AALBORG UNIVERSITY

Future ICT Supported Integrated Building Process - Potentials and Barriers

De Digitale Dage på UCN

University College Nordjylland, Aalborg Universitet, Tech College Aalborg, EUC-Nord and SmartCityDK
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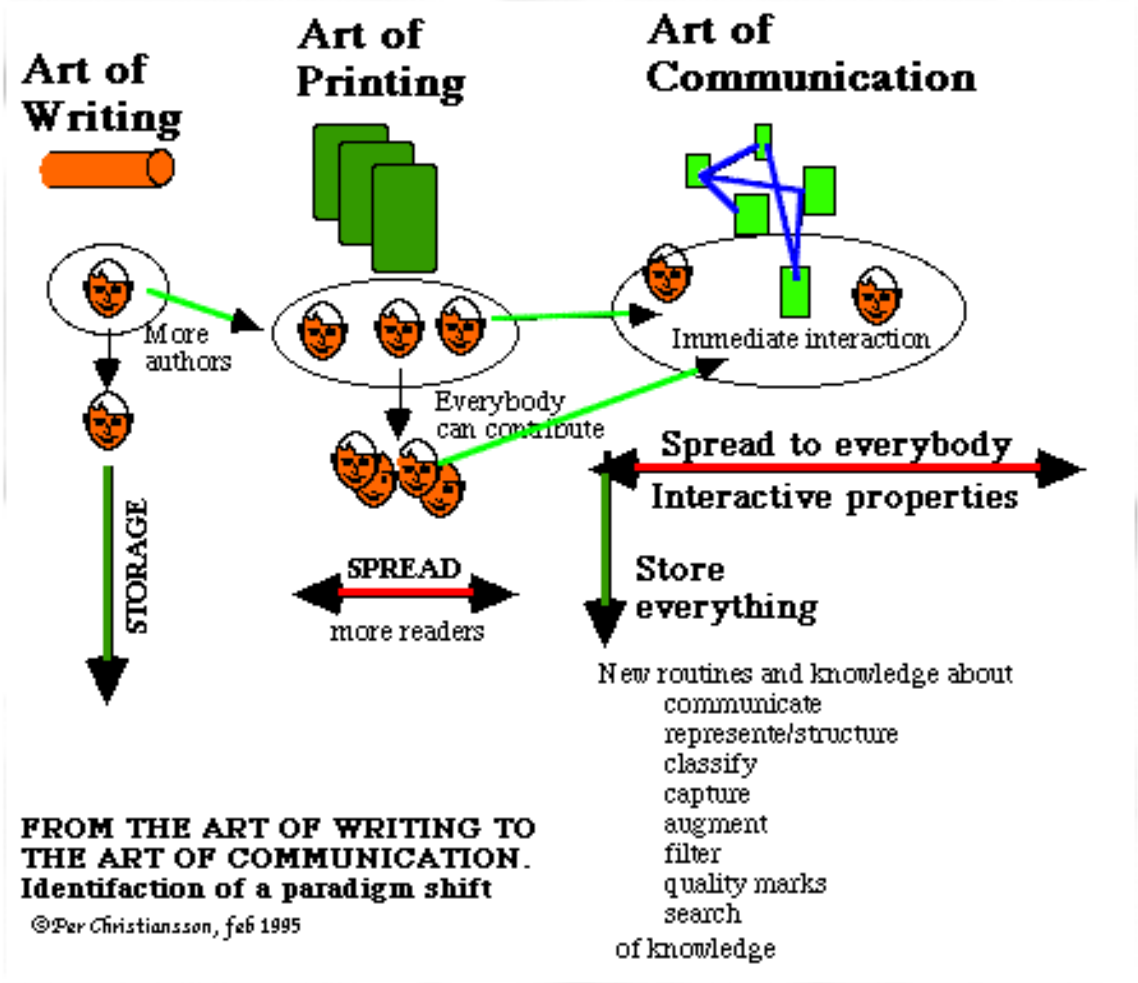
21.4.2010

CONTENT

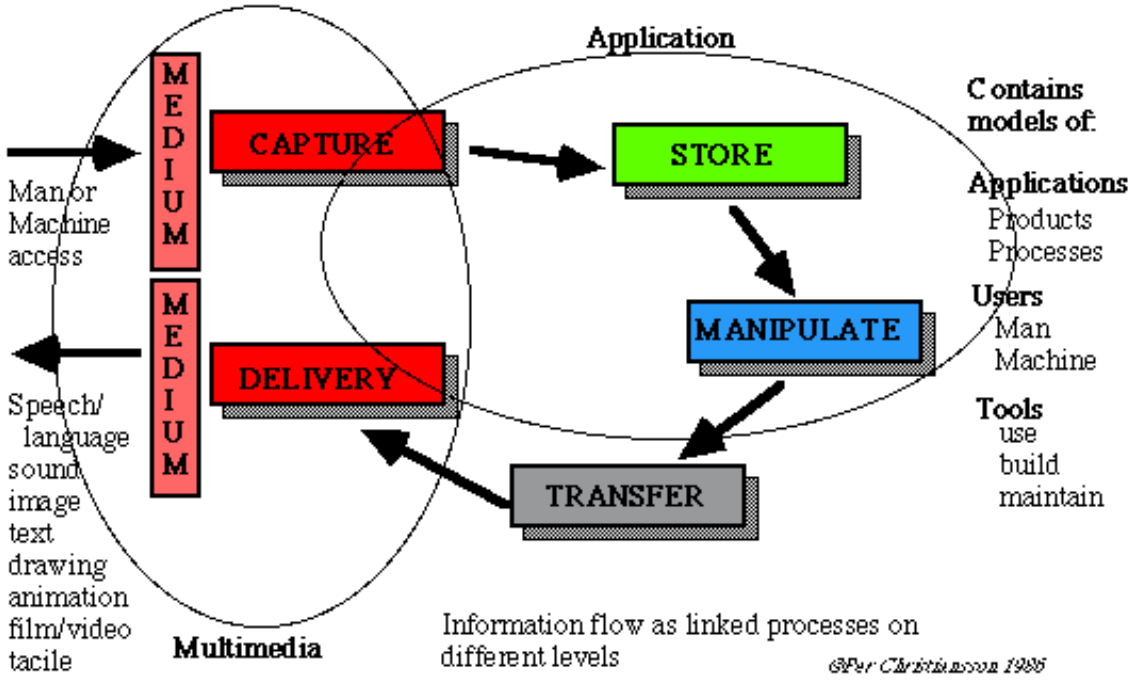
- The Ongoing Paradigm Shift
- Potentials
- Barriers/Challenges

THE ONGOING PARADIGMSHIFT

The Ongoing Paradigm Shift



ICT Definition

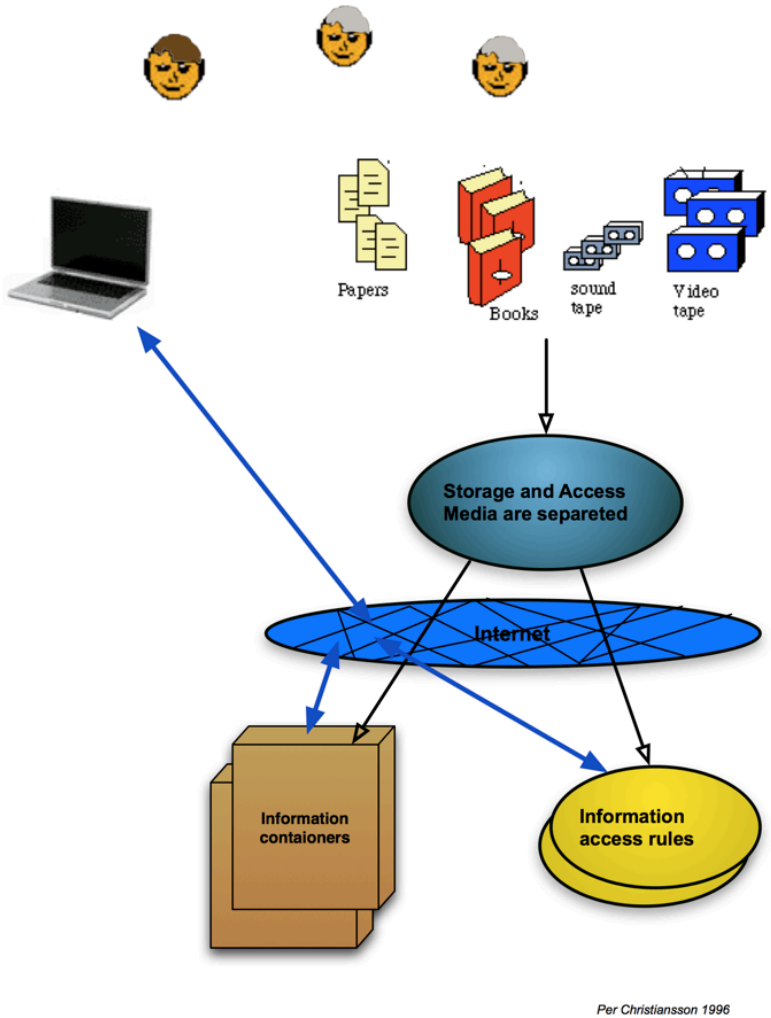


IT or ICT (Information and Communication Technology) is the collective term for technology that caputure, store, manipulates, transfer and deliver information. The process may involve machines and humans in any combinations and on all abstraction levels.

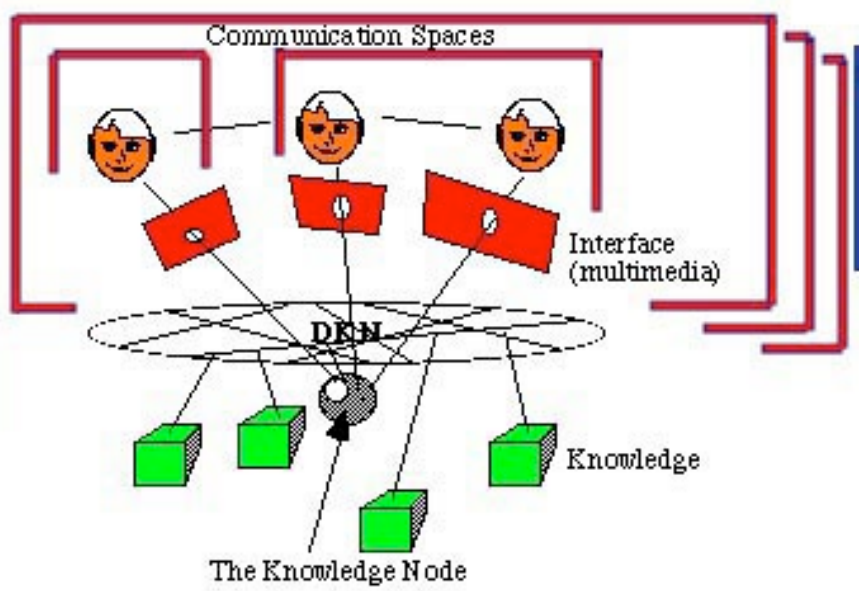
Development Trends in Society

- Local businesses are becoming global local-like businesses i.e. with greater needs for harmonization of cultural values on all levels. (The Global village)
- All information ('good' and 'bad') accessible through dynamic logical containers (QA)
- Separation of storage and access media
- Virtual spaces for communication, learning, working, and socializing
- Communities of interest,...
- Information Property Rights (IPR), information value/trading, added value, ..

Separation of Storage and Access Media



Users - models - networks



Due to introduction of ICT we must define some basic parameters to describe the collaboration in existing and not yet defined environments

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.

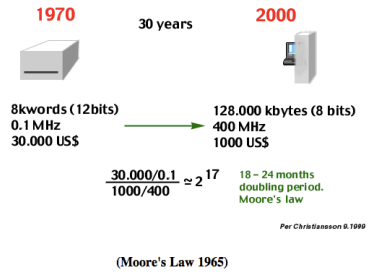
A virtual space may provide service to support *many* kinds of activities.
We may define virtual workspaces supporting collaboration, home health care space with access to distant doctors, different communities of interest or practice, virtual city space for service discovery and access etc.

