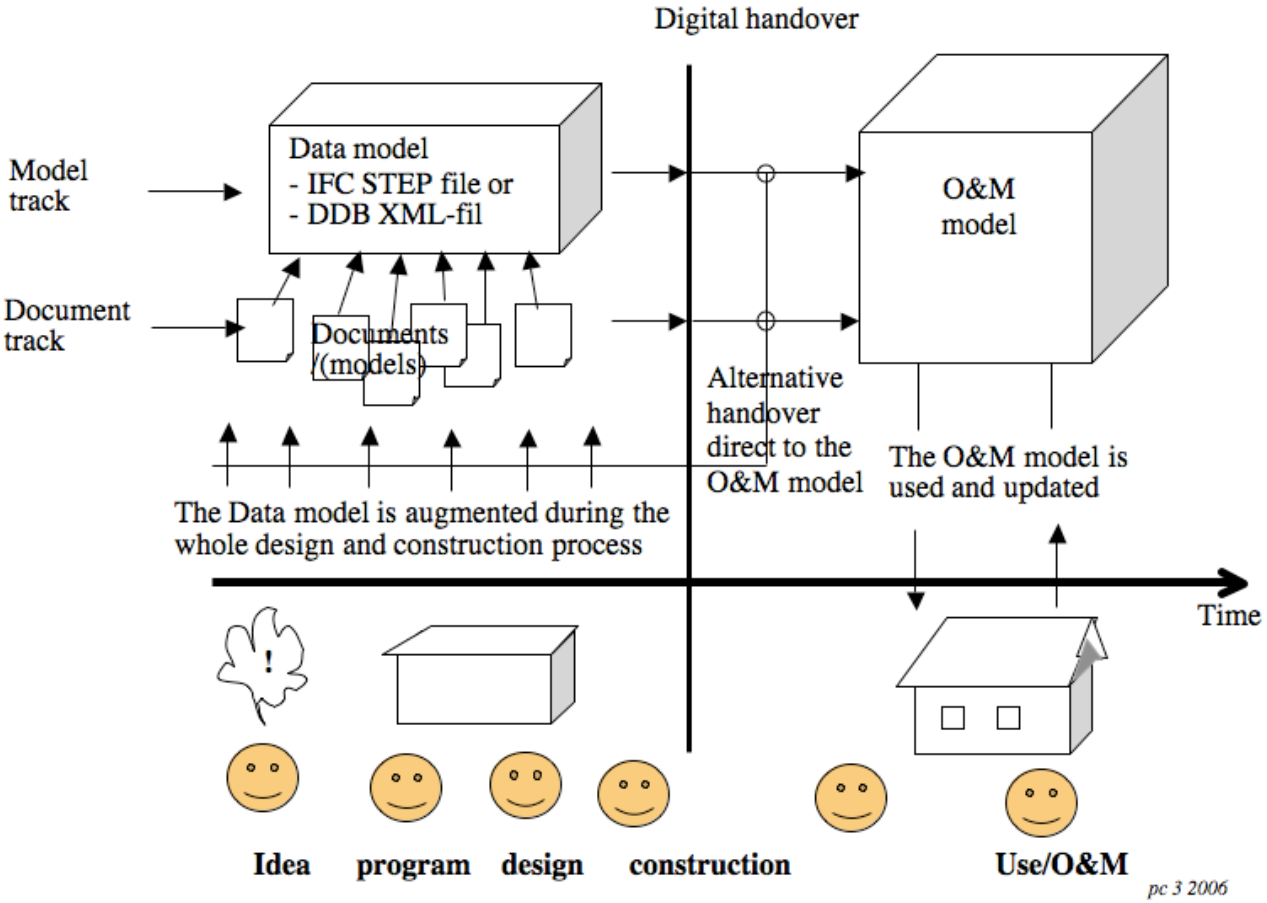
Arkitema assesing design alternatives in office design. The Virtual Innovation in Construction project. See also (Christiansson et.al., 2009)

Design Assessment (from the VIC project)



Clients and end-user groups assesing the overall design of Fredrikshavn Senhjerneskadecenter. From the Virtual Innovation in Construction project, VIC. See also (Christiansson et.al., 2009)

Requirements on Digital handover of buildings



The newly released, January 2007, Danish digital construction requirements lets public clients put requirements on the content of the digital models of the building handed over to the client after finalised construction. (DDB, 2006)

INTELLIGENT BUILDING

Intelligent Building history

- In 1982 AT&T establishes the concept "INTELLIGENT BUILDINGS" due to marketing reasons.
- The INFORMART building is erected in Dallas containing latest IB systems on display.
- 1984-85 The Smart House Development USA (National Association of Home Builders, NAHB). STS, Shared Tenants Services (using PABX)
- 1987 N.Y. Times "I.B. is a dumb idea".

