Building Service Engineering I.

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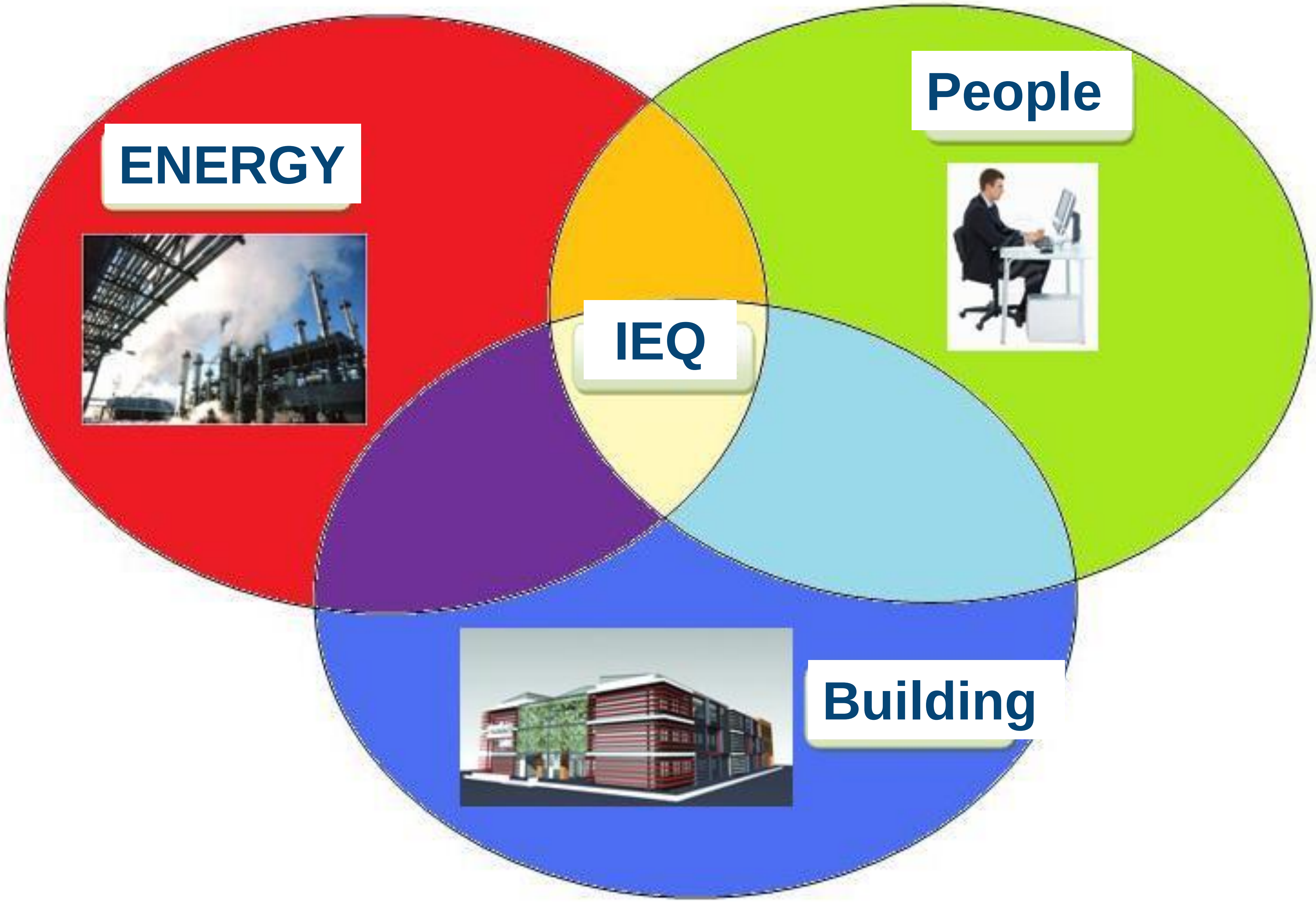
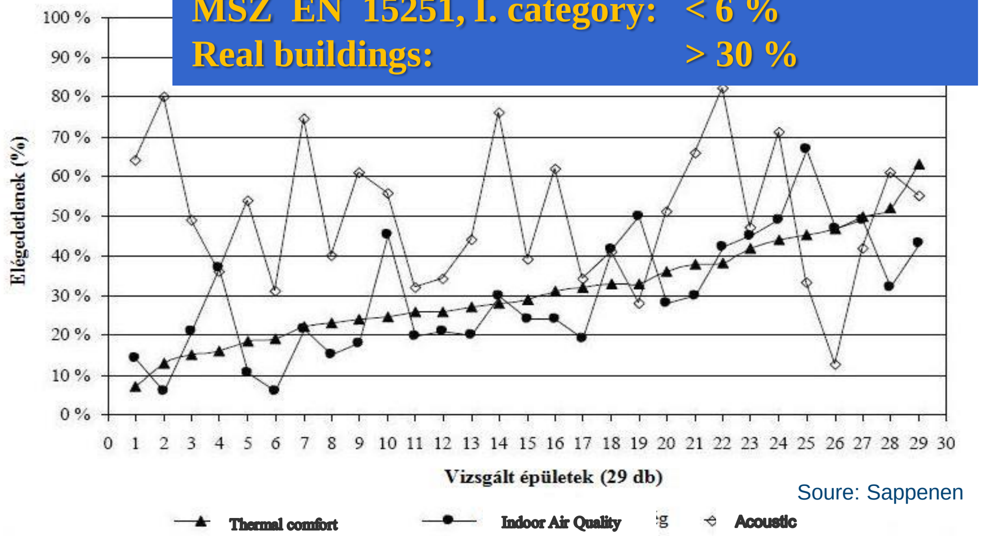

ENERGY
People
IEQ
Building

COMFORT

MSZ EN 15251, I. category: < 6 %
Real buildings: > 30 %



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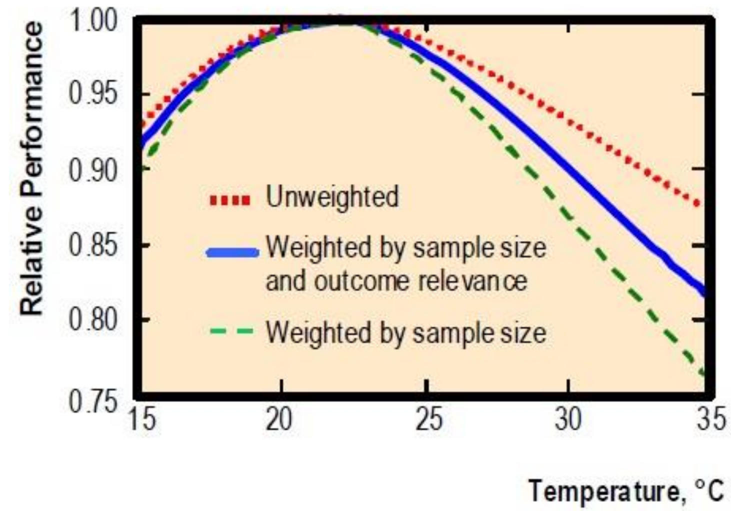
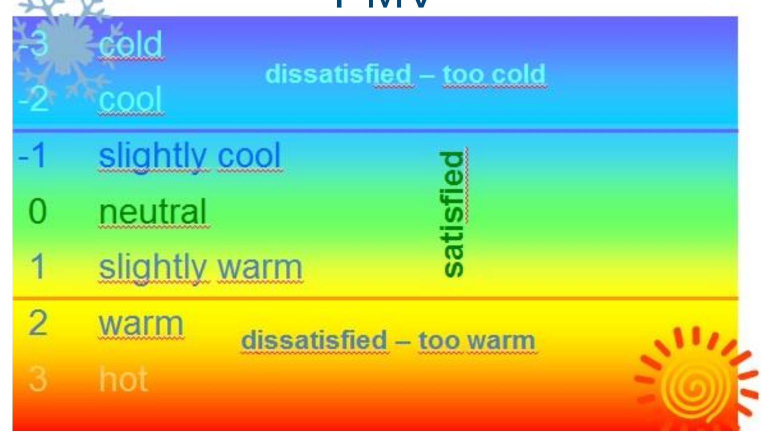


PMV



News
European Parliament

Cleaner energy: new binding targets for energy efficiency and use of renewables

Press Releases 28-11-2017 - 13:24

- EU energy consumption to be reduced by 40% by 2030
- At least 35% of all EU energy has to come from renewables by 2030
- Support for consumers who use self-produced energy