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

ICT Development Trends

- Moore's law will be valid for at least another 20 years (memory, speed, ubiquitous computing).
- Extended development and use of meta-data marked www-accessible information (e.g. semantic web based solutions).
- Web-services,...
- Portable units (computers, service/communication units).
  Many flat panel/mobile communication units in homes and workplaces
  Virtual spaces (public, priveliged, private). (Ubiquitous computing, Mark Weiser, 1988)
- Embedded intelligence (installation components etc.) with Internet connectivity (Internet of Things)
- Augmented reality systems

Video conferencing over Internet using whiteboard (KBS-Media Lab, Lund University, 1996, /1993/).



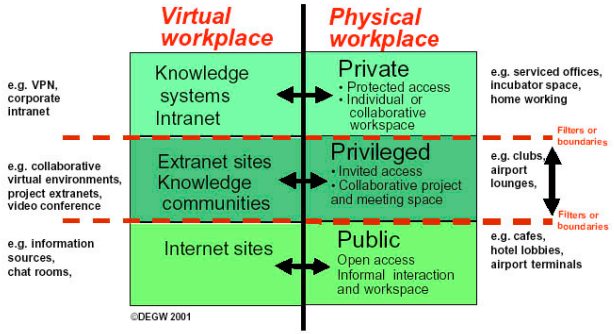
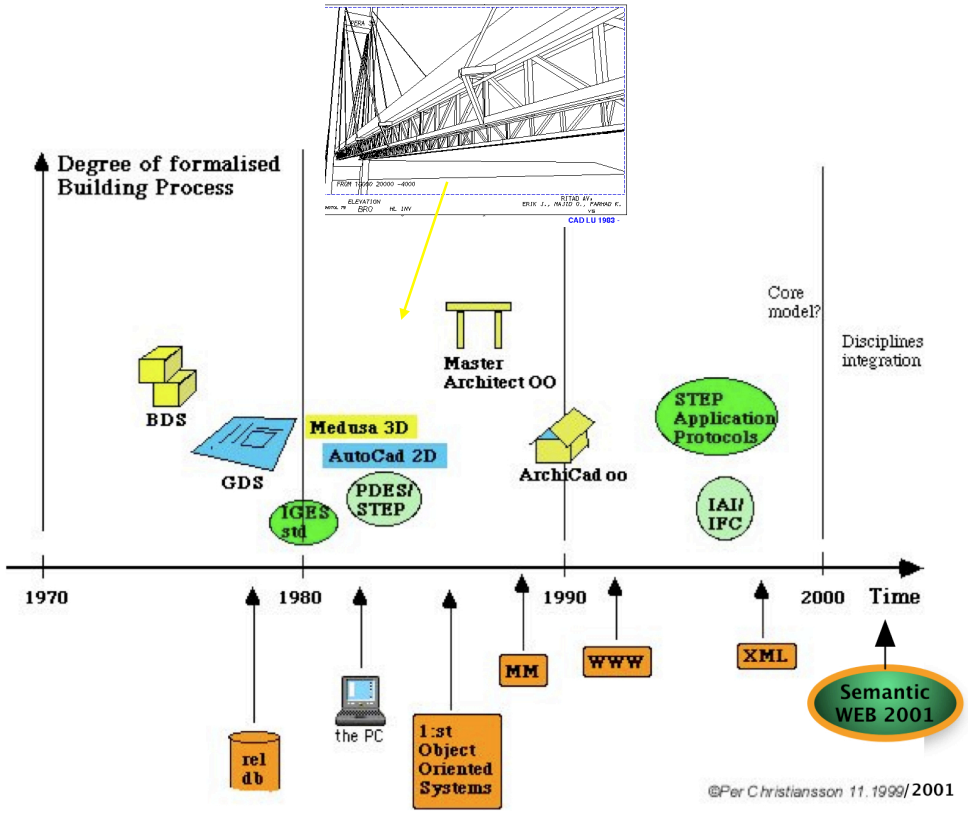


Figure 1 : SANE Space Environment Model.
Source : DEGW 2001

Building Process Development

- *Clients* get instruments to formulate better *needs* and *requirements* on buildings.
- We are introducing, also in practice, the *time dimension* (4D) in Virtual Building models, see e.g. (Fischer & Kam, 2002).
- Closer connections between *physical building* and *virtual building* model
- Virtual building (VB) *models access and exchange* is getting more standardized through use of the IFC standard, http://www.iai-international.org/.
- *Industry Foundation Classes* (1985). Based on ISO STEP (ISO 10303). Exchange of building model information. (IAI, BuildingSmart, http://www.buildingsmart.com/)
- Efforts are under way to create *International Framework for Dictionaries* (and Ontologies) (IFD), http://dev.ifd-library.org/
- *Information Delivery Manual* (IDM) supporting information exchange for business processes in the building and construction industry. http://www.iai.no/idm/, http://idm.buildingsmart.no/confluence/display/IDM/Home
- *Intelligent* products and buildings with *embedded* sensors and actuators are again in focus.
- Energy optimization and ecological and *sustainable* building is gaining importance.
- We should be in a continuing *reflective* development process aiming at *moving goals*.

Modelling history



Below are some highlights from the modeling/ICT history listed
- Ivan Sutherland creates SKETCHPAD (1960)
- Integration of building parts to a Product Model,(1970),
- Time-sharing computers (mid 1970s).
- User tools perspective. 3D modeling (1975), -IGES. Initial Graphics Exchange Specification in USA (1979)
- Cad database integration (1980). Applications spread physically in networks (1980).
- 1983. IGES/PDES. Product Data Exchange Specification/using step (USA) , ISO/STEP Stan-dard for Exchange of Product Model Data
- First practical object orientation implementation (1985). CIB W78 conference in Lund 'Conceptual modeling of buildings' (1988)
- PDES/STEP General AEC Reference Model(1988)
- Integration of mixed representations. Knowledgebases (1990). Integrated networks on services level ISDN (1990), INTERNET accelerates. Process modeling focus (1990). WWW (1990).
- IFC Release 1 (1996).
- (1993). January, 40 known http servers. October, 200 known http servers.
- (1994). May, First International WWW Conference at CERN Geneva. (KBS-Media Lab, Lund University on the web in April). June, over 1500 registered http servers. 2.5 million computers on the Internet.
- XML (1998), Resource Description Framework, RDF (1998), Semantic Web (2001). See also (Christiansson, 1998 & 2003), (Lai et. al. 2003).

Building Process models development have during the latest decades had periodic focus on achieving a highly formalized non-redundant building product model, Virtual Building, VB.

From Christiansson P, Carlsen M (2005) Virtual Building from Theory to Practice. *Proceedings W78 22nd Conference on Information Technology in Construction*. (Edited by R.J. Scherer, P. Katranuschkov, S.-E. Schapke). Dresden July 19-21, 2005. ISBN: 3-86005-478-3, CIB Publication No.: 304. (pp. 171- 175).

CAD Software History

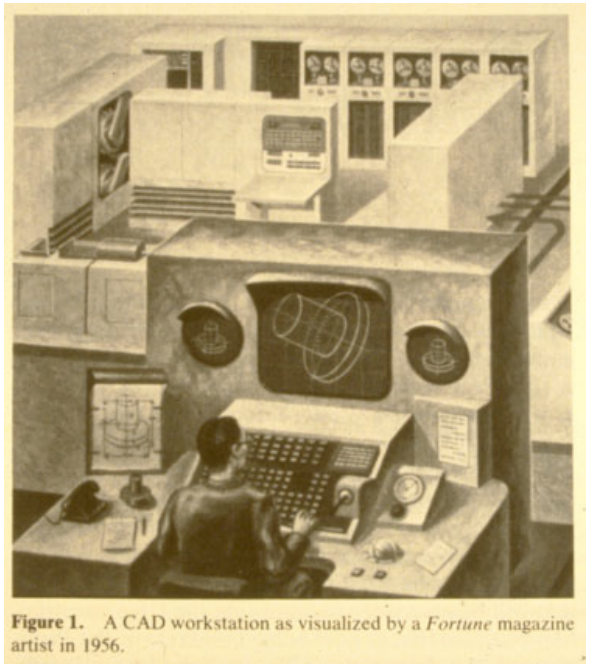


Figure 1. A CAD workstation as visualized by a *Fortune* magazine artist in 1956.

There are some CAD software history on the Web. M.Bozdoc 1955-2000 history at http://mbinfo.mbdesign.net/CAD1960.htm and http://www.cadazz.com/.

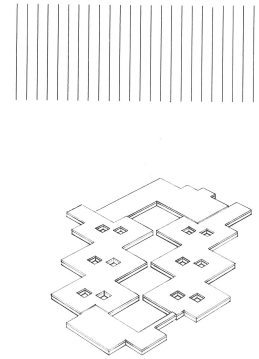
CAD Software History, BDS

BDS by Applied Research of Cambridge

BDS is an integrated set of computer programs which records, organises, analyses and reproduces the information associated with and generated during the design of a building.

BDS helps designers produce better buildings

BDS provides fast, detailed feedback on the performance, cost and appearance of any projected building. Alternative designs can readily be refined, revised or completely re-shaped and each new version rapidly evaluated to facilitate choice of the best scheme.

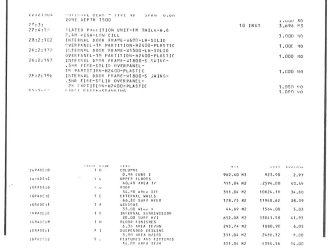


BDS saves time and advances start on site

The routine and time-consuming procedures attached to design - drawing, scheduling, calculations, etc. - can be completed automatically by BDS as the design proceeds. Thus production documentation of the final design is generated very quickly.

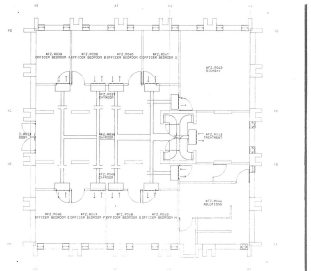
BDS provides better costings

From sketch design onwards, BDS measures the building automatically, giving more reliable estimates of capital commitment and costs in use.



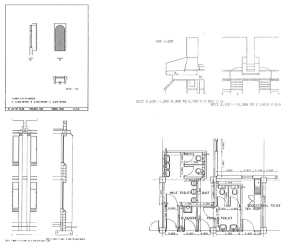
BDS makes coordination of the design process easy

Drawings, schedules and information produced by BDS automatically incorporate all design decisions made to date by all members of the design team. BDS also checks for incompatible decisions, in particular spatial clashing of elements. The resulting consistency of documentation can prevent expensive mistakes.



BDS produces highest quality drawings

Drawings produced by BDS include plans, elevations, sections and other arrangement drawings with any selection of elements. Annotation includes automatic dimensioning.



BDS gives fast access to relevant building information

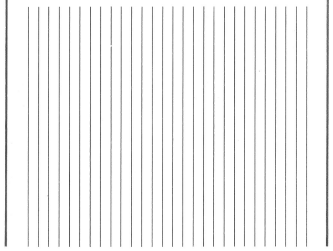
BDS has the capacity to store large amounts of data covering locatable building elements and other components, room equipment, costs, performance specifications, etc., for use when it does an evaluation and for quick retrieval by the design team.

BDS is extensible and can be tailored to your needs

BDS has been designed with enhancement in mind. It provides a firm basis for the development of new analytical tools and the automation of specific design detailing tasks. In addition it can handle a building project of any size and can be extended to hold almost unlimited amounts of building information.

