INTEGRATED DESIGN
- a must for low energy buildings

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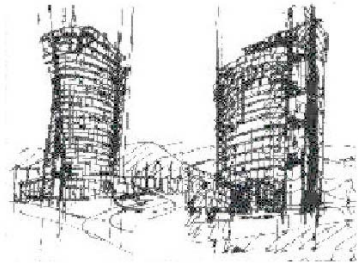
Photo: Wigenstad

Integrated design = an integrated design process

An integrated design process (IDP) is based on the well-tested principles of skills and teamwork. In such a design process, everyone is involved in defining the goals and in developing the design concept, using modern methods and tools.

Experience gained in a number of international projects (particularly IEA SHC Task 23) shows that it can be highly effective in producing high performance and environmentally friendly buildings.



Sketches by Helmut Jahn (Murphy/Jahn Architects - Chicago)

Features of a high performance, environmentally friendly building:

- A substantial improvement in energy performance relative to current standard practice,
- Reductions in resource consumption, such as land, water and materials,
- Significant reductions in atmospheric emissions, solid and liquid wastes.
- Superior indoor air quality, thermal comfort, illumination, and acoustic environment,
- Improved functionality, adaptability, and maintainability,
- Construction costs that are not significantly higher than in common practice, and that sometimes are reduced.

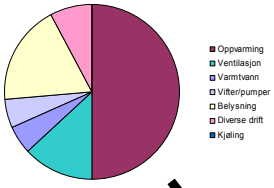
The design of such a building often requires more and/or different types of skills and knowledge than the design of a more traditional building.

It also requires a different design process, as the typical, traditional process is not well adapted to the handling of complex, multi disciplinary problems.

A so-called “integrated design process” is better suited for a situation where all aspects and all the sometimes conflicting requirements and goals of the ones involved need to be considered simultaneously.

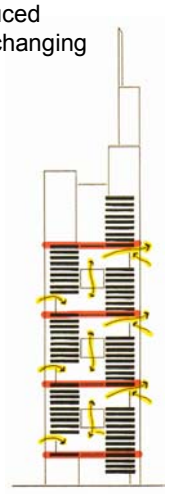
The present energy use situation:

- energy use per m^2 is reduced
- energy use patterns are changing



Traditional office buildings

Low energy office buildings



The situation …

The need for energy for hot water heating has become as large as the need for energy for space heating (in dwellings).

The need for electricity for lighting, ventilation, and other equipment is also large.

It is therefore necessary to consider total energy use rather than space heating energy use only.

Two future trends:

- **A further reduction in energy use per m²**
  as a result of stricter building codes (EPBD etc.) and …
- **Higher ambient temperatures**
  as a result of climate change

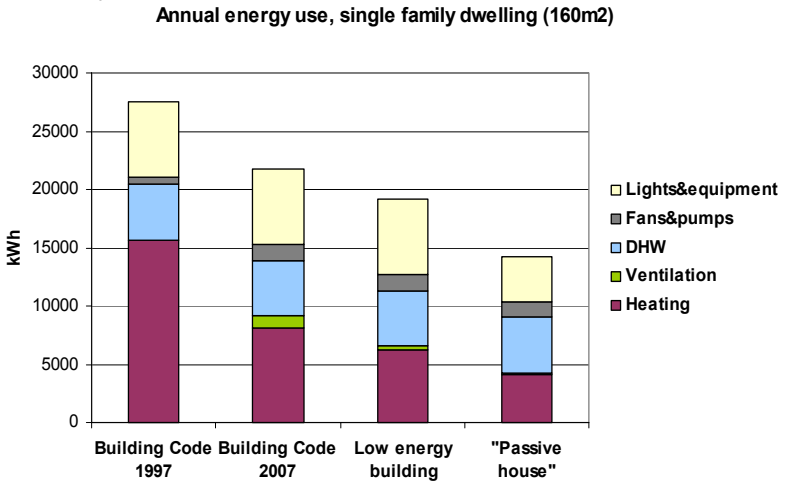
Two consequences:

- **Less need for space heating**
  and the heating need concentrated to the relatively darker winter months
- **More need for space cooling**

):
- **Active solar heating of DHW**
- **Passive solar cooling**
- **Solar cells**

Reduced energy use:

(example Norway)



The need for **hot water** and for **electricity** for lights and equipment make it necessary to use some form of “active” system
= solar thermal collectors and solar cells

In all cases – building integration
= a job for both architects and engineers!

Photo: Solarnor

Many future buildings will have <u>both</u> active thermal and PV systems

Dwelling in Finland

- **ground source heat pump**
- **solar thermal collector**
- **solar cells**

Community centre in Denmark

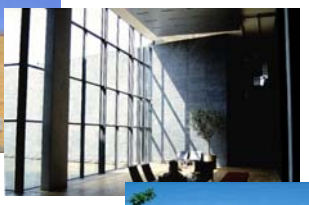
- **natural ventilation**
- **solar thermal collector**
- **solar cells**

Photo:
Kolding Municipality

However,
it may be the passive cooling systems that will have the greatest impact on architecture.