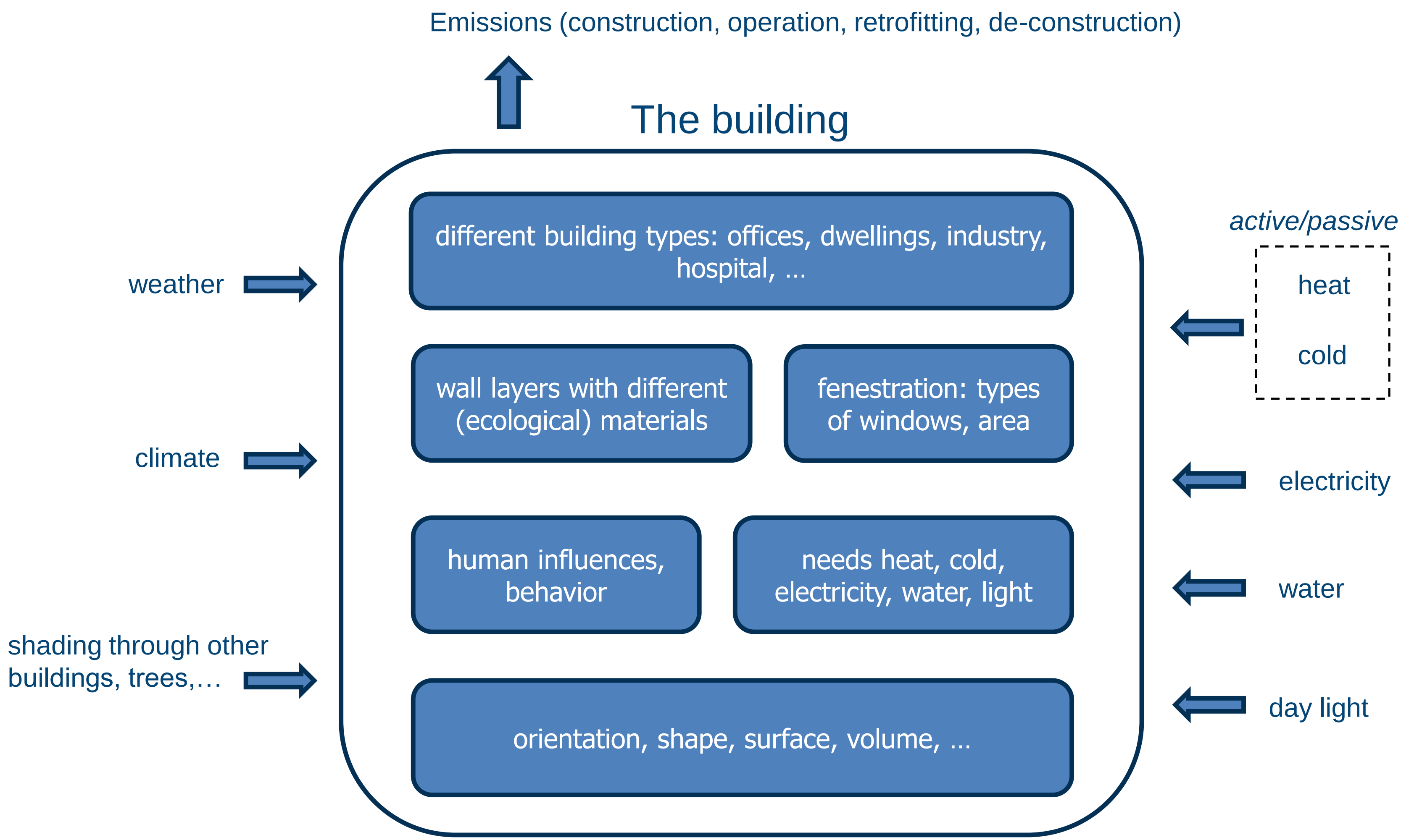
Better indoor climate – less energy

Content

Integrated Design Approach

- IEA Task 23
- ZERO-PLUS Project
- Exemple in Hungary – Palace of Art, Budapest

Integrated Design Approach (IDA), why?



complex interrelations

Integrated Design Approach (IDA), why?

IDES-EDU

- **Complex interrelations** between the environment, the building, technologies and the occupants
- But different disciplines working together (client, architect, different engineers, plumbers, …)
- the complexity and its interrelations have to be considered in order to get a holistic and optimized solution
- the understanding of this complexity and its interrelations leads to an

Integrated Design Approach

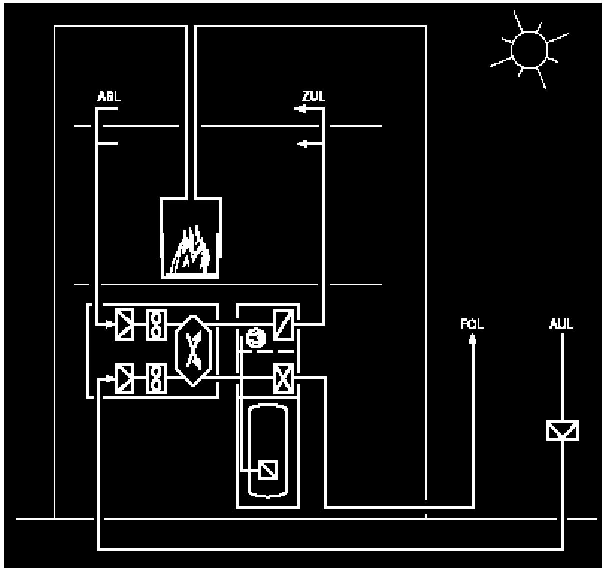
Issues during the design process

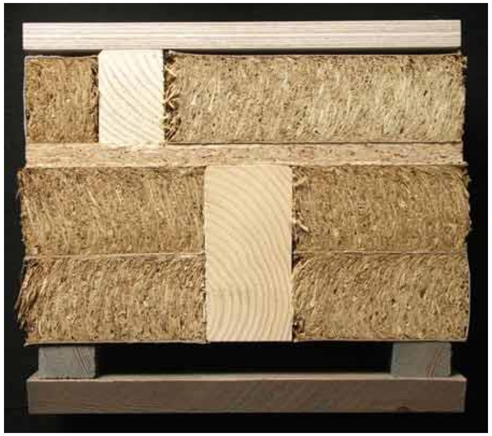
IDES-EDU

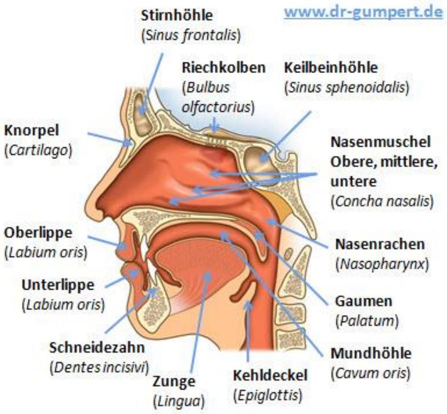
- **In order to successfully design high performance buildings the following issues have to be considered:**
  - constructive co-operation with client, designers, operators, users, contractors, authorities, … (cross-disciplinary teamwork)
  - consideration of all structural and technical concepts and systems in a holistic way
  - consideration of the impacts of the building project to the local/regional environment and the neighborhood
  - consideration of the life-cycle costs of the building and its technical systems (production, application, maintenance, waste disposal)
  - coordination of an optimized use of renewable energies in combination with the building technologies optimized towards maximum performance

(Löhnert et al., 2003)

The many faces of integrated design...

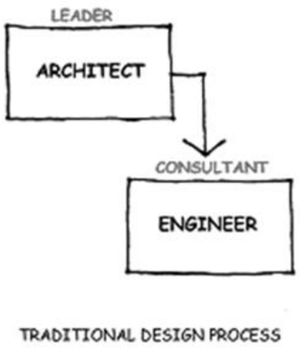






Traditional vs. Integrated Design Process

IDES-EDU



(Trebilcock 2009)

- **Traditional design**
  - a linear process
  - architect and client agree on a design concept (orientation, fenestration, general appearance, basic materials)
  - then mechanical and electrical engineers are asked to implement the design and suggest appropriate systems
- **Possible results of the traditional design:**
  - unused potential of solar gains, resulting in **higher heating demands**
  - exposure of glazing to summer sun, resulting in **higher cooling demands**
  - **unused potential of daylighting**, due to a lack of appropriately located/dimensioned glazing, or to lack of features to channel daylight further into the interior of the building
  - Exposure of occupants to **discomfort**, due to local overheating in spaces facing west or glare in areas lacking adequate shading
  - Dedicated engineers may suggest advanced heating, cooling and lighting systems, resulting in only marginal performances increases but **higher investment costs**

(Löhnert et al., 2003)