BDS means:

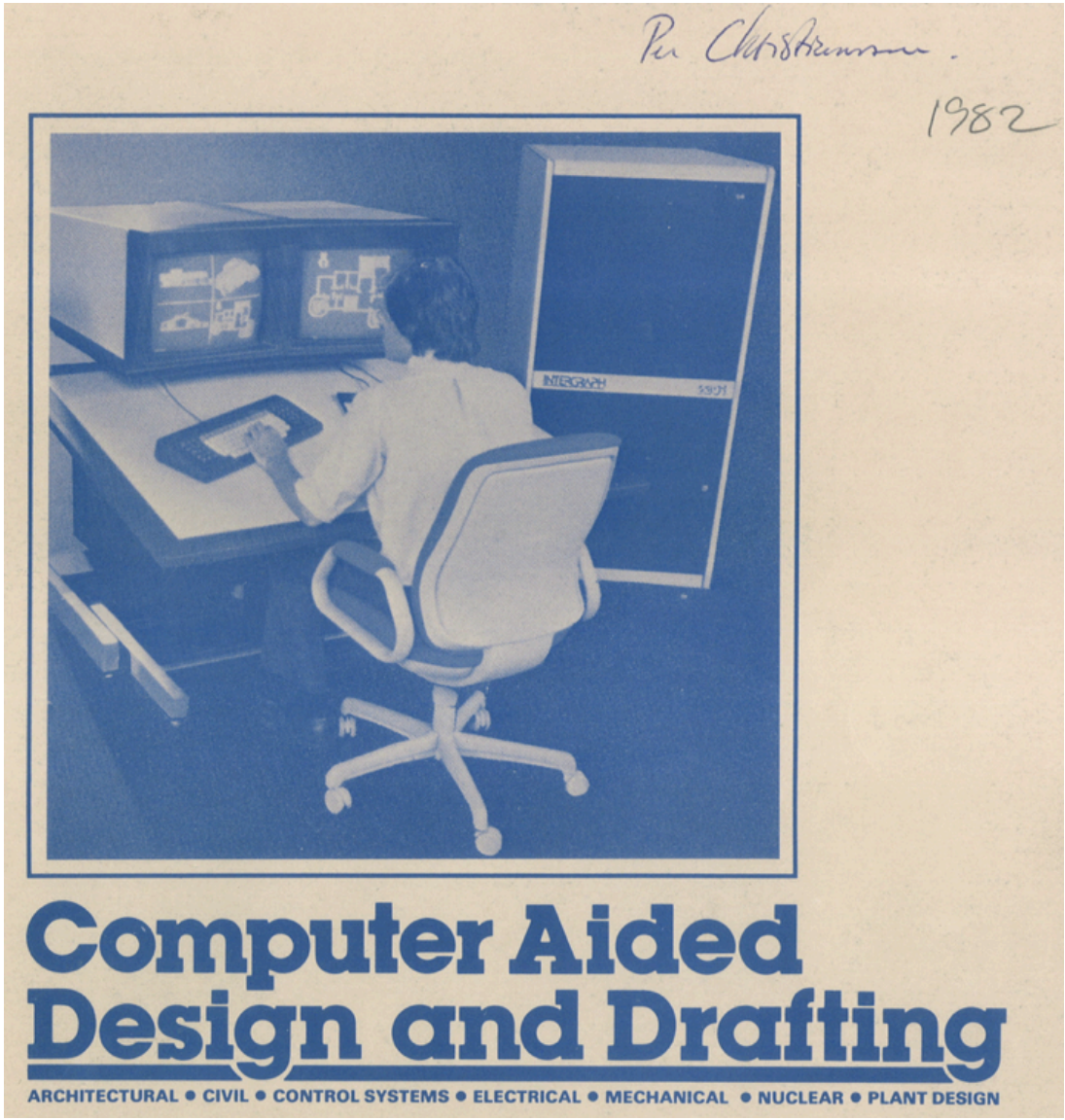
Greater productivity for the designer
Better estimates all round
More reliable instructions to the contractors
A better building for the client



Building Design System (BDS), Appied Reserch of Cambridge. (1978-). ARC formed 1970

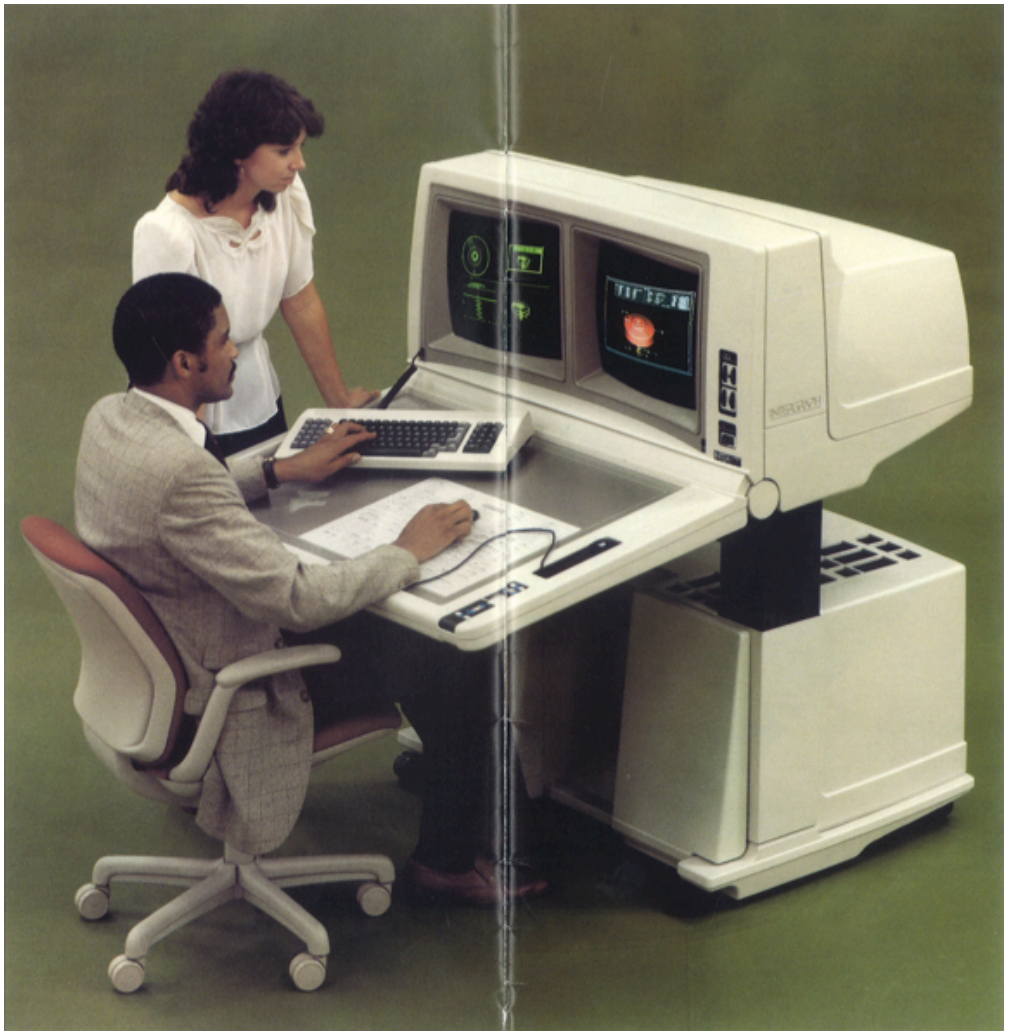
CAD USA 1982

Bechtel was an early user of advanced 3D Cad systems for their plant system



CAD USA 1982

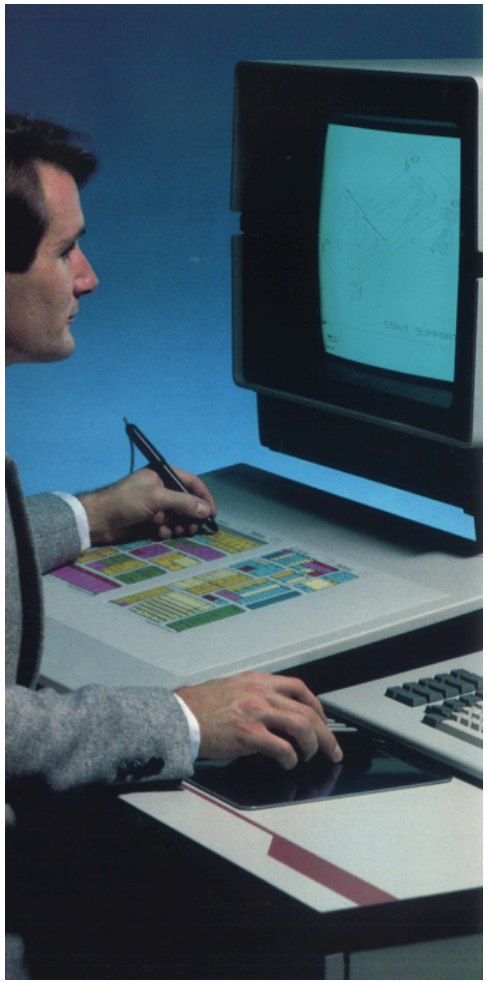
"Intergraph Corporation manufactures interactive computer graphics systems to meet the needs of a broad spectrum of engineering and mapping applications. Since its founding in Huntsville, Alabama, in 1969, Intergraph has has proress rapidly to become one ogf he leading suppliers of turnkey systems"



The MEDUSA system

Cambridge Interactive System (CIS) 1977-1980. Partner with Prime Computer, USA, 1980. Computervision bought CIS in 1983. Two versions after that (1) CIS MEDUSA on Prime and Vax computers) and (2) Prime Medusa (on Prime computers).

See also http://en.wikipedia.org/wiki/MEDUSA



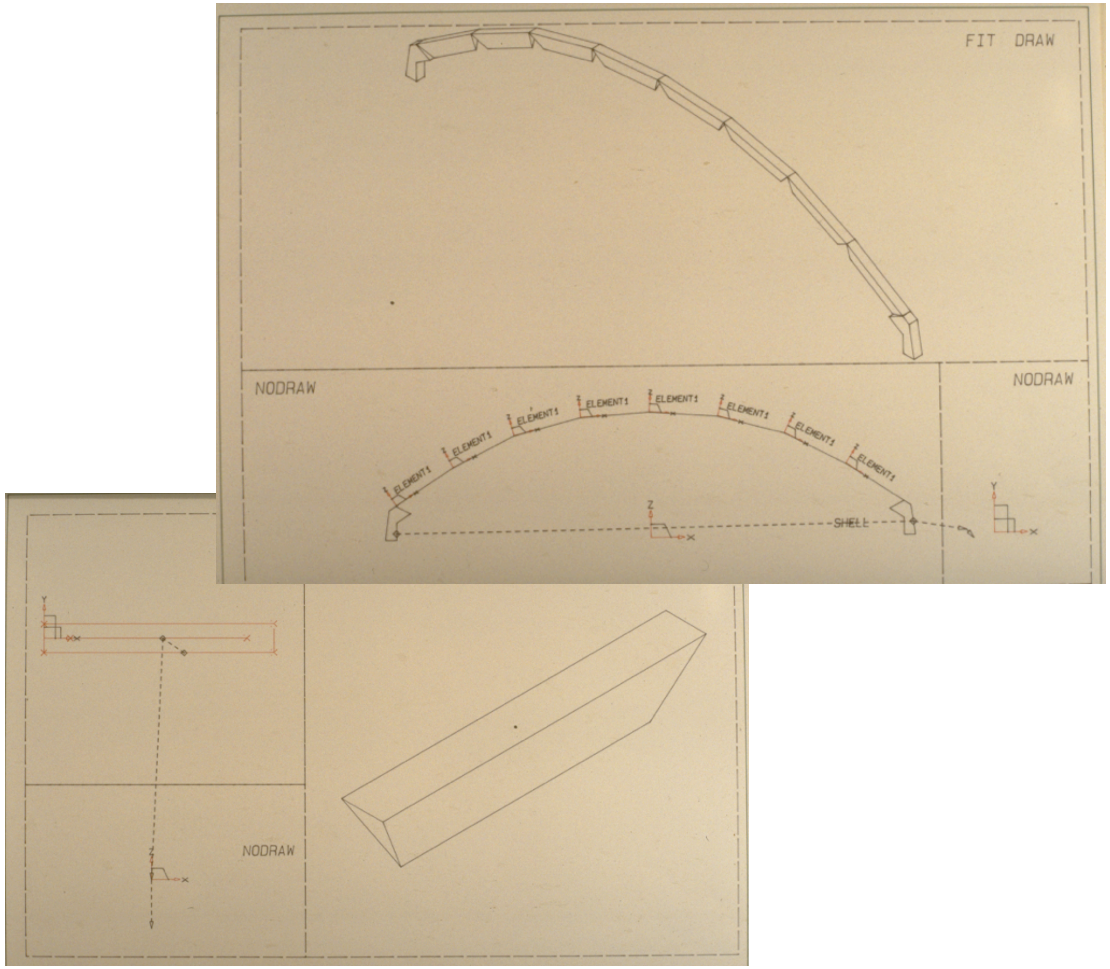
Så här arbetar du med MEDUSA:

När vi har utformat arbetsplatsen har vi tagit stor hänsyn till såväl ergonomiska frågor som till operatörens bekvämlighet.
MEDUSA styrs med s k menyteknik vilket erfarenhetsmässigt är det smidigaste och säkraste sättet att arbeta på. Instruktionsmenyn har en unik färgkodning som är mycket lätt att lära sig. Bildskärmen har hög upplösning vilket bidrar till tydlighet och mindre ansträngning för synen, vilket är viktigt. När vi har utvecklat Medusa har vi noga sett till att systemet inte lägger onödiga begränsningar på användarens sätt att arbeta. Kommunikationen med systemet är logiskt och enkel att förstå. Detta har också visat sig i praktiken då operatörerna redan efter några få dagars utbildning har kunnat utnyttja systemets alla möjligheter utan några som helst problem.
I utrustningen ingår en separat textskärm för hjälptexter, frågor mm. Ett separat digitaliseringsbord för ritningsinmatning kan också erhållas. Det är enkelt att hantera olika menyer liksom det är enkelt att vid behov skapa nya.

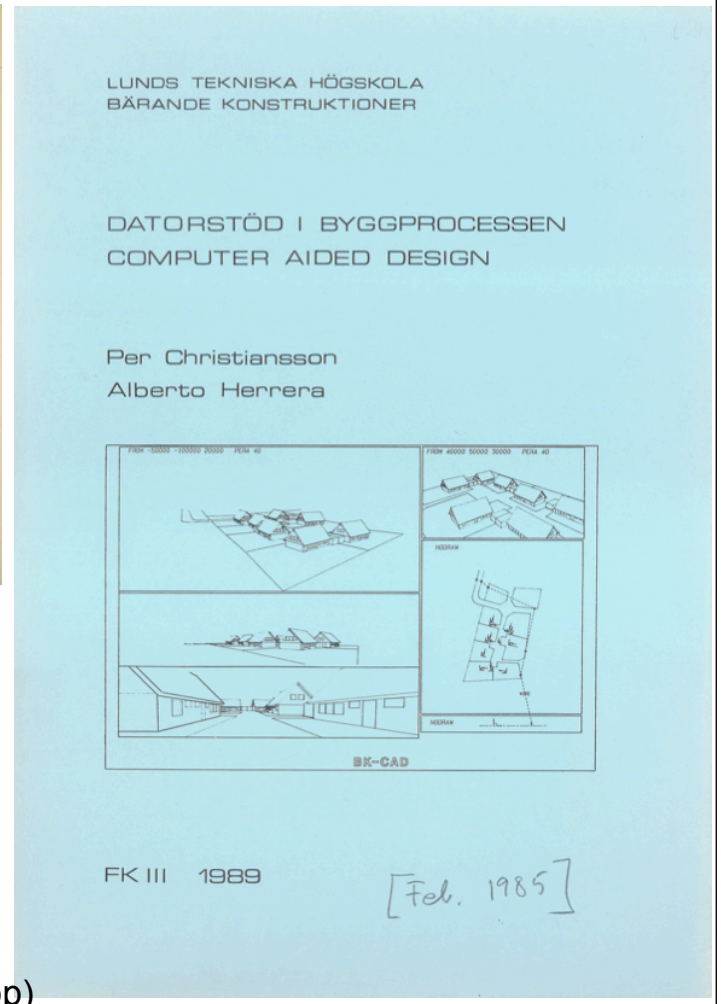
CAD Software History

Cad WS 1982. Lund University (ca 30.000 EU per/station 1982)

The MEDUSA system. Lund University 1982- 1/4



Medusa modelling techniques.


LUNDS TEKNISKA HÖGSKOLA
BÄRANDE KONSTRUKTIONER

DATORSTÖD I BYGGPROCESSEN
COMPUTER AIDED DESIGN

Per Christiansson
Alberto Herrera

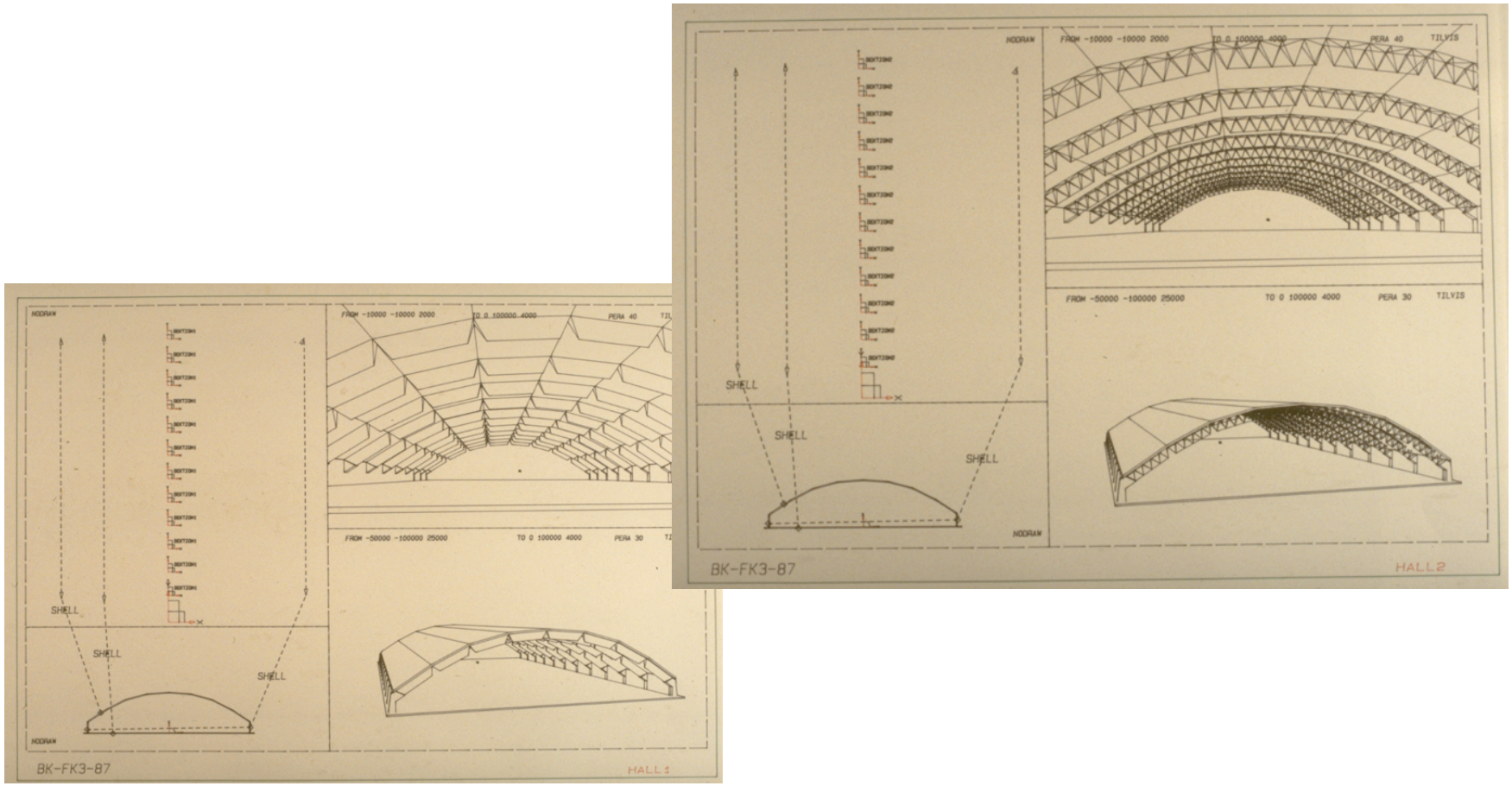
BK-CAD

FK III 1989

[Feb. 1985]

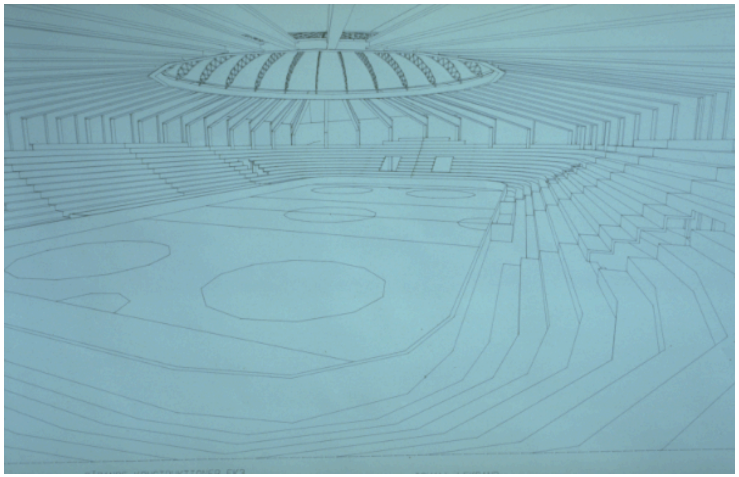
See also (190 pp)

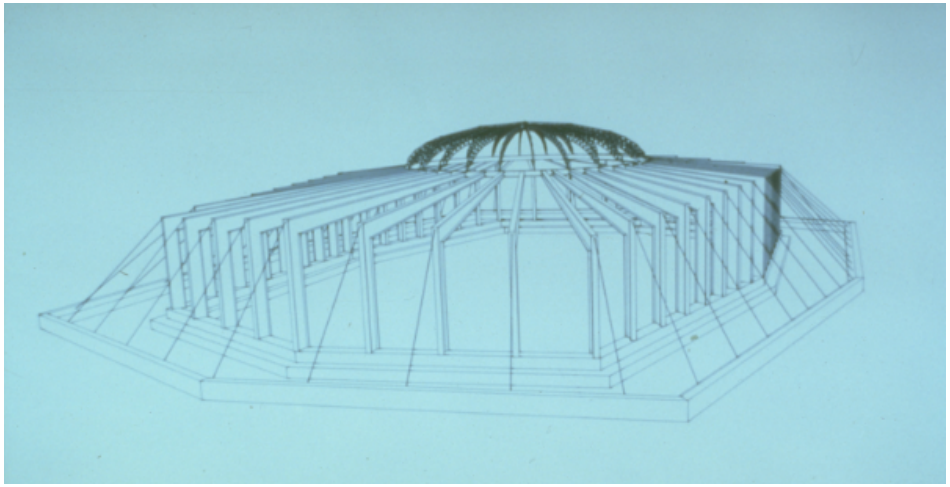
The MEDUSA system. Lund University 1982- 2/4