- **Natural ventilation**
- **Thermal mass**
- **Solar chimneys**
- **….**
- **Double facades**

Photos:
Kolding Municipality,
Hestnes



These are often building concepts that require the expertise of both architects and engineers, as well as the use of advanced simulation tools = IDP!

Solarfabrik

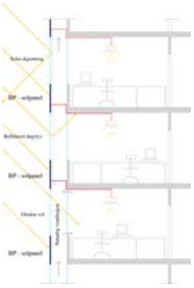
Freiburg, Germany

- **atrium**
- **natural ventilation**
- **passive cooling**
- **solar cells**
- **biomass**

BP Solar Skin

Trondheim, Norway

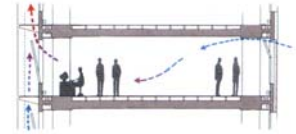
- **double facade**
- **solar chimney**
- **PV as solar shading**

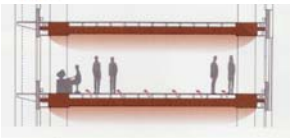


GSW Headquarters

Berlin, Germany

- **double facades**
- **thermal mass**
- **night ventilation**
- **solar shading**
- **“Venturi wing”**





Integrated design processes …how?

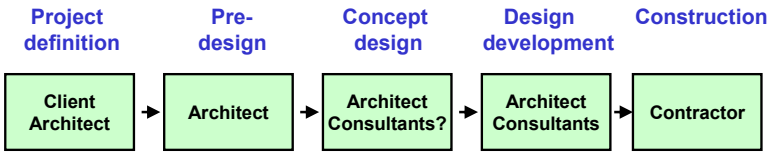
The IDP contains no elements that are radically new, but integrates well-proven approaches into a systematic process that:

- uses a holistic approach
- concentrates the effort on the earliest phases of design, and
- focuses on the performance goals throughout the process.

This requires that the whole team (i.e. client, architect, engineers, …, users) jointly defines the program and goals of the project – before design begins!

Such a process, aimed at everyone understanding and agreeing on the goals at the start, makes it possible to identify (and hopefully eliminate) ambiguities and conflicts and simplifies future discussion.

The traditional design process



The architect and client agree on a design concept, and the mechanical and electrical engineers are then asked to implement the design and to suggest appropriate systems.

I.e. the most important design parameters (building shape, orientation, etc.) are determined by the architect, while technical systems are “added on” at a later stage. This often results in a sub-optimal solution.

To summarize the problems with the conventional process ....

The main design parameters (massing, orientation, fenestration pattern) may be assumed by the client and architect in the Pre-design phase.

Engineers and specialists are often locked out of the design decisions made during the Concept Design Phase.

Input on orientation for passive solar, daylighting potential, measures to control solar overheating, etc. is often not considered, or sought only in the Design Development phase.

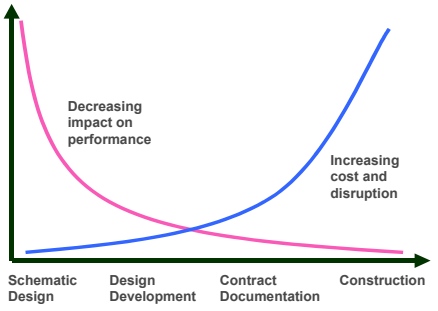
By this time, the client and architect have usually committed themselves to a sub-optimal solution.

From problem to opportunity

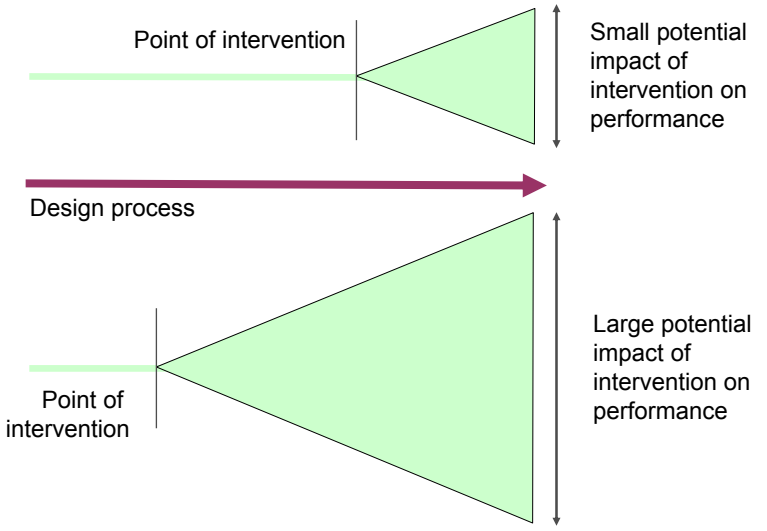
There are points of opportunity during the design process when it is possible to have a major impact on the eventual performance of the building, with relatively little effort.