Traditional vs. Integrated Design Process

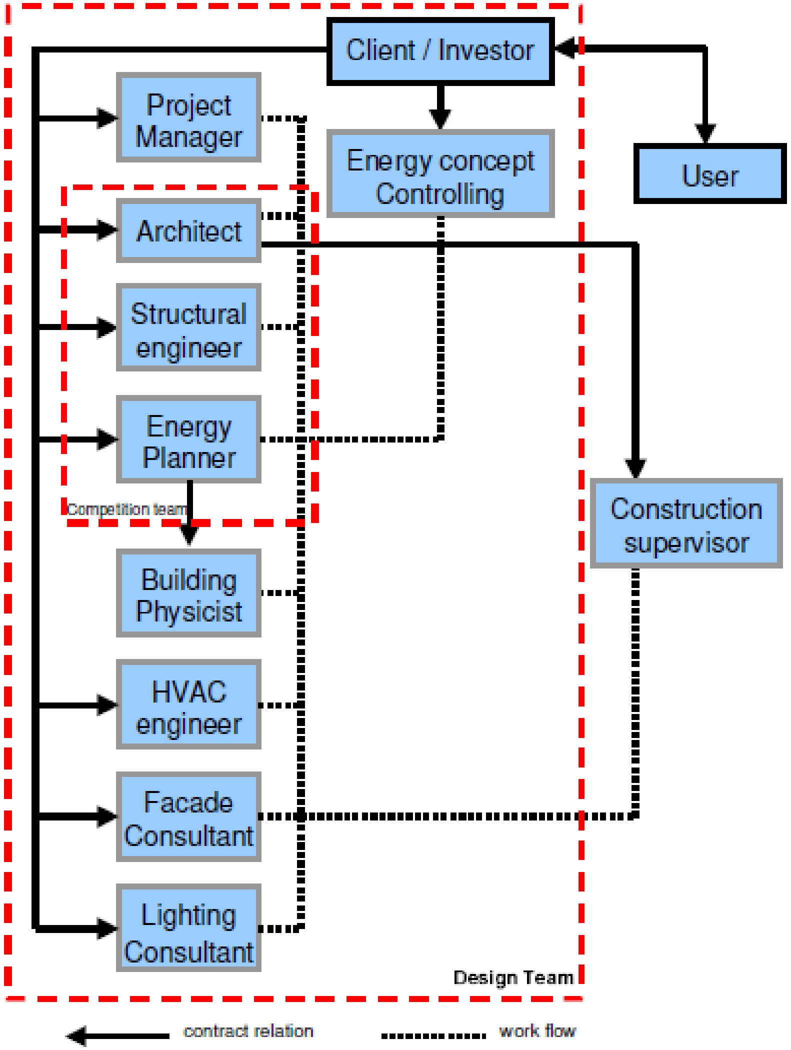
IDES-EDU

- **Integrated Design**
  - an iterative process
  - considers and optimizes the building as an entire systems including its technical equipment and surroundings for the whole life cycle
  - all actors of the project cooperate across disciplines and agree on far-reaching and crucial decisions jointly form the beginning
  - the design concept is subject to iterations early in the process, which is done by a coordinated team of specialists
  - all participants contribute their ideas and knowledge very early and collectively
  - concepts are worked out together for all design issues for the early design phases
  - the concepts of energy and building equipment are not designed complementary to the architectural design but as integral part of the building very early

(Löhnert et al., 2003)

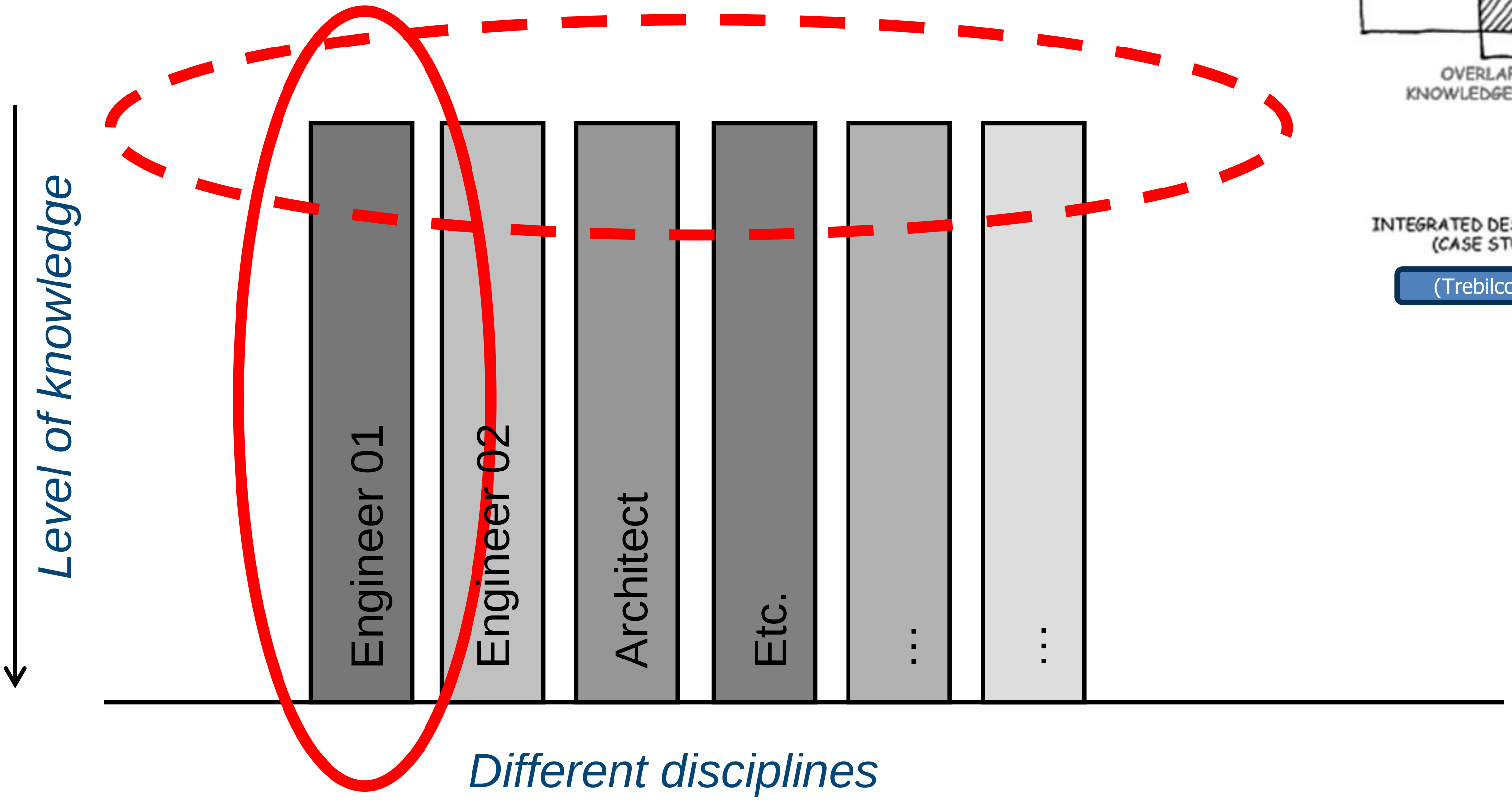
The design team – a possible constellation

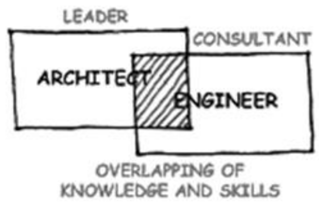
IDES-EDU



(Poel. B. et al. 2002)

The transfer to education – IDES-EDU





INTEGRATED DESIGN PROCESS
(CASE STUDIES)

(Trebilcock 2009)