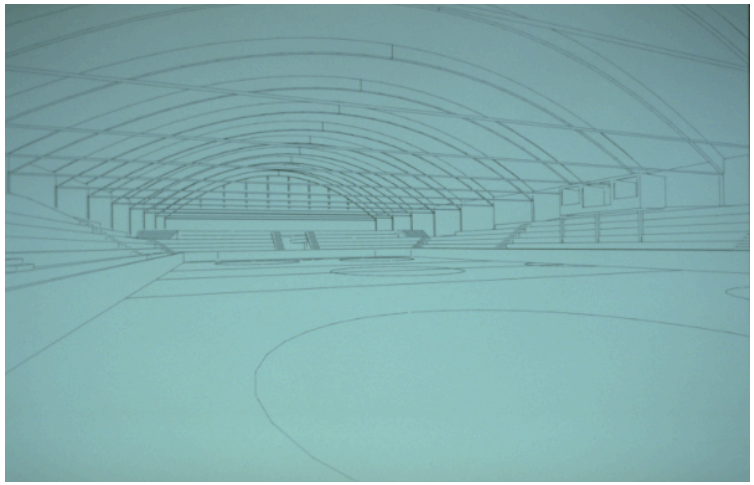


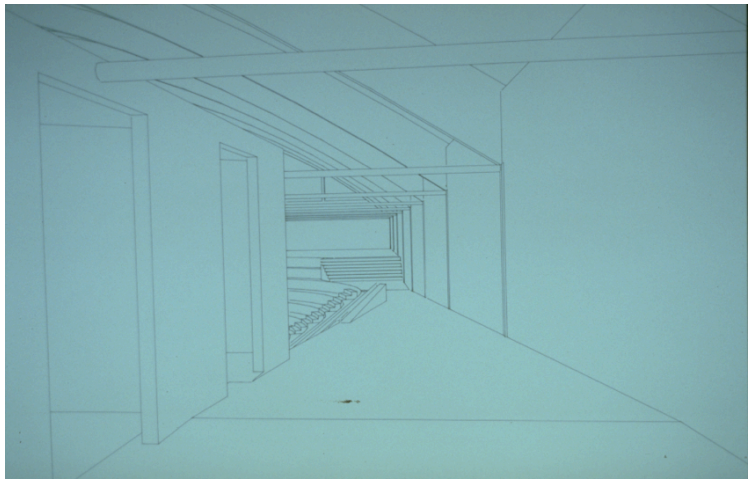
Medusa modelling techniques.

The MEDUSA system. Lund University 1982- 3/4



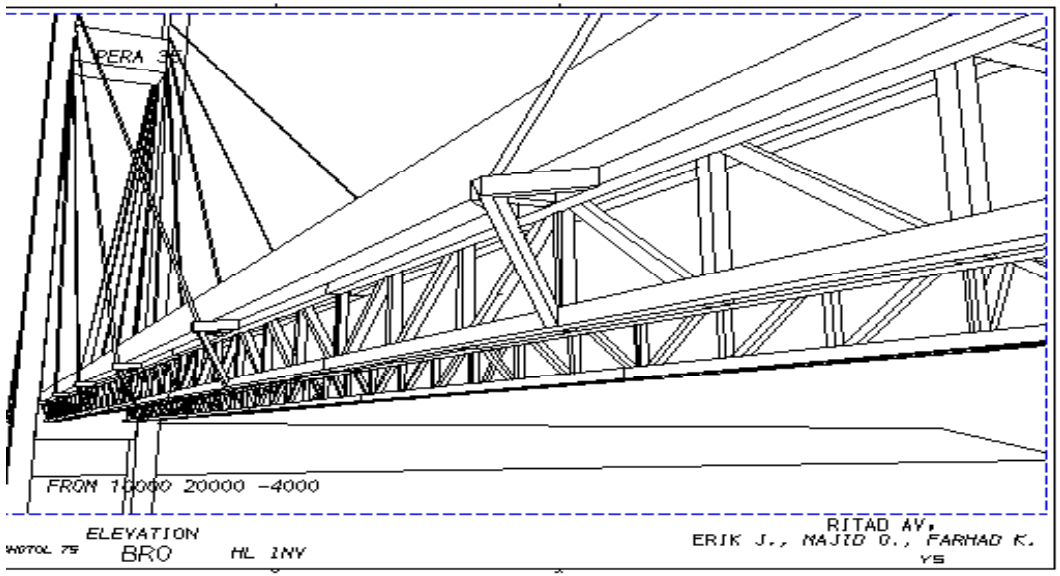






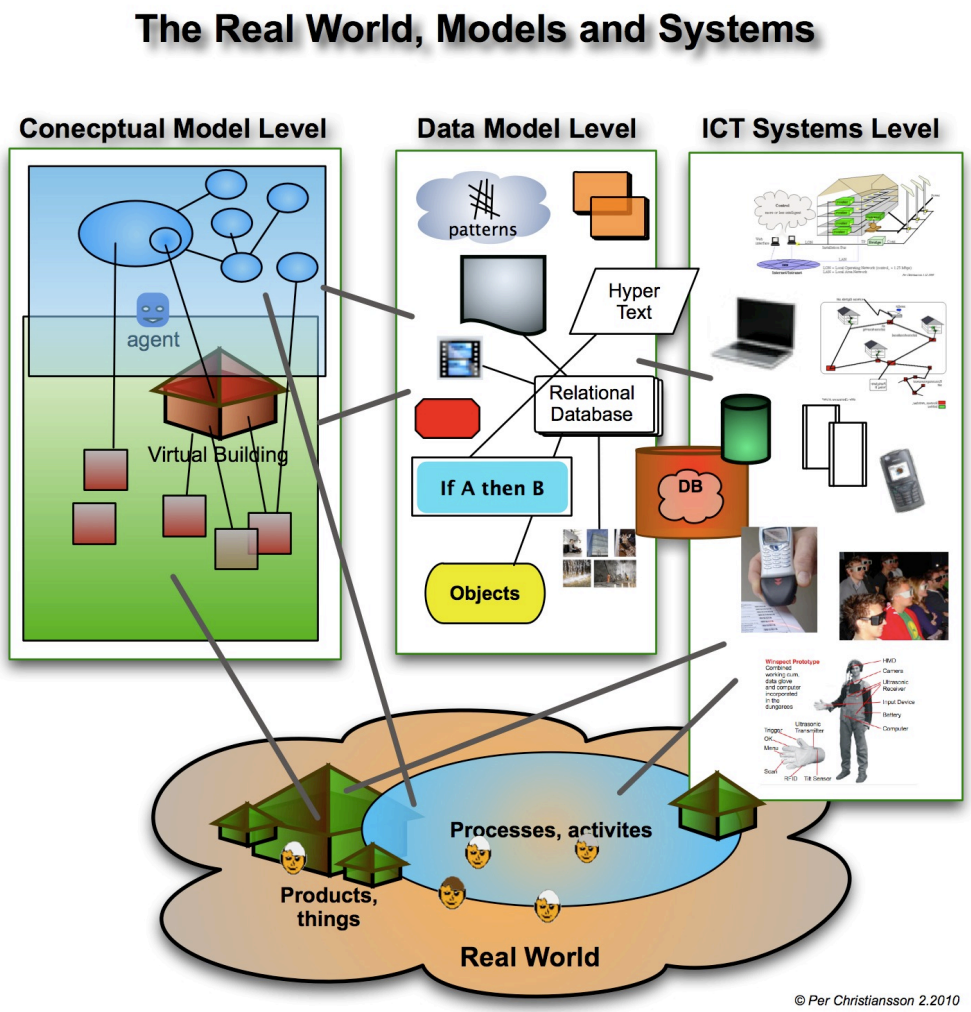
Student works 1986 KBS-Media Lab, Lund University

The MEDUSA system. Lund University 1982- 4/4



Student works 1987 KBS-Media Lab, Lund University

Models of the Real World



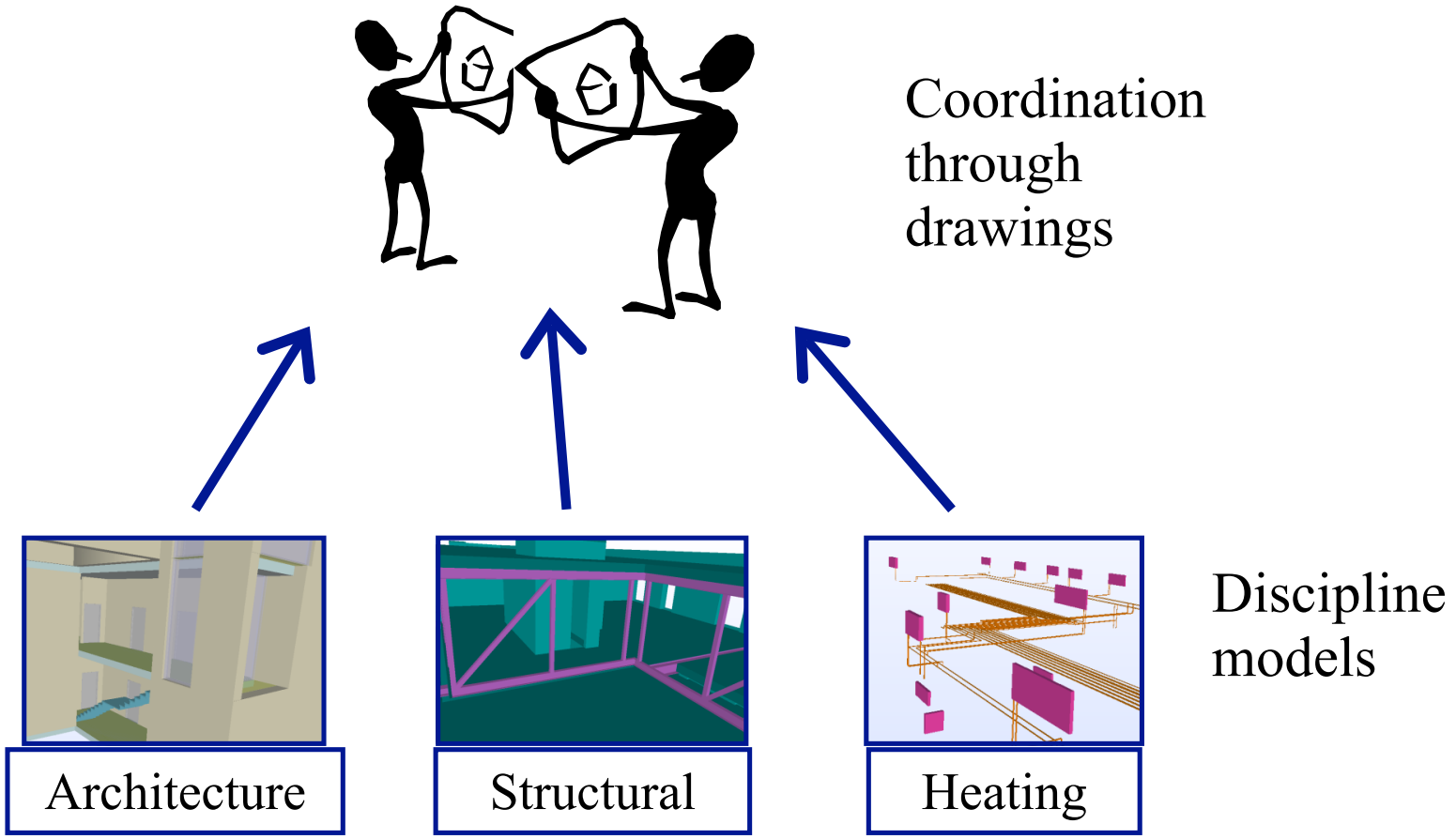
The HOLISTIC view

The holistic view.We use different kinds of *ICT support* in the building process and the built environment.

The ICT systems support different functionalities in the building process and built environment.