These points of opportunity occur very early in the design process.

80% of the impact for 20% of the effort...



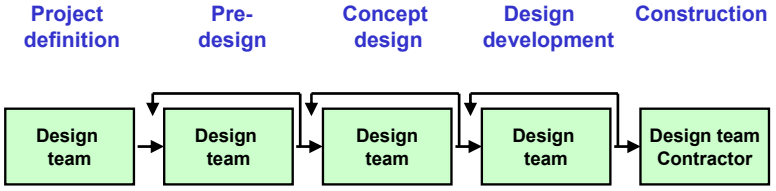
Early intervention pays



The integrated design process includes the following steps:

- Start with a client and design team committed to high performance, and willing to alter the normal design process.
- Select a design team with a wide range of technical skills and with a positive attitude to teamwork.
- Make sure that key personnel remain on the team throughout the process.
- Commence with teamwork from the very start of the Pre-design stage.
- Define performance goals at the outset and refer to them throughout.
- Use new methods and tools throughout the process.

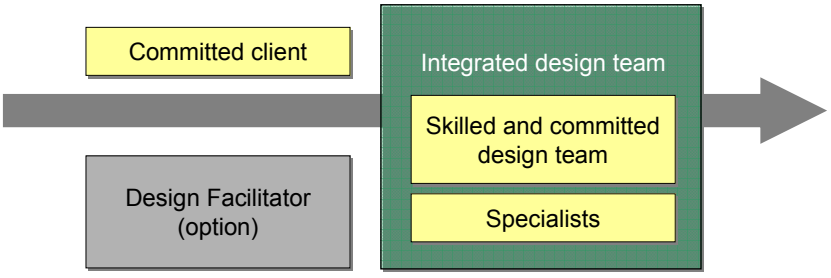
The integrated design process



The whole team participates already from the start, jointly setting the goals. (Such an open inter-disciplinary discussion and synergistic approach often leads to improvements in the functional program.)

Design iterations are performed already in the early stages, reducing the need for such iterations late in the process when they will be costly and disruptive.

The first step is to work with the client to ensure that the right team is in place <u>before design begins</u>



It is important to note that …

- The design professionals should be paid on a lump-sum basis or an equivalent that will avoid penalizing them financially for reducing the size and cost of mechanical systems. (Performance based fees?)
- If a Design Facilitator is to included, he or she is to be an advisor, and is to support the design team in their work without disrupting the process. This requires an ability to make rapid decisions and to provide helpful information and support quickly.

The features of the IDP process:

- Timing: it brings engineering and specialist experience and knowledge to the table at a very early stage.
- Complexity: a broad range of performance issues are considered.
- Iteration: it keeps options open on the basic features of the design until the potential performance of alternatives can be assessed.
- Options: conversely, the client is not rushed into a premature commitment to a primarily visual solution.

The features ...

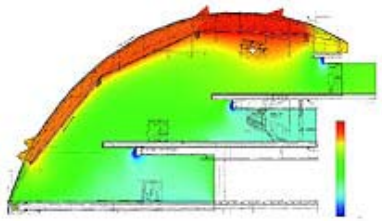
- Leadership: the architect plays the role of a team leader but is not the only decision-maker during Concept Design and Design Development.
- Skills: the architect acquires valuable new technical skills, while the client and engineers gain insight into the complexities of architectural design.
- Morale: engineers have a chance to show how much they can contribute to the early design phases.
- Conflict: friction can be avoided by informing consultants about the process before they are retained.

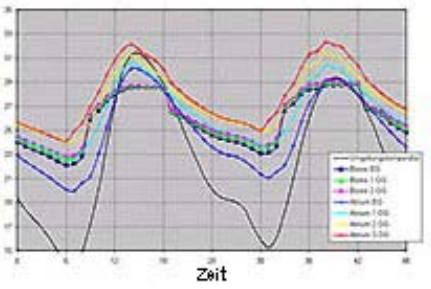
The features ...

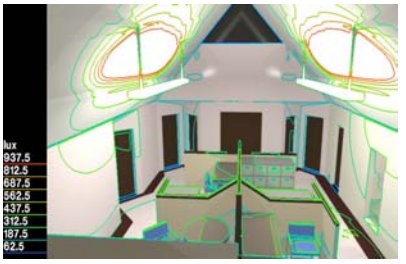
- Specialized knowledge: most design teams do not include the specialized knowledge needed for modern design work. IDP therefore provides access to specialists as needed for short-term advice, such as daylighting, thermal storage, glazing characteristics, material selection, etc.
- Responsibility: as in conventional projects, most of the hard work is up to the design team. IDP is not intended for inexperienced designers, and the process only helps the team to make the right decisions.