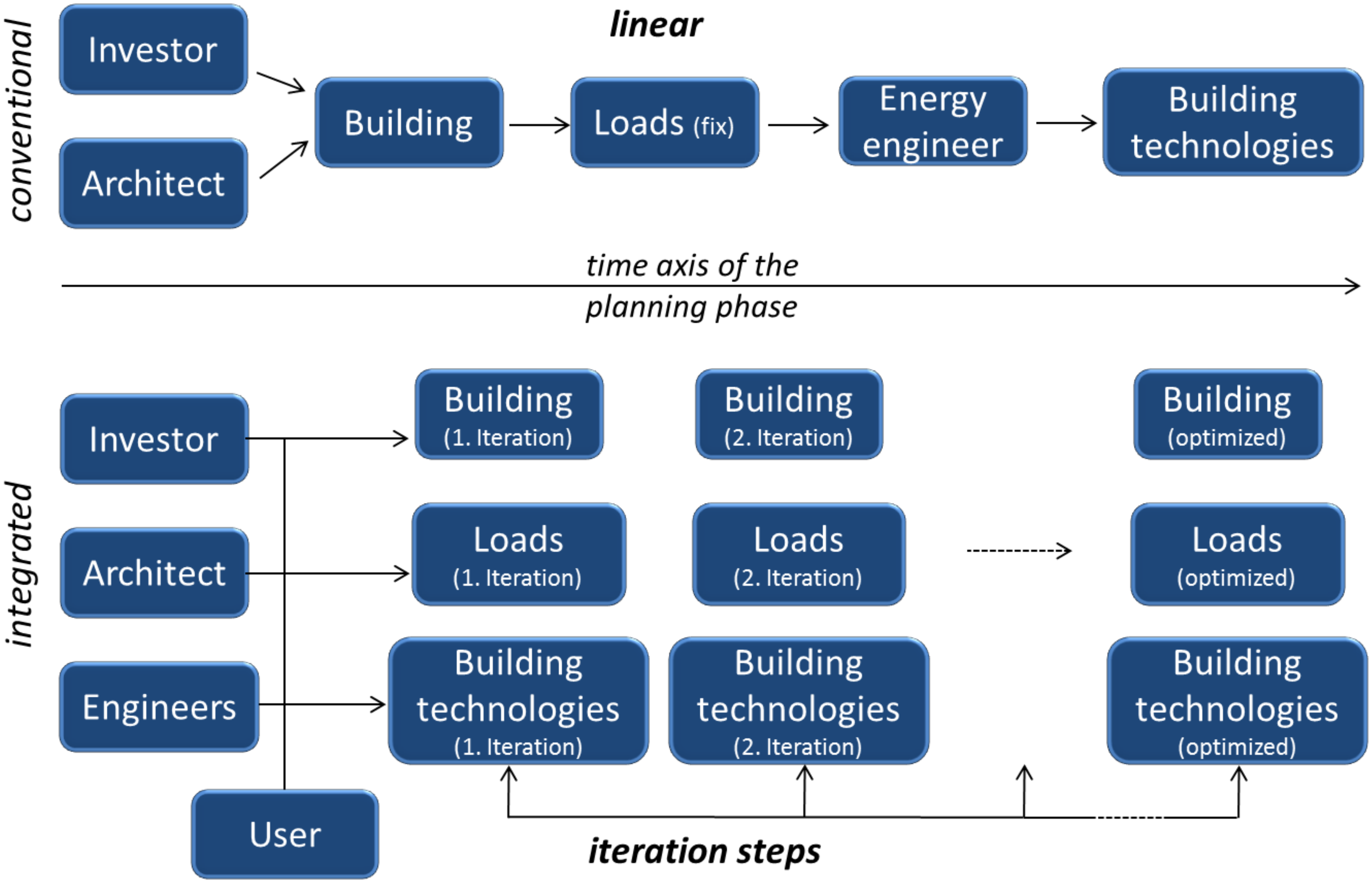
The engineer vs . architect

- **The engineer**
  - understands the process as a series of work steps leading form interim results to overall results
  - the entire problem is dissembled into clear partial problems for which partial solutions can be found, which can be merged into a final solution
  - the need for simultaneous alternatives is often neglected
- **The architect**
  - understands the work process as a series of circular movements
  - these circular movements will take the architect from a preliminary idea through analysis of related impacts and their iterative consideration of the given circumstances
  - Within the circle of hypothesis and analysis the solution and the problem will be investigated simultaneously

The consideration on different approaches of designers and engineers is to improve the mutual understanding and communication!

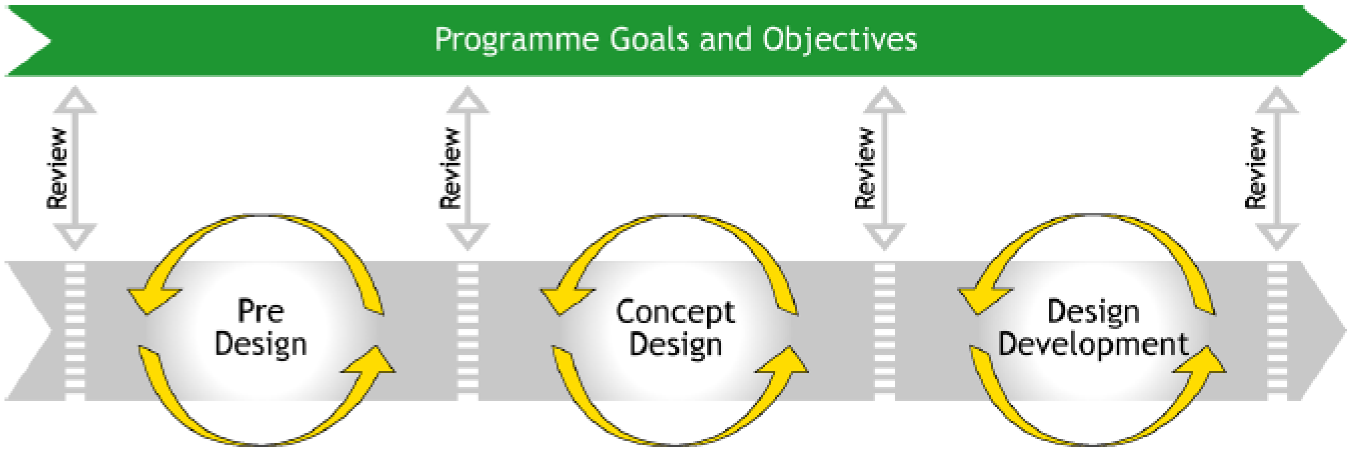
(Löhnert et al., 2003)

linear vs. iterative and integrated



Process

- **From iteration to integration**
  - design optimization means, that iterations have to take place during the various design phases including pre-design, concept design and design development
  - the interfaces between the iterative workflows, which are characterized by initial tasks, (interim or partial) results and findings, need to be organized by a qualified project management
  - clear decisions and careful process documentation are necessary in order to guarantee a smooth transition from one design phase to the other without losses of information



(Löhnert et al., 2003)

Integrated Design Process - Summary

IDES-EDU

- necessary due to complex interrelations between the environment, the building, technologies and the occupants
- all **project team** members must be willing to design high-performance, high-quality and sustainable buildings
- the integrated design process starts at the early stage of the building project with **inputs of all actors form the very beginning**
- is characterized by an **iterative and integrated process** during the various design phases
- the iterative and integrated character helps to evaluate **design alternatives** and to follow the **principle of optimization**
- cases of integrated design approaches already exist, so we can analyze them, learn from them and apply the integrated design approach for new building projects

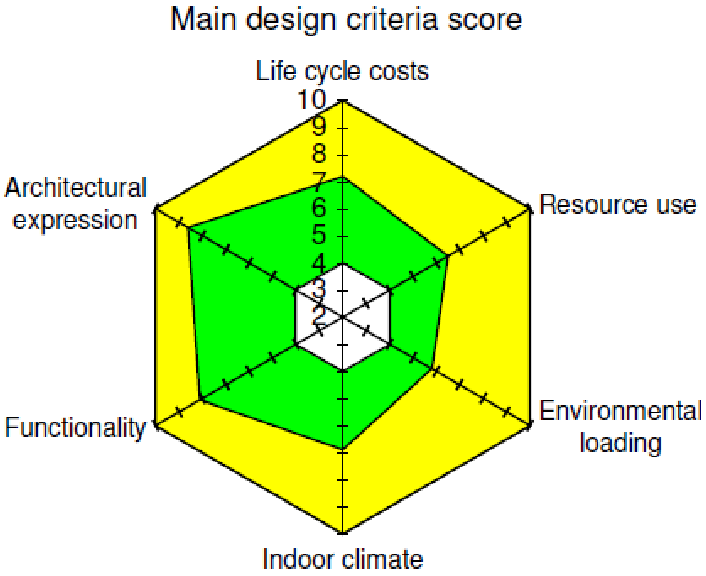
- **Design Phases**
  - Basic: In this phase the team is set-up, where competences and communication qualities are considered. It is essential that the participants are committed and interested in following the process and willing to cross the normal professional boundaries. The first analysis of site, building programme and feasibilities are discussed.
  - Pre-Design: This phase contains setting up the goal for the project. The client formulates the objectives and the design team must translate these demands into programmatic requirements, performance goals and design criteria (architectural qualities). The site and the climate are explored to find its potential. The projects budget and cost must be set and evaluated during the whole process.

IEA Task 23

- **Design Phases**
  - Concept Design: The detailed characteristics of the site are registered and in connection to that a range of designs is developed and constantly investigated and evaluated against requirements, performance goals and objectives. The evaluations should be supported by design assessments and simulations tools. Preliminary building designs are developed, where e.g. concepts of natural light, materials, ventilation and heating is approximated in relation to reliability, flexibility and costs.
  - Design Development: During this phase the final design (building proposal), its construction principal and materials, sizing of technical installations as well as strategies of solar control, day lighting etc. is found. Detailed drawings, simulations and calculations are evaluated with regard to the requirements and against benchmarks which were identified early in the project including cost demands.
  - After the Design Development phase the process continues with construction documents, contracting, building execution, supervision, hand-over etc .