- 'Automated Buildings', 'High Tech. Buildings', and 'Smart Houses'

- Services for sustainable performance
- Services for human/building interaction
- Services for health and well-being

Intelligent Building history

In 1986 we arranged a national Intelligent Office workshop at Lund University Sweden, where some still valid conclusions were drawn

- man/machine environment important,
- lack of knowledge, information vulnerability,
- flexibility requirements not fulfilled,
- too little holistic problem views,
- new building construction coordination and procurement forms needed,
- lack of standards..
-

Services announced around year 2000 by IB-system companies were typically - fire alarm, energy control, heating control, telephony/computer net, ventilation control, climate, surveillance, lightning, power, security, passage control, and automatic door functions.

Intelligent Building history

Around 10 years ago there started to be more focus on broader social and life-quality end-user aspects on services e.g. for example elderly/handicap living support, home health care, and home distant working.

A number of protocols and network solutions to integrate more or less intelligent sensor/actuator control units have been developed.

- 1990 LonWorks technology work starts (LON), Local Operating Network for IB systems,
- EIB, European Installation Bus, and later KNX (ISO/IEC 14543),
- BACnet, a Data Communication Protocol for Building Automation and Control Networks,
- OSGi, Open Service Gateway Initiative,
- ZigBee,
- Z-Wave
- ….. RFID (Radio-frequency identification)

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

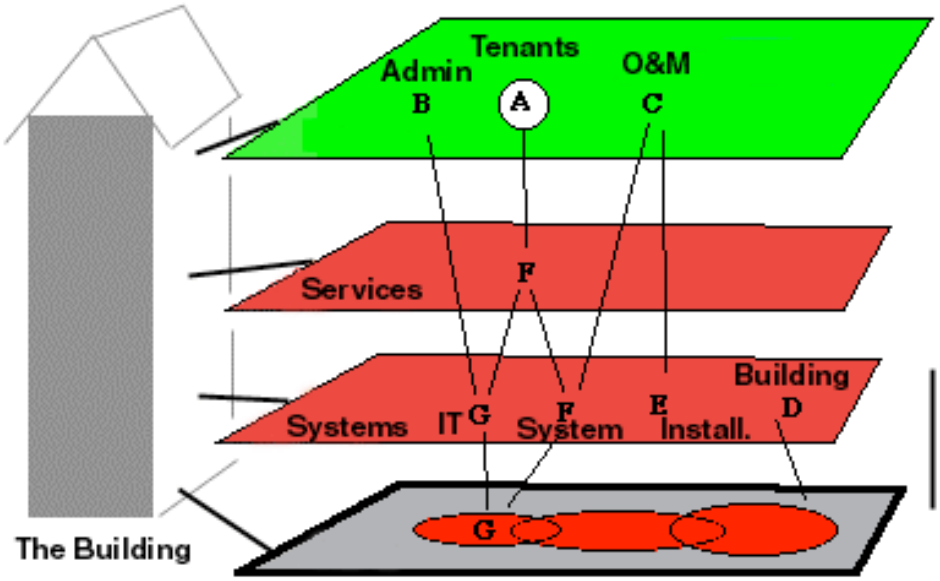
- be *flexible* and *responsive* to different usage and environmental contexts
- be able to *change state* (with long and short term memory)
- contain tenant, O&M, and administration *service systems*
- support *human communication*
- accomplish *'intelligent' behaviour* and *transparent intelligence*
- *Integrate* different IB systems to form complex systems
- have a distributed long term and short term *memory*
- support *introduction* of *new* (sometimes not yet defined) *services*

Intelligent Building definition

Some important characteristics CONT.

- be equipped with *sensors* (stationary and mobile) for direct or indirect input and manipulation of signals from users, systems and the building structure
- be equipped with *actuators* for direct or indirect manipulation of installatations and the building structure
- accomplish '*intelligent*' behaviour (self diagnosis, trigger actions on certain events and even learn from use)
- *integrate different IBI systems* to form complex systems
- contain IBI life time *standardized solutions* as far as possible
- be *well documented* (in 3D with functional descriptions) available as a Virtual Building with connection to physical builiding
- provide *canalization* (*information roads*) that shall house 'wires' carrying new services
- provide dynamic *secure information domains*
- *.....*

Intelligent Building history



OSI	TCP/IP	
Application (QoS, privacy,..)	Application (email, www, ...)	
Presentation (op-sys links)		
Session (logon)		
Transport (error check,..)	TCP	LonWorks follows OSI
Network (packet routing)	IP	
Datalink (protocol mng)		
Physical (bits, ethernet,..)		