Features …

- using modern methods and tools …







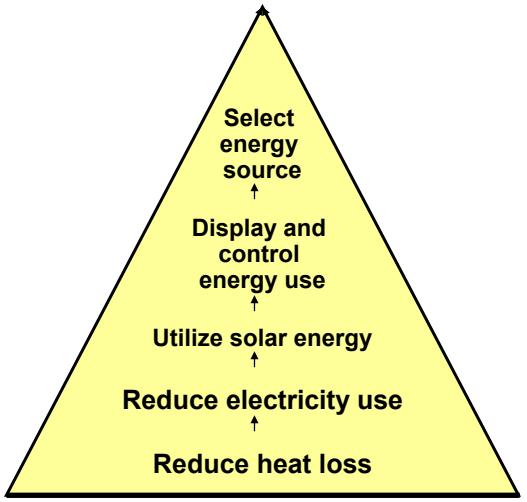
Summary of the technical strategy followed:

- First establish performance targets for a broad range of parameters, and develop preliminary strategies to reach these targets.
- Then minimize the heating and cooling loads through orientation, building configuration, the use of a high-performance building envelope, carefully located glazing, and by reducing electrical consumption;
- Meet the reduced load requirements through the maximum use of solar and other renewable technologies and the use of efficient HVAC systems - while maintaining the goals of a high-quality indoor environment, maintainability, economy, and measures to reduce environmental loads.
- Iterate the process to produce at least two, and preferably three, concept design alternatives, using energy simulations as a test of progress, and then select the most promising of these for further development.

Our strategy:

Simple, robust, and user friendly technologies.

- comfort
- freedom
- cost effectiveness



The Kyoto Pyramid

Using ”the Kyoto pyramid”:

1. Reduce heat loss
   - **super insulated and air tight envelope**
   - **efficient heat recovery of ventilation air in heating season**
2. Reduce the use of electrical energy
   - **energy efficient lighting and equipment**
   - **low pressure drops in the ventilation system**
   - **low specific fan power**
3. Utilize solar energy
   - **optimum window orientation**
   - **atria/sunspaces**
   - **proper use of thermal mass for heating and cooling**
   - **solar collectors**
   - **solar cells**
4. Display and control energy use
   - **demand controlled lighting, ventilation, cooling, and heating**
   - **user feedback on energy use**
5. Choose correct energy source and carrier

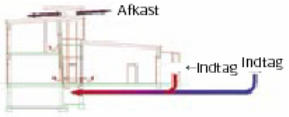
Results and consequences

- More time is spent in early design tasks, but experience shows that time is saved and problems are minimized in later stages.
- The process can result in better buildings; ones with energy and emission performance roughly half of current good practice, healthier and more comfortable indoor environments, with more ability to adapt to changing future needs - and often with more interesting architectural results!

Results...

- Construction costs are not significantly higher.
- Operating costs will be considerably reduced because of reduced operating energy consumption.
- Maintenance and replacement costs will be reduced because of smaller mechanical plants and more efficient equipment.
- Experience shows that buildings like this are easier to lease, even in soft markets.
- The IDP process is applicable to a wide variety of buildings, including office buildings, multi-unit residential buildings, libraries and retail stores.

Community Center
Kolding, Denmark



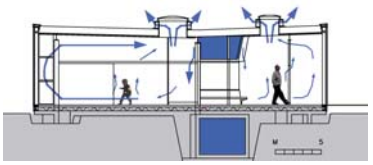
- hybrid ventilation
- precooling of ventilation air in basement
- solar cells
- double façade
- atrium
- thermal mass

Phot:o:
Kolding Municipality

Kvernhuset secondary school
Fredrikstad, Norway

- hybrid ventilation
- precooling and –heating of ventilation air in concrete culverts
- exposed concrete in interiors
- ground source heat pump
- solar cells (for demonstration)

Photo: Wigenstad

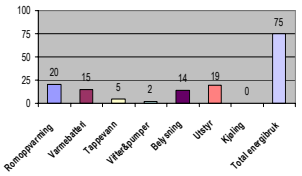


Pynten office building
Oslo, Norway

- central atrium
- hybrid ventilation
- precooling and -heating of ventilation air in concrete culverts
- daylighting
- minimized envelope area to reduce transmission gains and losses
- "healthy" materials to reduce ventilation loads

Photo: Nils Torp Arkitekter

Energy use (kWh/m²yr)



Energy use:
1/3 of reference

CONCLUSION

- by using an integrated design process,
- by using a holistic approach (avoiding sub-optimization of single systems), and
- by focusing the effort on the earliest stages of design,

the designers are able to reach very high levels of performance, even without the use of experimental technologies, and at little or no extra cost!