IEA Task 23

- **Tools**
  - The methodology suggests using various tools to verify and refine the design both in relations to costs and building systems
  - The core team must be aware of the benefits of different tool and when to use them
  - A tool called Multi-Criteria Decision-Making (MCDM) was developed to the methodology
  - The purpose of MCDM is to help the design team understand each other and communicate and take decisions on a common basis. Thereby it can also be used as a weighting of different design proposals, because the tool give an overview of the entire project



[MCDM, IEA Task 23]

IEA Task 23

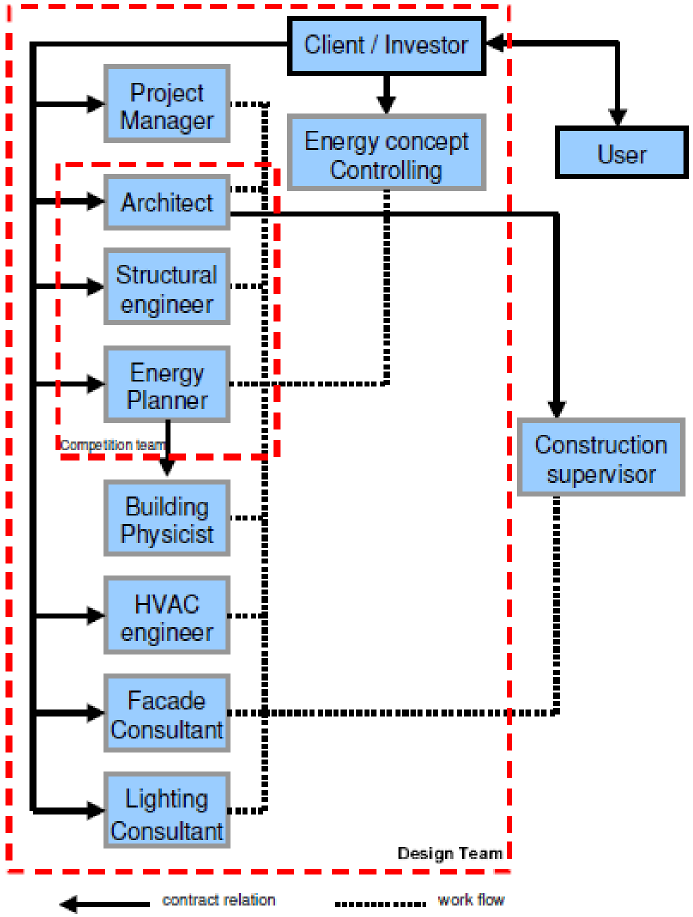
- **Example: The headquarters of Deutsche Post AG located in Bonn (2003)**
  - The city of Bonn was very interested to keep the about 3000 direct working places in the city and convinced the Deutsche Post to stay in Bonn. Therefore a high rise building with more than 40 stories was possible
  - A low energy building, which already reaches future planned low energy standards - 25% below the existing code
  - The client required a representative building with a human-determined working environment, individual control and access, operable windows in a high rise building and an energy saving of

[http://www.dp-dhl.com/en/media_relations/media_library/fotos/post_tower_2010_02.html]

[http://www.dp-dhl.com/en/media_relations/media_library/fotos/post_tower_architecture.html]

IEA Task 23

- **Example: The headquarters of Deutsche Post AG located in Bonn (2003)**
  - The IDP was already introduced in the competition
  - The IDP brought a synergy effect and resulted in a low energy and high comfort building
  - The IDP made it posible to design a building with the integration of the ventilation concept in the building form
  - The compensation of higher investments in the building facade, which are partially compensated by savings in the technical equipment could only be argued in an IDP
  - Parts of the building components were not available before this project started, but were developed and finally installed
  - The basic concept, developed in the design team (mostly in the competition) determined strongly the building form and effectiveness



[Poel. B. et al. 2002]

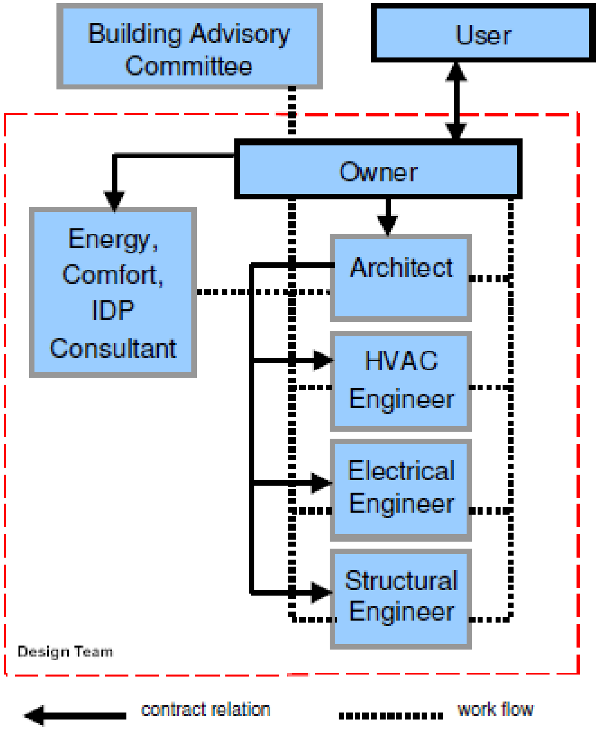
IEA Task 23

- **Example: Mayo Replacement School, Mayo, Yukon Territory, Canada (2002)**
  - High level of environmental and energy performance in accordance with the Canadian C-2000 Program for Advanced Buildings
  - The building achieves exceptional energy performance with a compartmentalized HVAC approach incorporating simplicity, elegance and effectiveness. Individual room ventilation is demand-controlled by occupancy sensors. The building also uses a dual-fuel electric/oil heating plant to take advantage of local availability of off-peak electricity and groundwater cooling.
  - Other features: triple pane spectrally-selective glass in operable windows, extensive day-lighting using generous vision and clerestory glazing with automatic dimming control, and careful material choices based on environmental criteria

[www.goo http://www.gfshymko.com/projects_mayo.html gle.com]

IEA Task 23

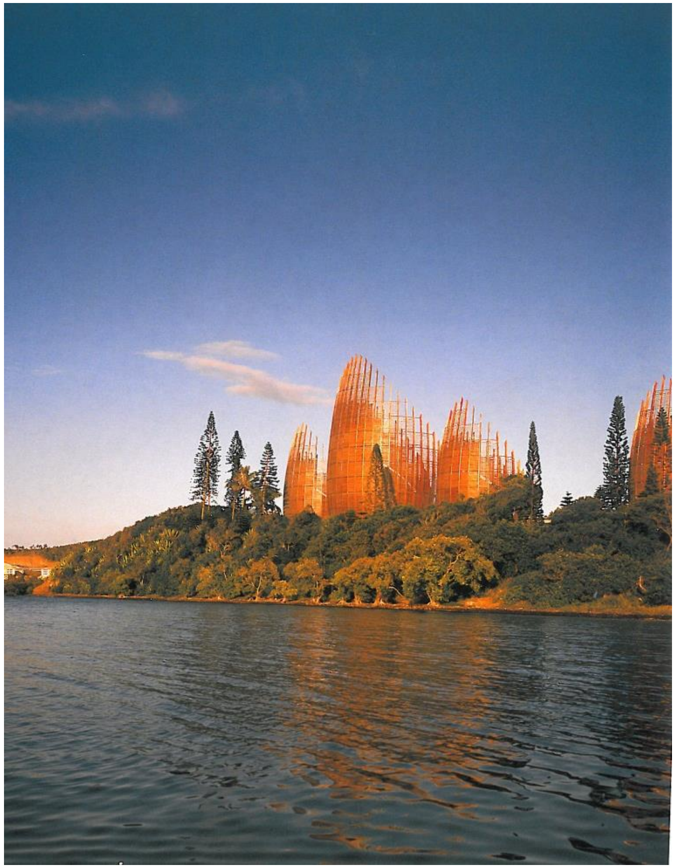
- **Example: Mayo Replacement School, Mayo, Yukon Territory, Canada (2002)**
  - The energy, comfort, sustainability and integrated design process consultant acted as the design facilitator in addition to his pure engineering task
  - The design team participated as a unit in high-level decision-making
  - Once general design directions were determined, the team solved specific design issues within their disciplines, with iterative interdisciplinary consultation
  - All actors were ultimately satisfied with the process, and the resulting building both in performance and appearance
  - Overriding trade-off is the balance between envelope articulation, massing, day-lighting, and passive solar gain vs. heat loss associated with envelope and fenestration area