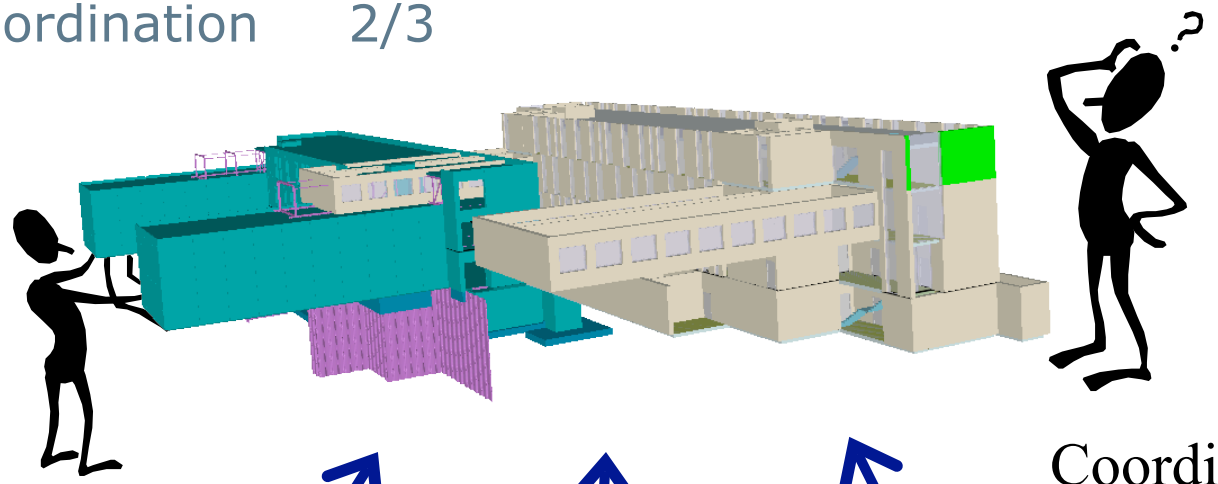
POTENTIALS

Model coordination 1/3

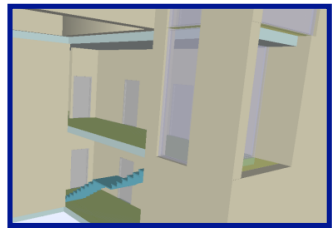


From project: Jørgensen, K. A., Skauge J., Christiansson P., Svidt K., Sørensen K. B., Mitchell J. (2008) "Use of IFC Model Servers. Modelling Collaboration Possibilities in Practice". Aalborg University, Aarhus School of Architecture, and University of New South Wales. May 2008. (60 pp.)

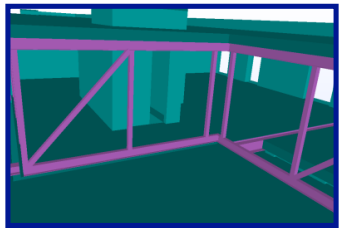
Model coordination 2/3



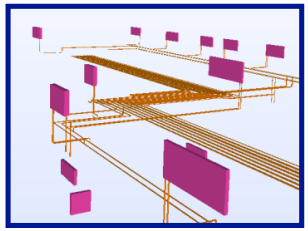
Coordination through aggregate models



Architecture



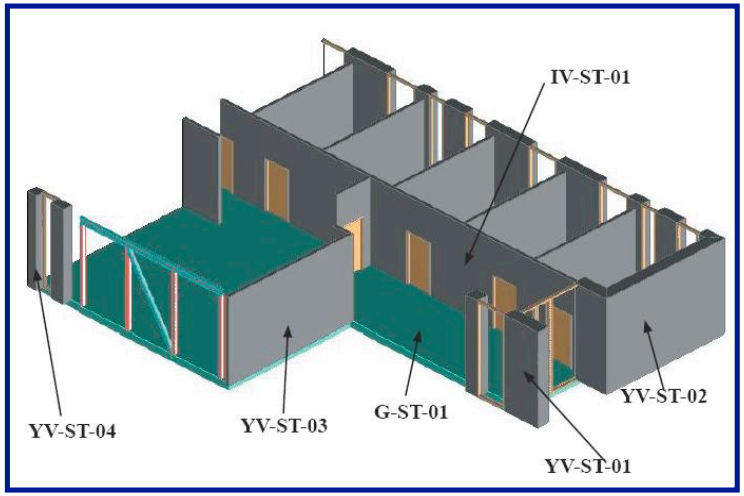
Structural



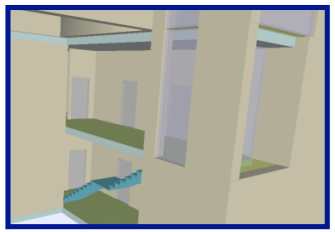
Heating

Discipline models

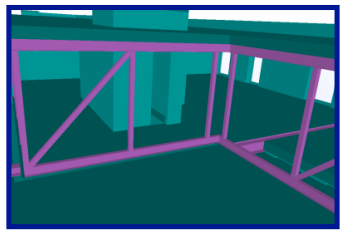
Model coordination 3/3



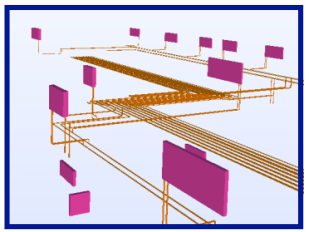
Shared model on model server



Architecture



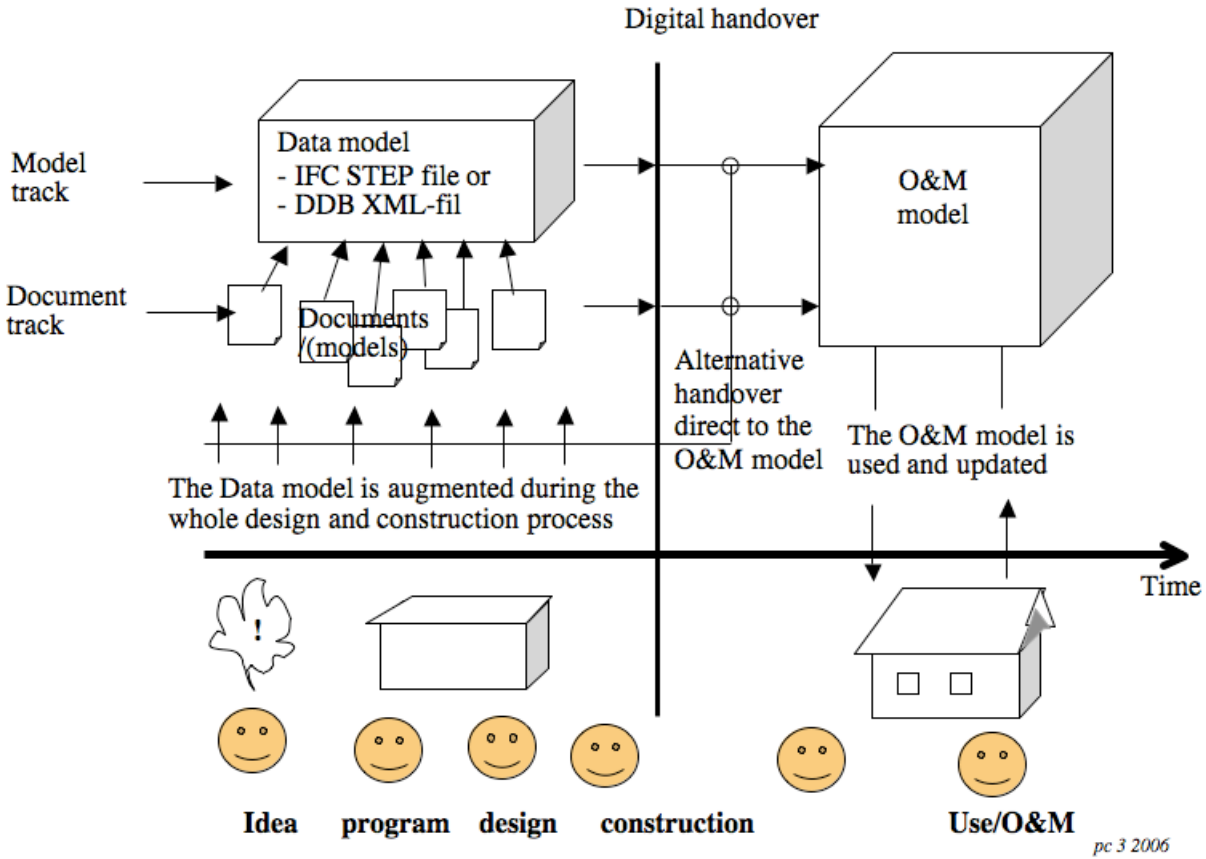
Structural



Heating

Discipline models

Virtual Building/BIM model delivery to client



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)

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 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.

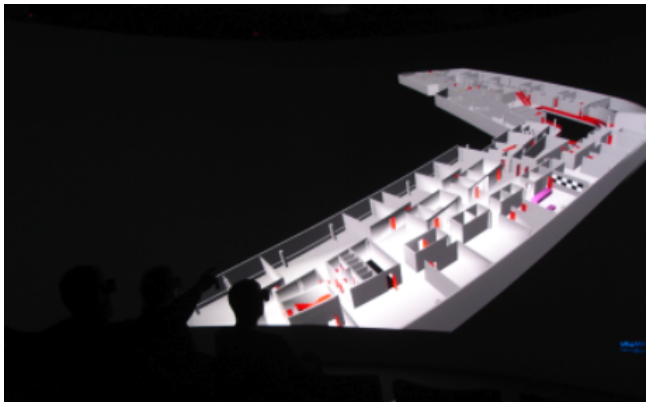
Advanced ICT tools enhance our possibilities for effective, efficient and user-friendly collaboration in both physical and virtual environments.

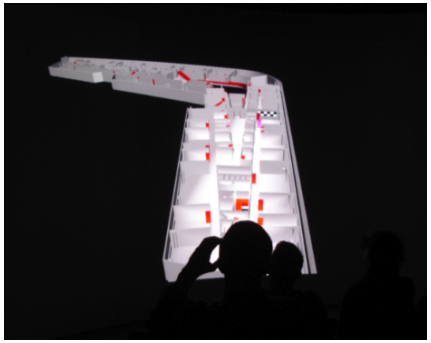
End-user become a prosumer, producer and consumer.

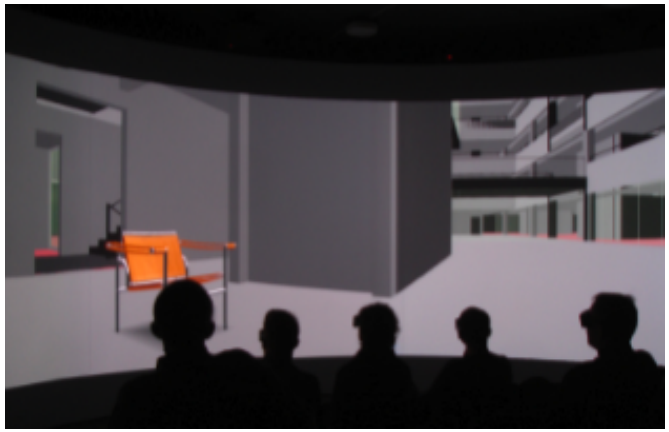
The VIC Method (Virtual Innovation in Construction)

The Arkitema and Rambøll headquarters VIC cases

Design Assessment (from the VIC project)







Aktiviteter i Panorama og CAVE

Design Assessment (from the VIC project)