- Wiring
- 'Canalization' (information roads)

Intelligent Building services may be directed towards 3 groups of people 1) residents/end users including end user external service providers, 2) operation & maintenance personnel, and 3) building/ facility administration personnel.

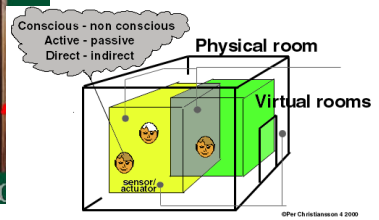
Services announced today [2000] by IBI-system companies are typically - fire alarm, energy control, heating control, telephony/computer net, ventilation control, climate, surveillance, lightning, power, security, passage control, and automatic door functions.

Collaboration

4 parts video conference, 2008

Desktop collaboration

Remote lecture and application sharing between Aalborg and Lund Universities 1999



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.

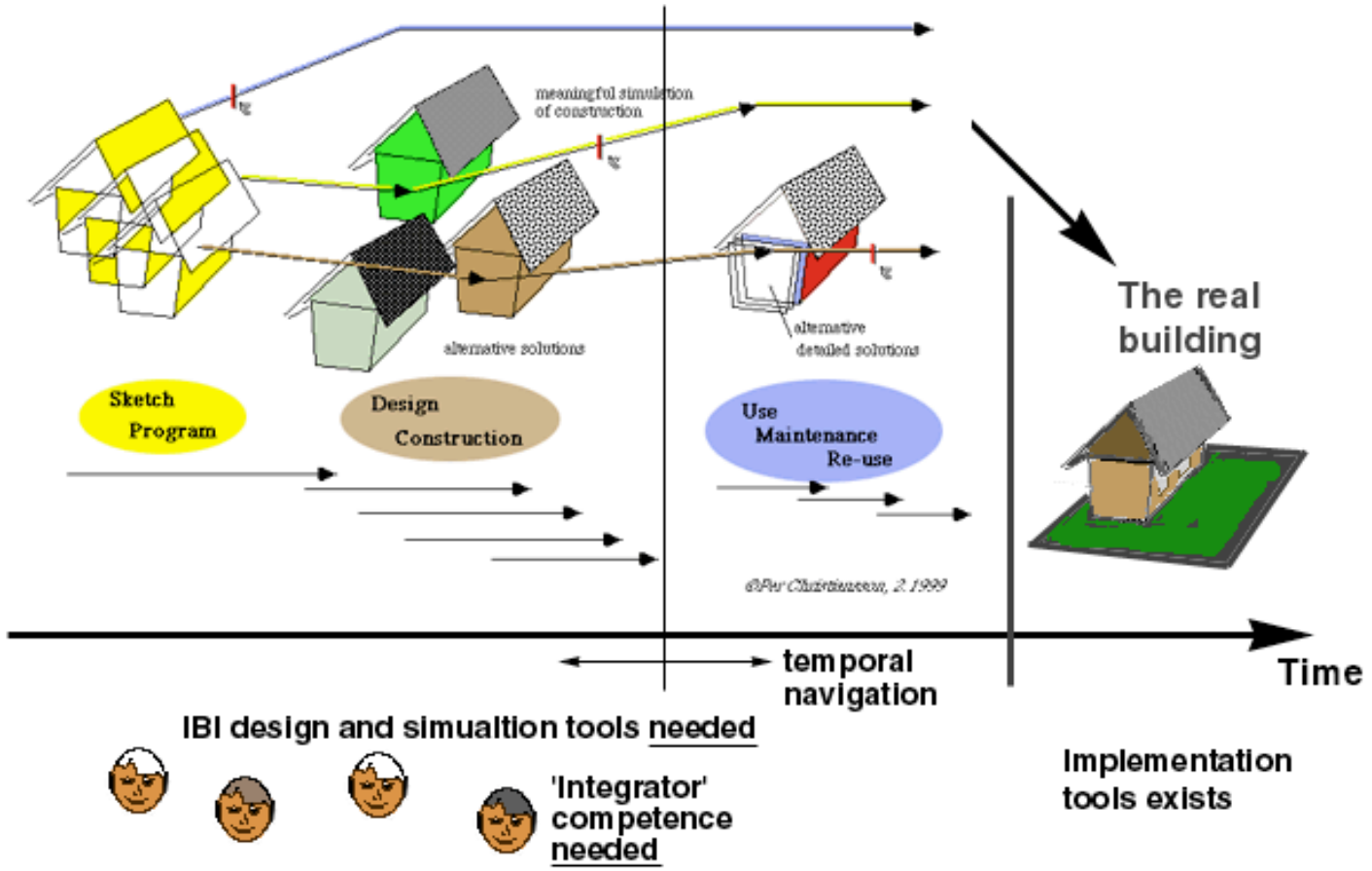
A VS do *not* have to be *stationary* but can e.g. follow a person defined as the immediate surrounding of that person. In this latter case wireless connection to the space is a necessity and maybe a complication in interaction with stationary spaces.