[Poel. B. et al. 2002]

Examples of holistic solutions

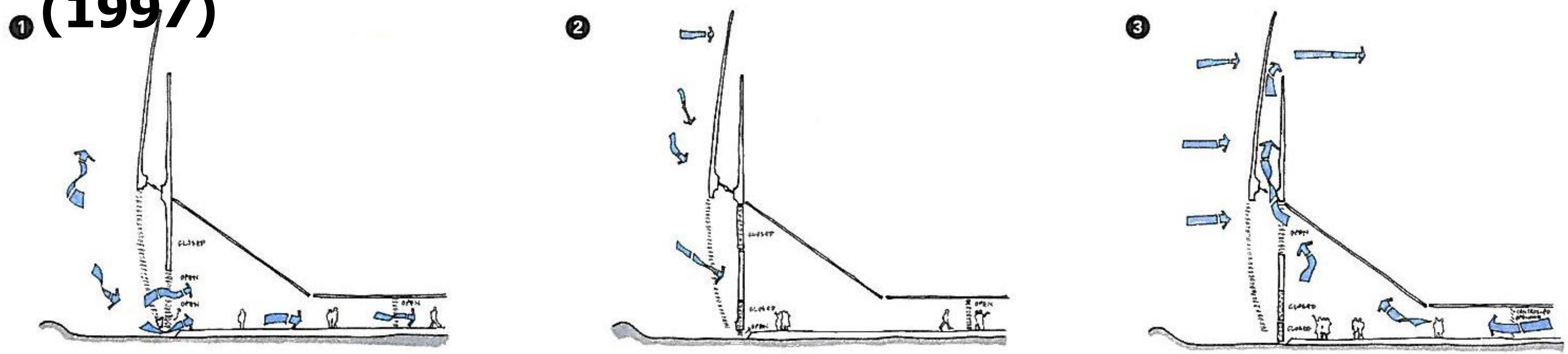
- **Cultural Centre. Renzo Piano, Nouméa, New Caledonia (1997)**
  - The "Cases" promote natural wind-driven ventilation by directing and accelerating breezes into internal spaces and by setting up convective stack ventilation within the building
  - The Cases are constructed by a mixture of local specially adapted material
  - The forms are traditional yet taller than local hut, they are as tall as the surrounding pine trees
  - The Cases stand as sculptures in the landscape
  - Louvres in the Cases open and close in response to the wind condition – several openings allow ventilation

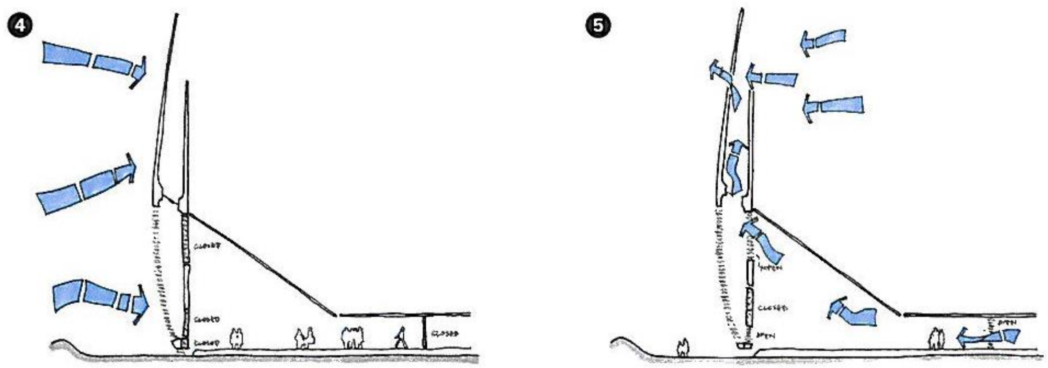


[Hawkes D. et al. "Architecture, Engineering and Environment" Laurence King Publishing in association with Arup (2002)]

Examples of holistic solutions

- **Cultural Centre. Renzo Piano, Nouméa, New Caledonia (1997)**





←

Various modes of operation for openings in the case.

1 Light winds
2 Moderate winds
3 Strong winds
4 Cyclonic conditions
5 Reverse winds

[Hawkes D. et al. “Architecture, Engineering and Environment” Laurence King Publishing in association with Arup (2002)]

ZERO – PLUS Project (H 2020)

About ZERO-PLUS Project

ZERO-PLUS

Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology

ZERO – PLUS Project (H 2020)

ZERO-PLUS Case Studies

Voreppe, France

Granarolo dell'Emilia, Italy

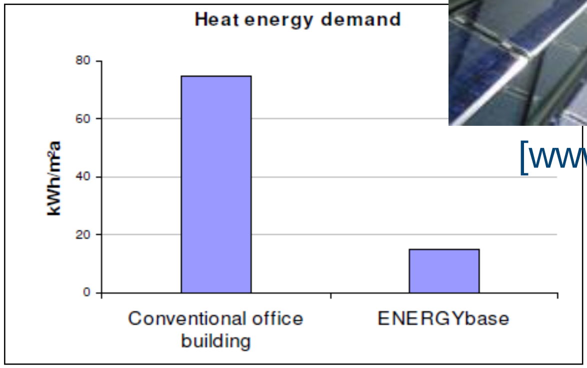
Peyia Village, Paphos, Cyprus

Integrated Energy Design

- **Example: ENERGYbase, Vienna, Austria (2008)**
  - The project is a reference project highlighting the compatibility of ecological and economic considerations in the construction of state-of-the-art commercial and office properties
  - Fulfil the Passive House Standard
  - Geothermal energy fully covers the heat and cooling need
  - A photovoltaic plant (400 m²) at the folded south façade supplies a part of the electricity need
  - Passive use of solar energy
  - Ventilation system allows the use of solar energy in summer for solar cooling.

[www.intendesign.com]

[www.google.com]

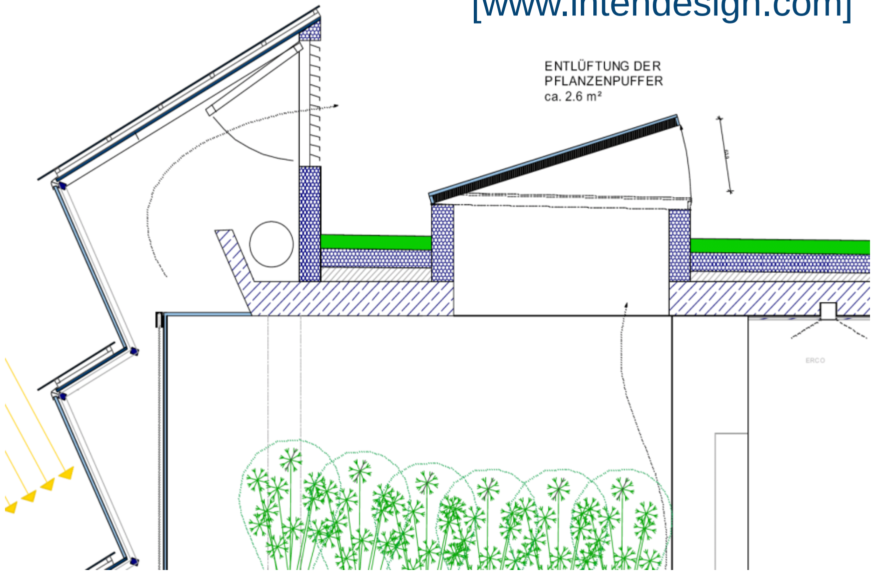


[www.intendesign.com]

Integrated Energy Design

- **Example: ENERGYbase**
  - Plant buffer rooms naturally condition the air even during the winter
  - During regular workshops architect, research institutions, engineers and the building owner discussed concepts and agreed on further steps
  - To analyse the characteristics of the building and to set measures to further lower the energy need and to rise the comfort, simulations were done during the concept phase
  - More information:

[www.intendesign.com]



[www.intendesign.com]