Taking notes


2 more workplaces


from opposite direction

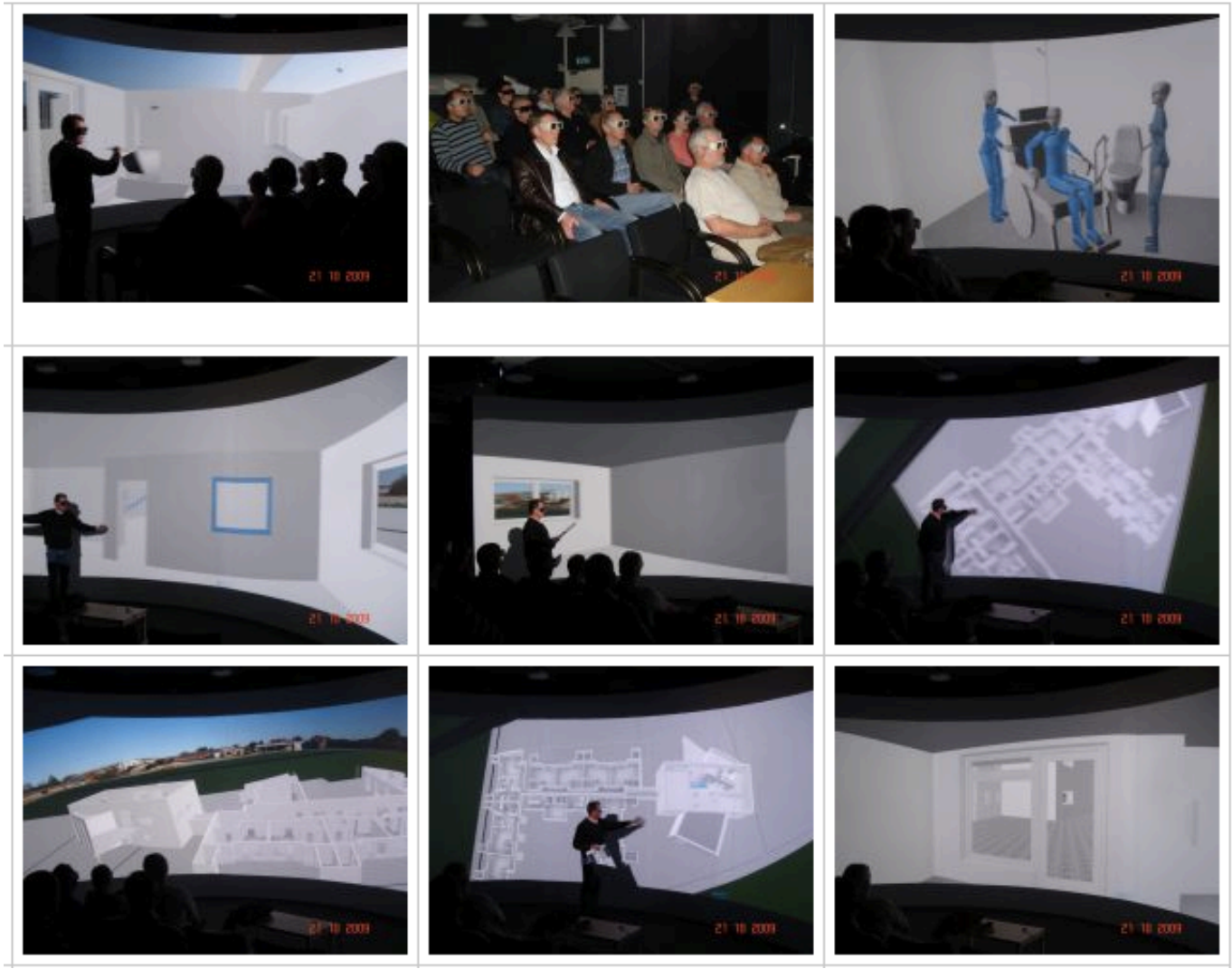

in the CAVE


In the Cave


atrium view

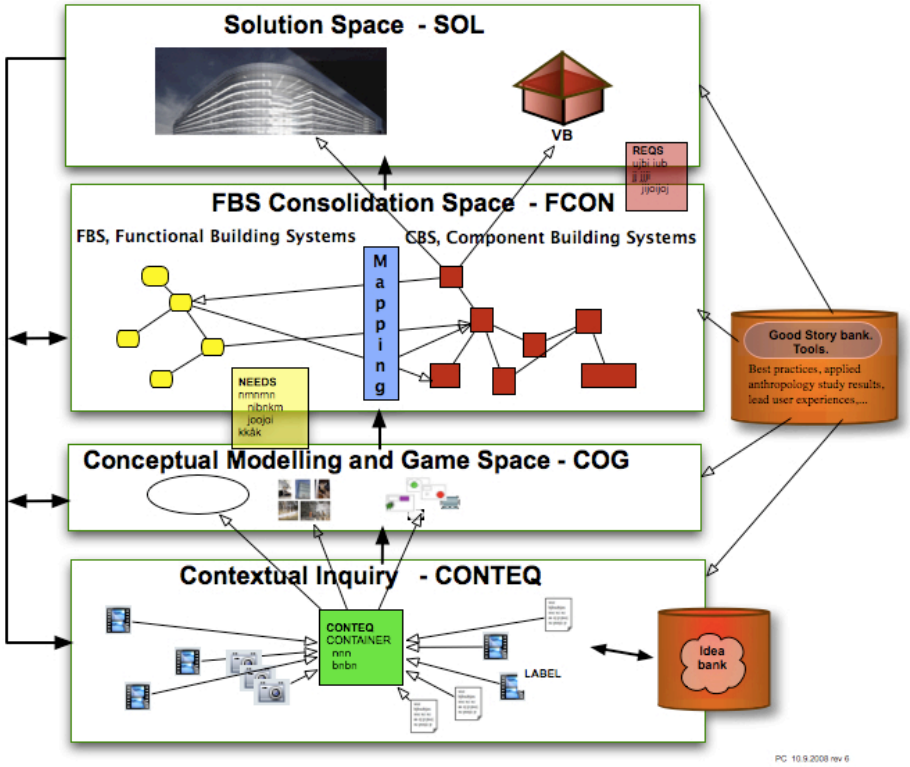
Arkitema assesing design alternatives in office design. The Virtual Innovation in Construction project. See also (Christiansson et.al., 2009)

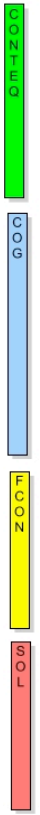
Design Assessment (from the VIC project)

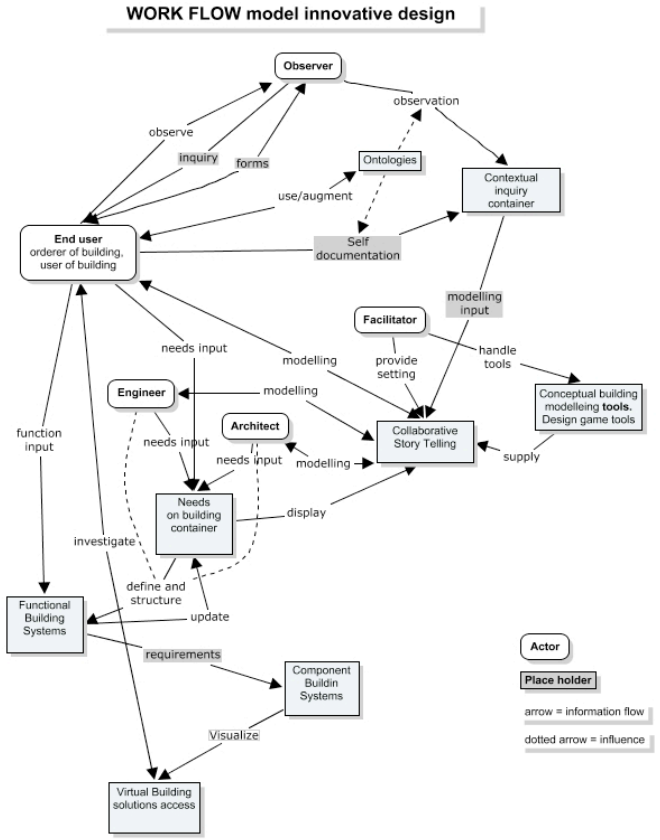


Clients and end-user groups assesing the overall design of Fredrikshavn Senhjerneskadecenter. From the Virtual Innovation in Construction project, VIC. See also (Christiansson et.al., 2009)