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.

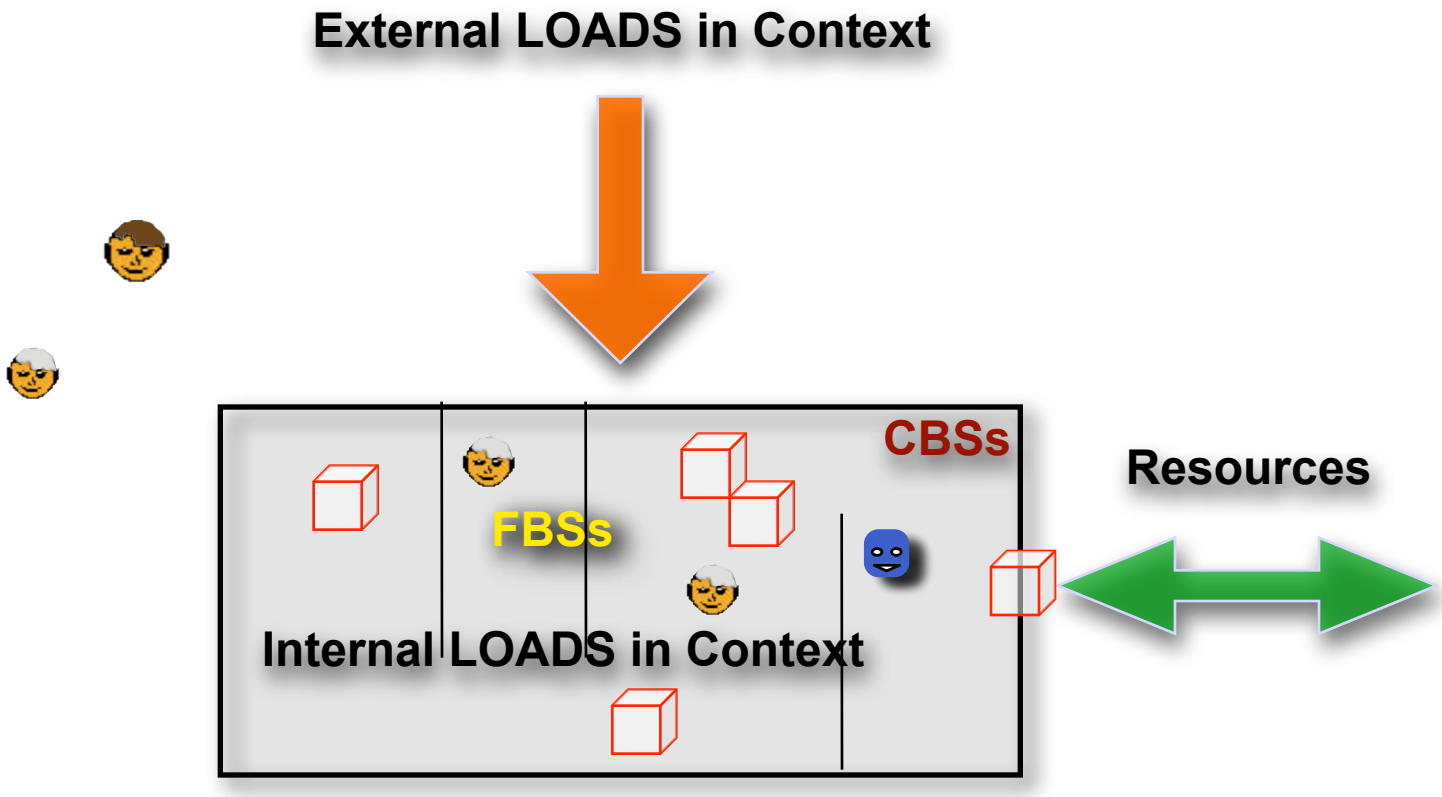
NEEDS

Early design tools



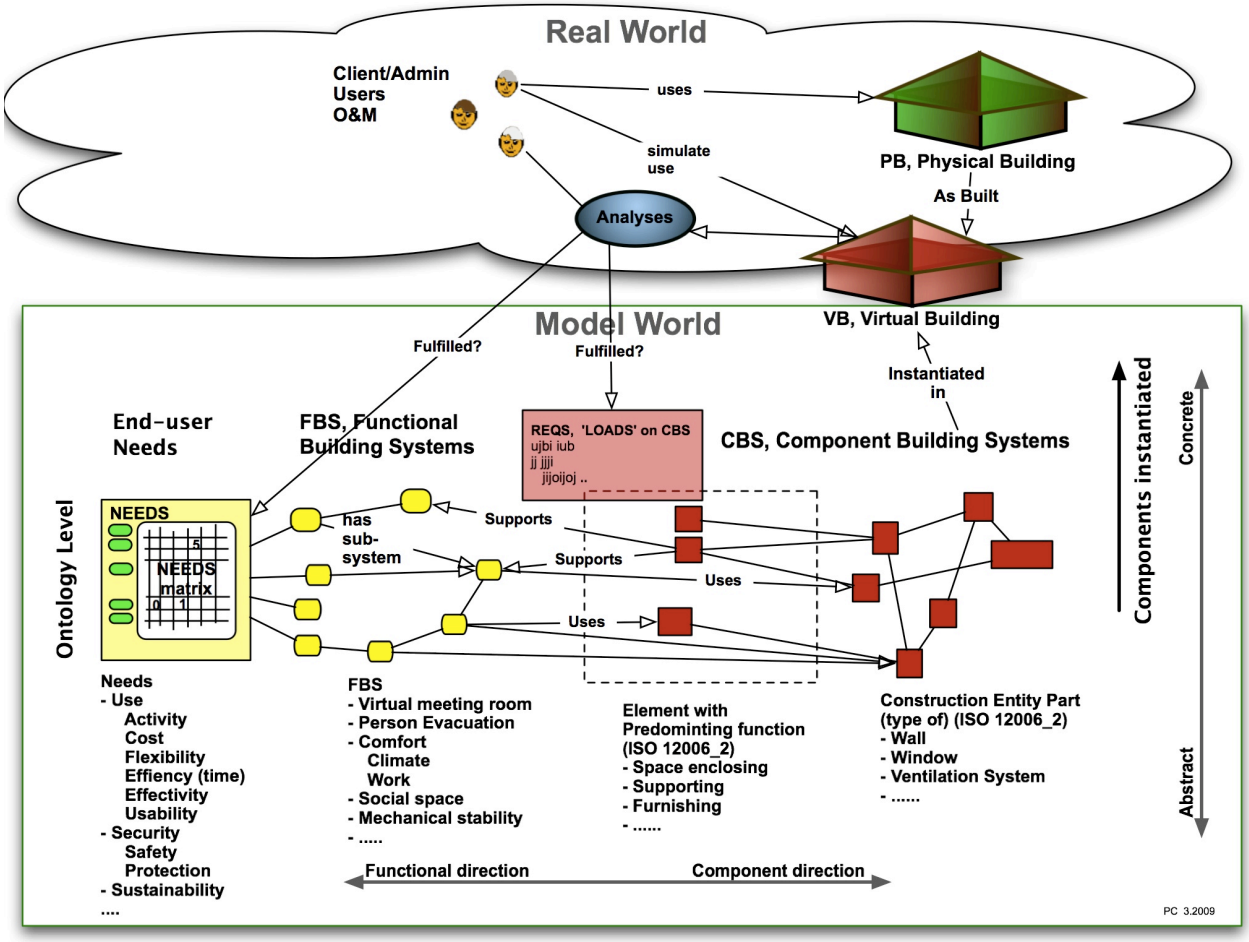
In the future we will to a higher extent design and try out the building during it's whole life cycle before it is even built.