New Approch of HVAC Design and Performance

Palace of Arts
in Budapest, Hungary

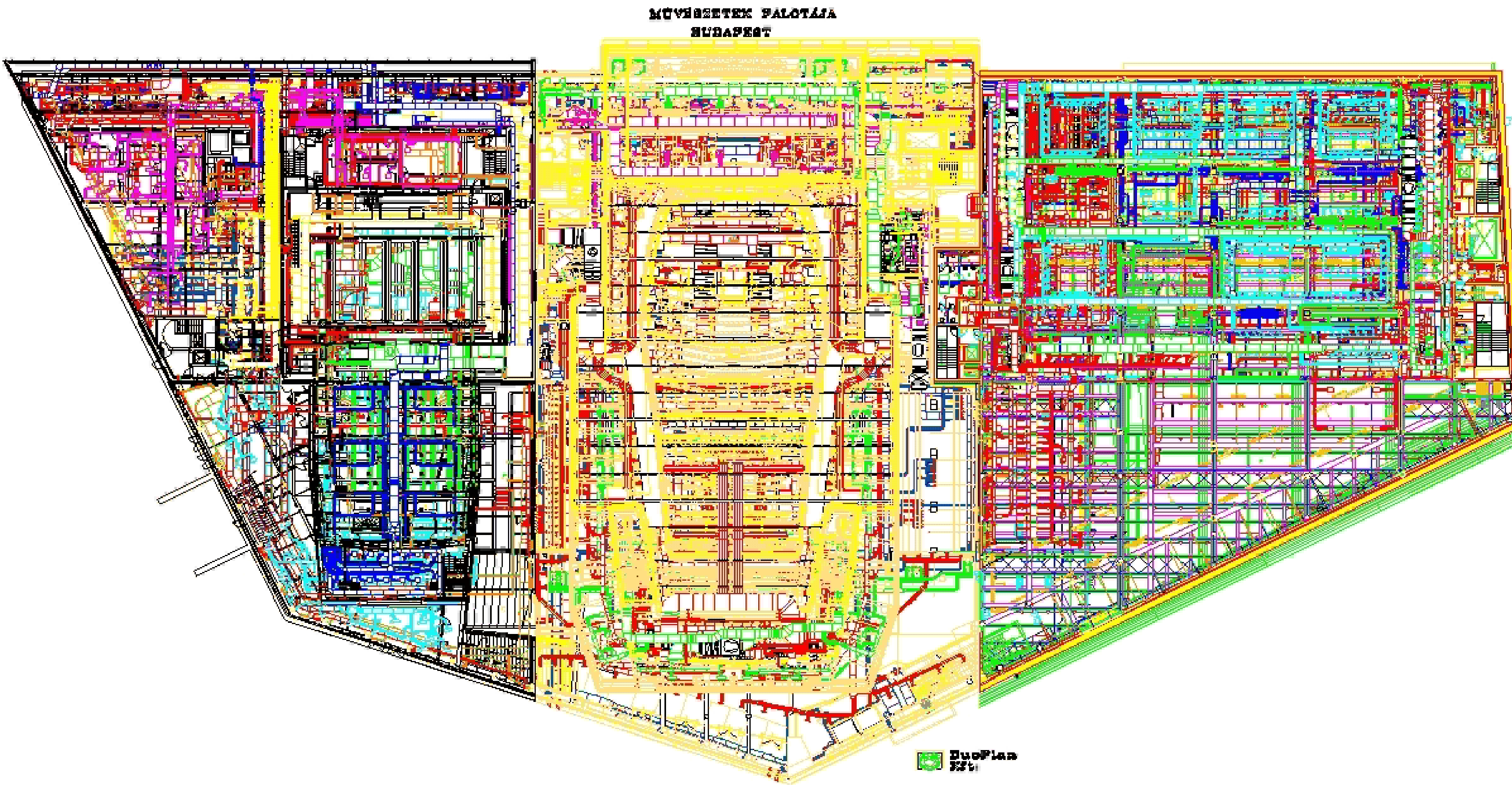
New Approch of HVAC Design and Performance

The Palace of Arts embodies three separately functioning building's sections:

- **Ludwig Museum of Contemporary Art**
- **National Philharmonic – Concert Hall**
- **Festive Theatre – Theatre Hall**

The whole indoor space is 64,000m^2, if we would fill with guests, 4500 people would fit in.

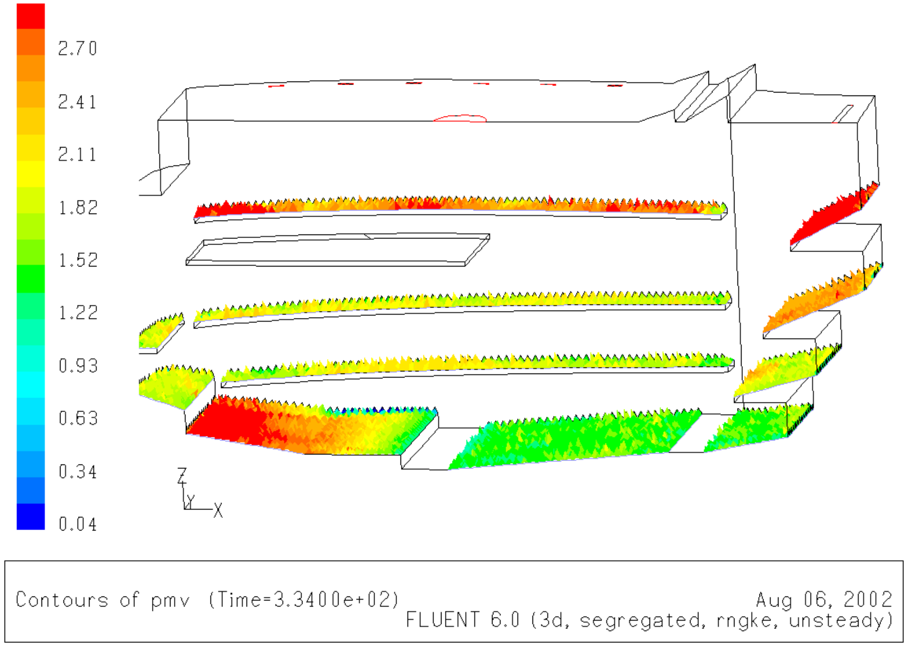
New Approch of HVAC Design and Performance