The VIC Method

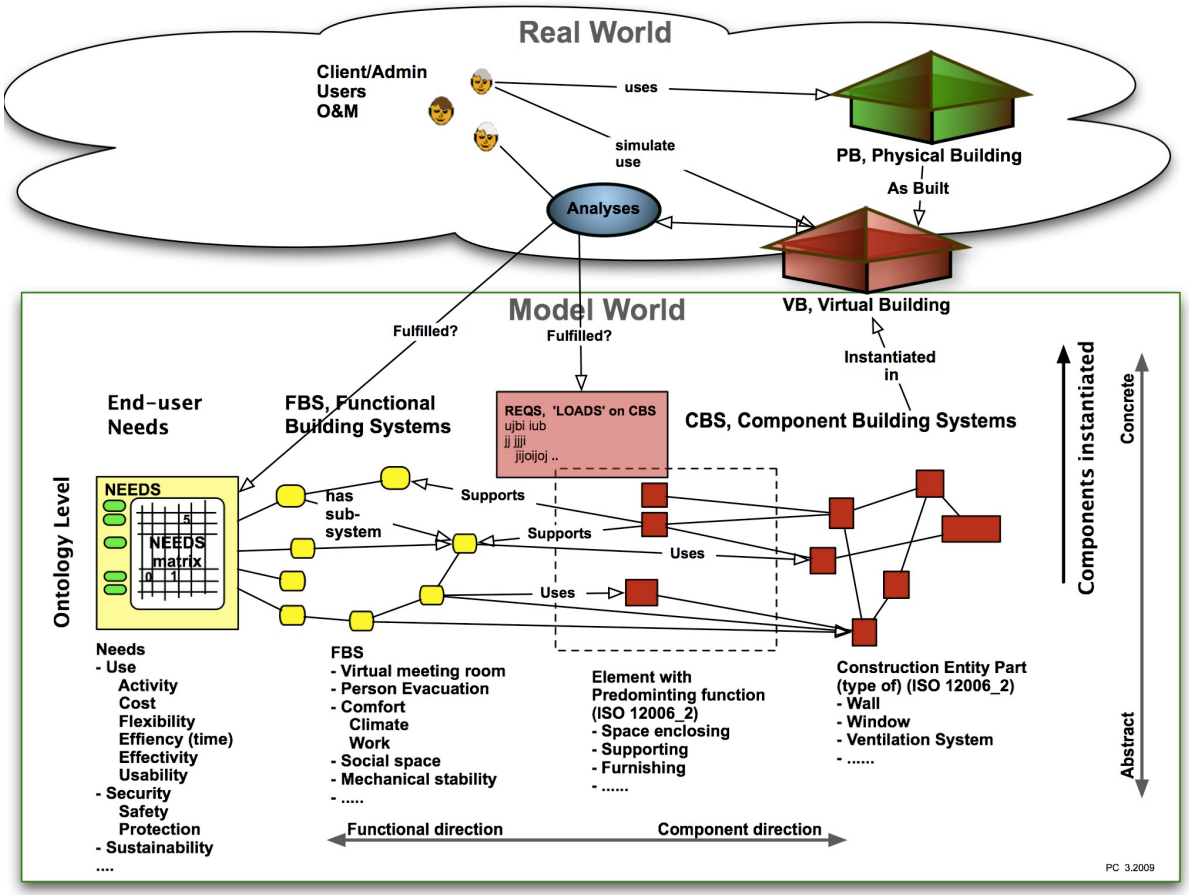






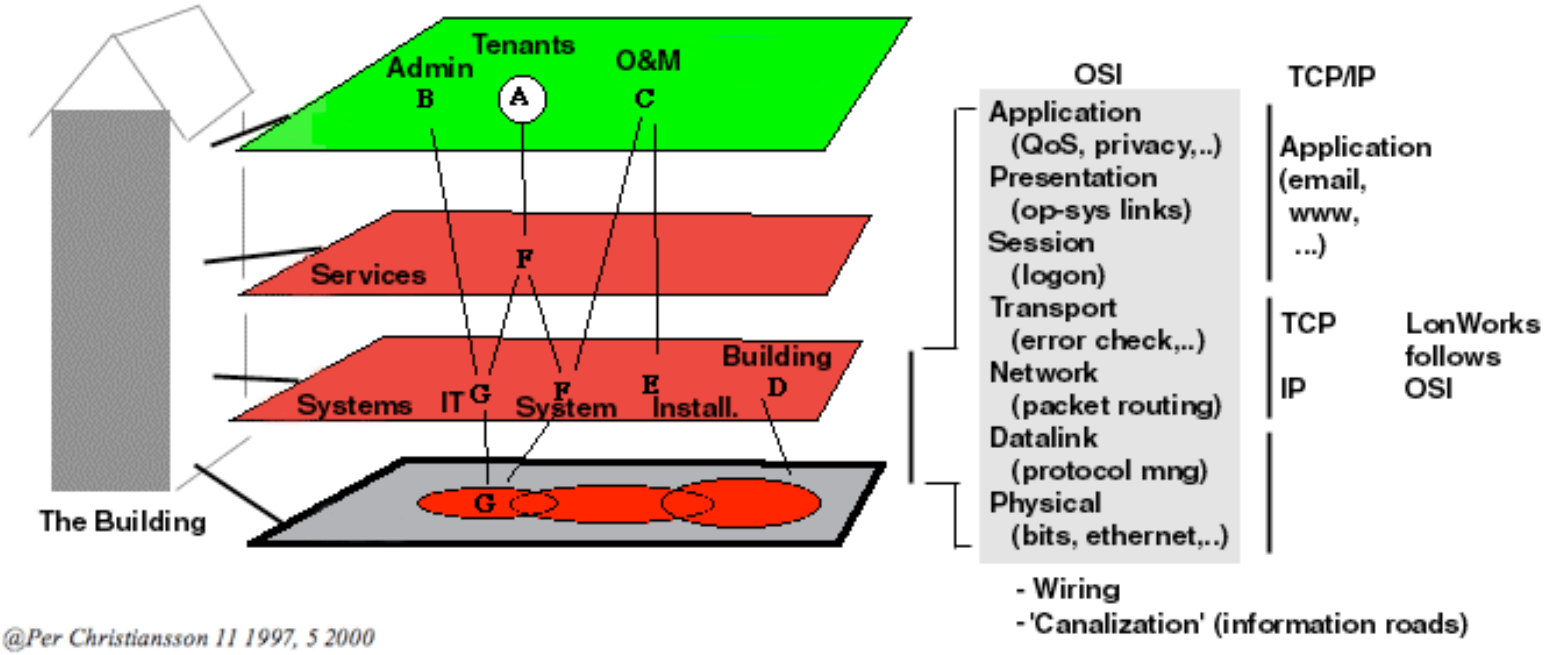
VIC-MET supports innovative and creative design with end user participation. (Christiansson et.al., 2009)

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)

Intelligent Building Layers



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.

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

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.

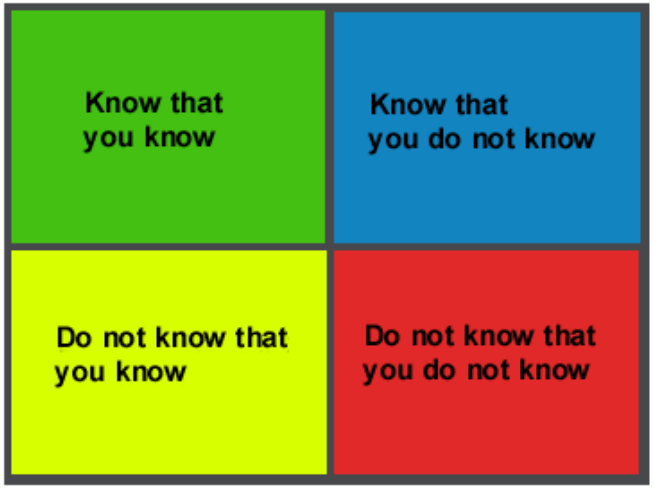
BARRIERS/CHALLENGES

Some Challenges or Barriers

- Knowledge is the main success factor
- Organizational changes
- Political understanding
- Meta ontology development (global level)
- End user driven system development

Knowledge. The Critical Success factor.

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



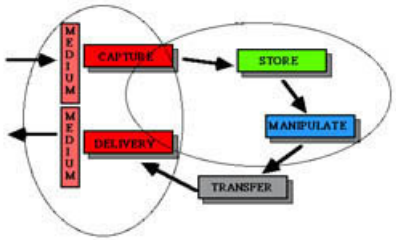
Building Informatics, AAU, teaching domains

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

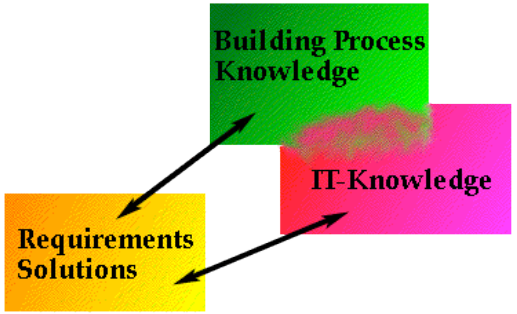
Virtual Buildings (VB)
- CAD
- Product and process models and modelling
- Classification
- Conceptual modelling
- 3D geometric modelling

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.



Organizational Changes

- Do the mistakes *early* in the building project on the virtual building (an old dream)
- Higher moral and *professionalism* (split profit and loss)
- Recreate the old pre-renaissance *Master Builder* (competences integration)

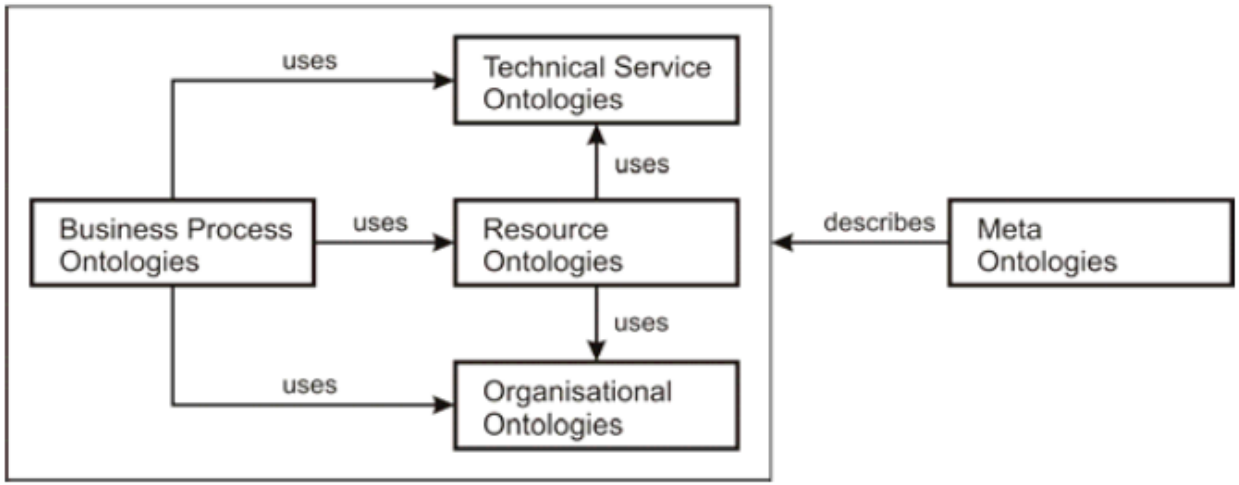
Sustainable build environment

We have talked about sustainable buildings and environment for a while (+ 20 years).

What can that be? How can it be achieved?

- NOT things that are designed to break after 10 year
- *Dismiss* late industry era leadership mantra - *produce more with lower quality* to maintain wheels rolling e.g. more water in soap, less in the same package, and no or little knowledge about what you are producing
- Replace *amateur leadership* with people knowledgeable about the 'business' they are kept to be responsible for.
- Economists and jurists shall have *advisory* roles (not leaderships)
- *Learning*, learning learning (both practical and theoretical)
- Creating societies where peoples job *profiles* match their competence/intelligence profile (people are different)

ONTOLOGIES (VIC-MET example)



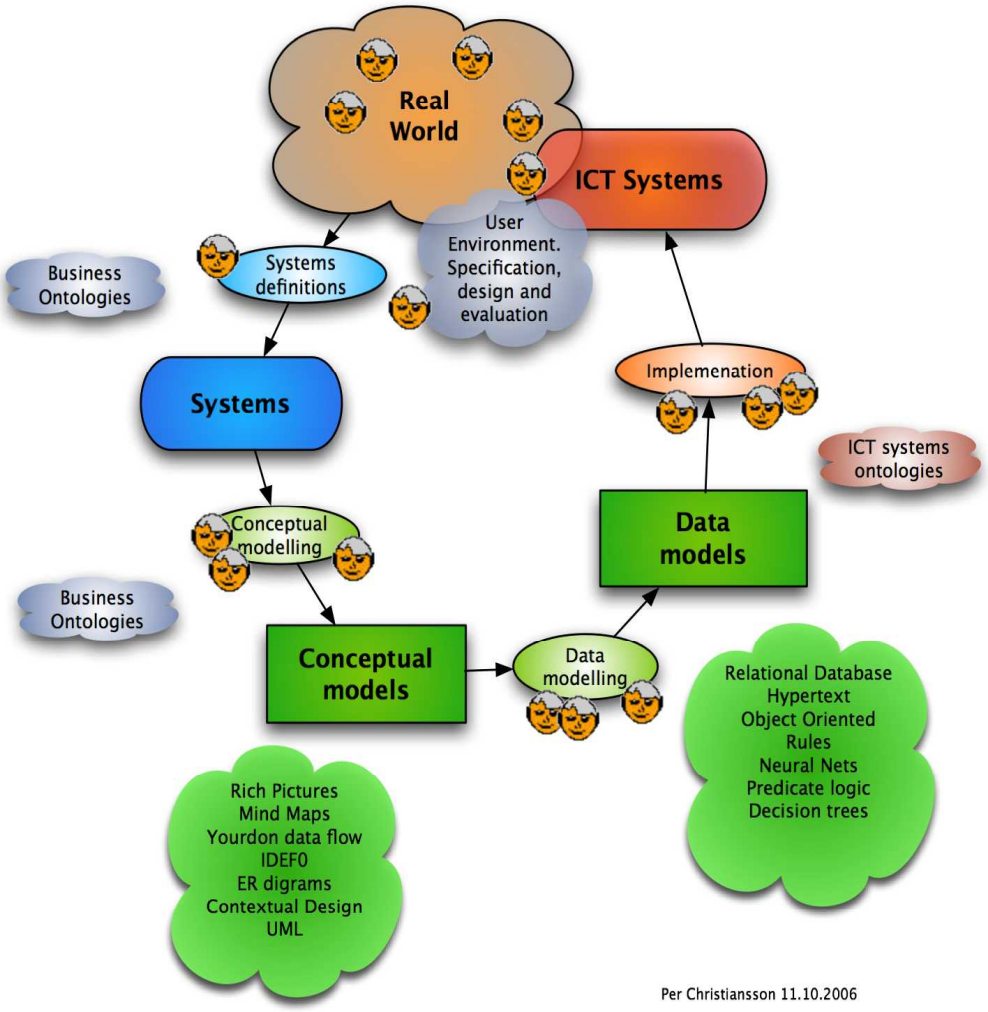
Business process ontologies (end-user needs, Functional Building Systems [FBS],…..)

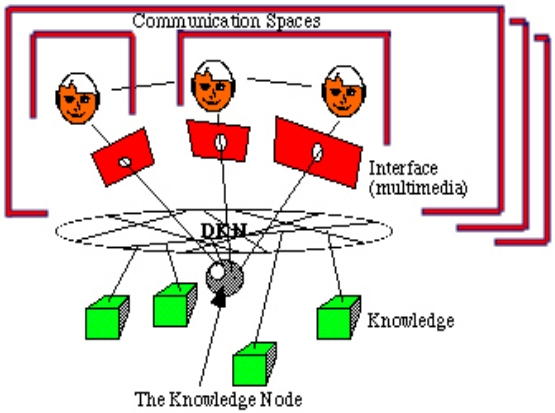
Organizational ontologies (actor roles, company organizations and interrelations, design paradigms, building project organization….)

Resource Onotologies (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).

System Development





- **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

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