Sustainable Buildings



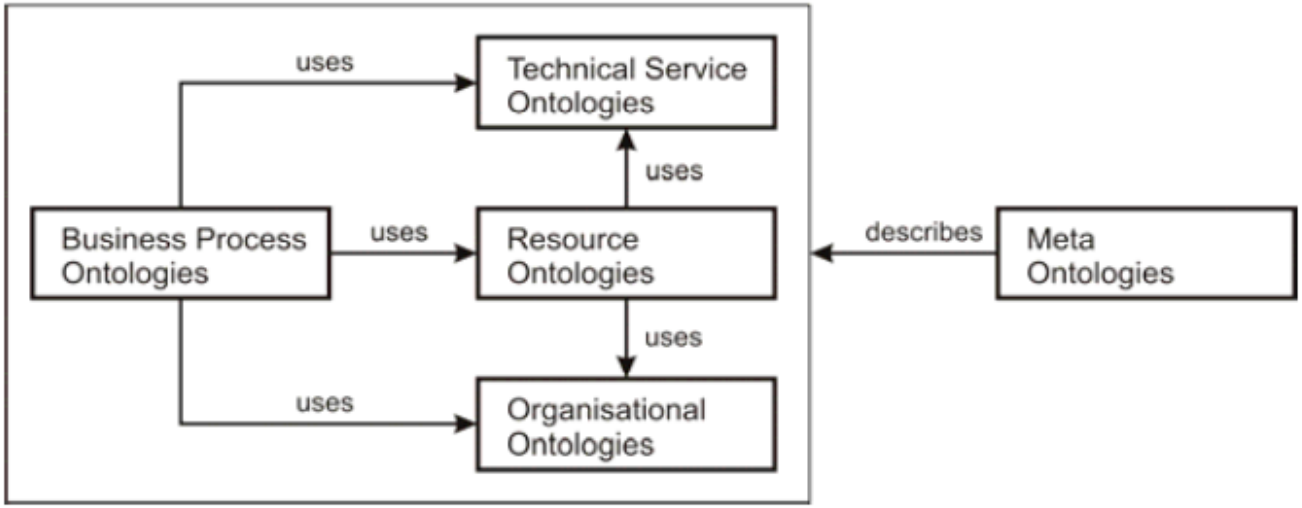
- Flexible, adaptable and responsive during use,
- Low energy consumption during construction, use, demolition, recycling
- Real time buying anf selling og electric energy .....
- System integration

Functional and Component Building Systems, FBS - CBS



Formalisation of the building design process. References are made to (ISO 12006-2, 1001). From (Christiansson, Svidt, Sørensen, 2009)

ONTOLOGIES (VIC-MET example)



Business process ontologies (end-user needs, Functional Building Systems [FBS],…..)

Organizational ontologies (actor roles, company organizations and interrelations, design paradigms, building project organization….)

Resource Ontologies (VICMET tools, Component Building Systems [CBS], Virtual Building models…..)

Technical service ontologies (services enabling data communication through heterogeneous networks and also standardized use of hardware and software from different suppliers).

End user needs and requirements capture

There is a great need today to secure development with below specified areas to secure smart buildings to meet future needs from end users and technology providers

- Systematic description of existing and future *application/business services needs* in terms of application domain, functionality, involved actors, organisation, and use contexts.
- Systematic description of existing and future available smart *building/smart city services* in terms of application domain, functionality, and use context.
- Systematic description of existing and future available *resources* that can support provided services.
- *Ontologies* and dictionaries have to be further developed especially on business and meta levels to secure effective systems interoperability, and information handling.

Future Directions

We can ascertain that we are facing some major challenges and possibilities to create *user friendly* and *improved services* in the IB/Intelligent City domain.

We shall bear in mind that it is a *slow* process involving *de-facto* standards development very often driven by *bottom-up* processes. It is important to try to establish a *sustainable top-level framework* and meta-classification to ensure efficient services use of underlying resources, service definitions, and service interoperability.

- *Business* level *ontologies* and *Service Oriented Business Architecture* must be subjected to increased development efforts.
- *End-users* must be better involved in service needs capture, service design and evaluation. Client/end-user needs capture and requirements formulation and modeling must be further advanced.
- The *impact* on social behaviour, economics, and personal values should continuously be *monitored* and taken into account..
- Descriptions and structuring of *Building Functional Systems* to support requirements set-up and modelling in connection with building design and end-user service ontologies specification as well as model-based control of technical building services must be developed.
- An important effect of efficient IB energy systems is the possibilities to *reduce energy consumption* through more optimal energy use.

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