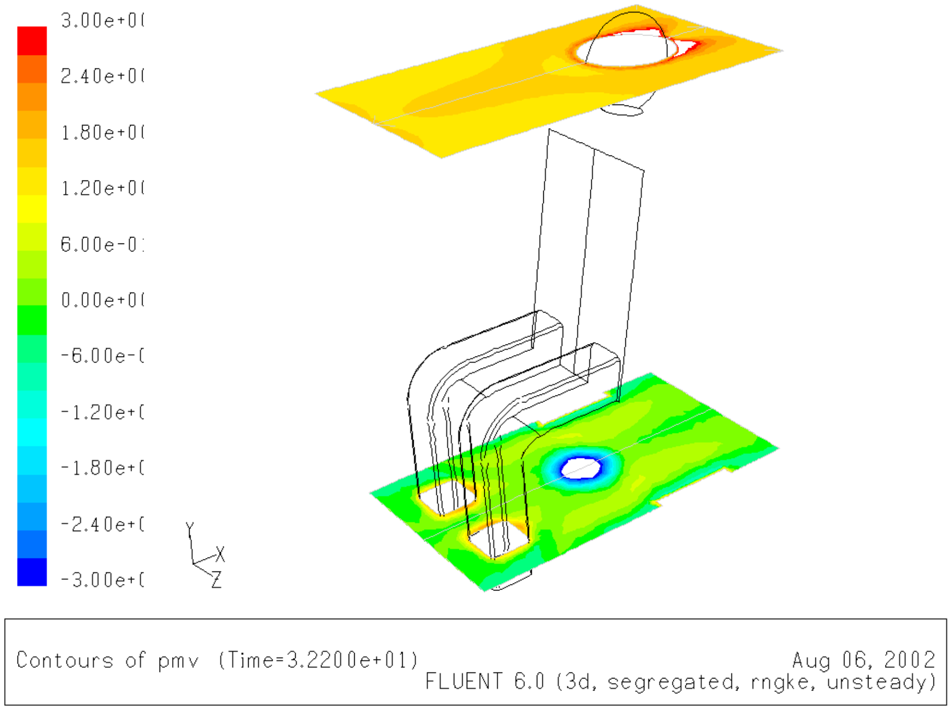
Concert Hall – Small Model Simulation

Concert Hall – Labor Measurements

Concert Hall – CFD simulation

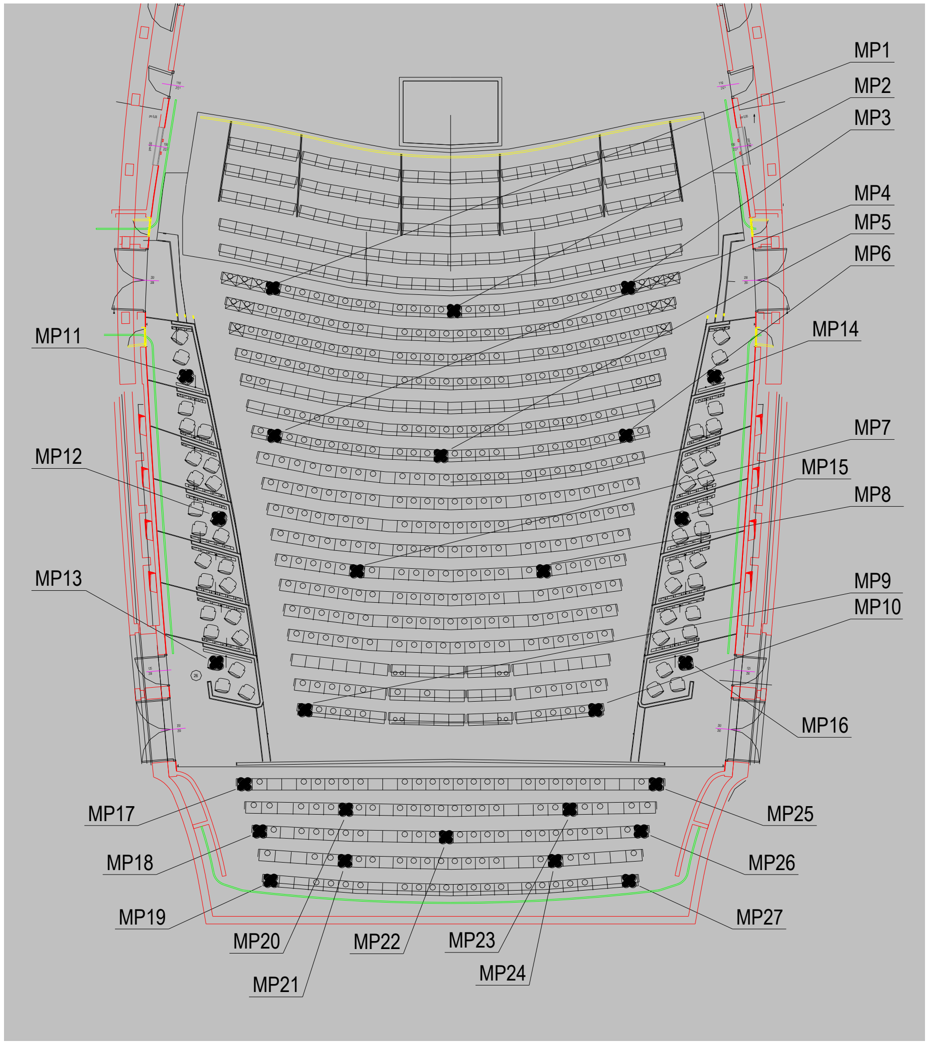


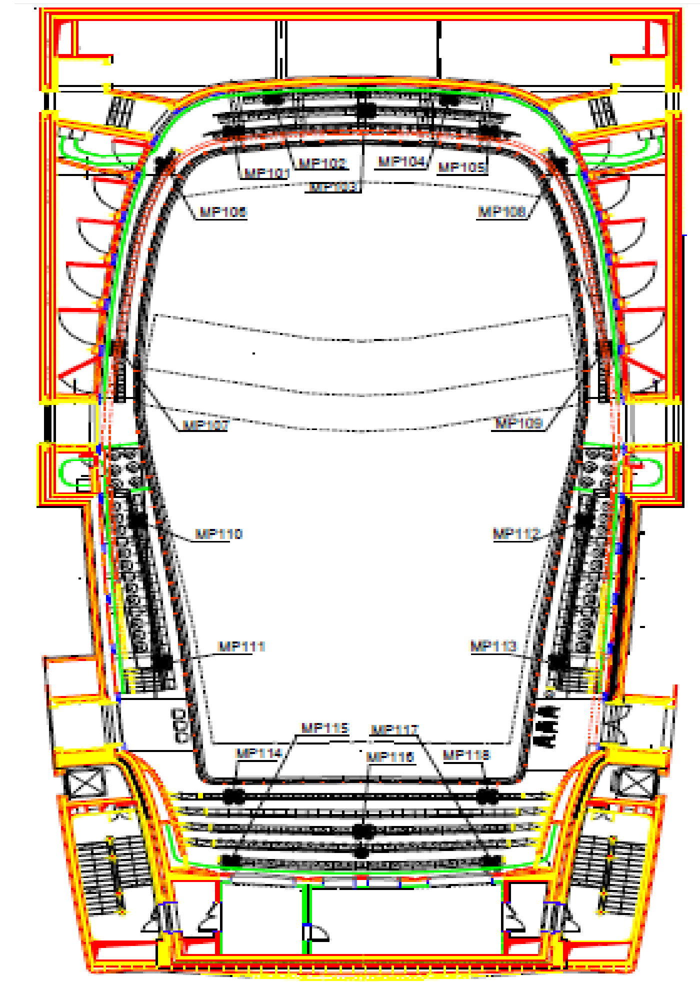
Hydronic parameters
Thermotechnical parameters



Comfort parameters
- **PMV values**
- **PPD values**
- **Dr values**

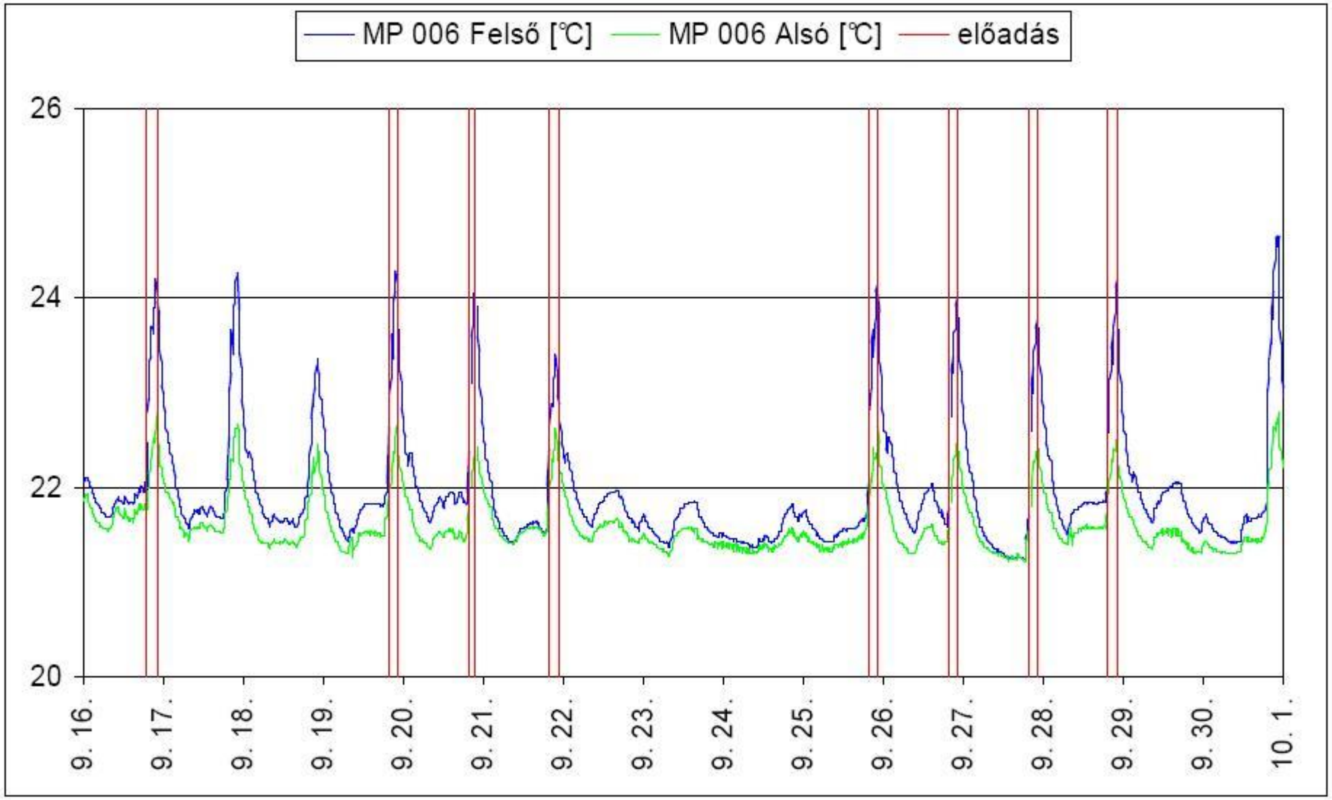
Concert Hall – Real Measurement





1. karzatra kihelyezett adatgyűjtők pozíciója

Concert Hall – Real Measurement



In the concert hall we positioned 69 data loggers, to measure and record the temperature and humidity on the course of 4 weeks in every 10 minutes.

Conclusion

- **The examples show how the knowledge from both the architectural and engineering field can result in very well integrated solutions.**
- **Most processes can benefit from an integrated design approach and one of the presented methodologies can be used.**
- **Goal: Better comfort with less energy**

Thank you the attention!

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