THE INTEGRATED DESIGN PROCESS IN PRACTICE

Demonstration Projects Evaluated

INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme

Task 23 - Optimization of Solar Energy Use in Large Buildings

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Cover: *Hand sketches of the Headquarters of Deutsche Post in Bonn by Helmut Jahn (Murphy/Jahn Architects – Chicago)*

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Task 23 - Optimization of Solar Energy Use in Large Buildings

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Participating countries

Austria	Germany	Spain
Canada	Japan	Sweden
Denmark	The Netherlands	Switzerland
Finland	Norway	United States

Contents

1. Introduction

IEA Solar Heating and Cooling Programme Task 23

The objective of Task 23 was to stimulate integrated design of large solar low energy buildings, also taking into account sustainability. The Task focussed on the design process since this was acknowledged as a future obstacle for further implementation of solar energy and sustainability in larger buildings. Task 23 developed an generic approach towards the Integrated Design Process (IDP) that is applicable in a much wider spectrum of projects than solar and sustainable buildings.
To facilitate IDP a number of tools and methods were developed as a means to support practitioners during the IDP. The tools consist of a series booklets and software tools.

The **Introductory booklet** explains why the IDP is a beneficial approach and the IEA SHC Task 23 Package with it's tools and methods is presented in relation to the design process.

The **IDP Guideline**, is a comprehensive description of the philosophy, rationale and features of the IDP process, and of the companion *IDP Navigator*. The Guideline provides interactive access to background information, including key issues and recommendations in a checklist format.

The **IDP Navigator** provides detailed support to users in identifying the elements and inter-relations between steps in the Integrated Design Process, and to adapt the process to specific projects. The structure and contents of the Navigator is consistent with the Guideline.

A **Case Stories booklet** characterises the design process used in a number of high-performance projects. These projects formed part of the background information used by Task 23 members to develop IDP methods and tools.

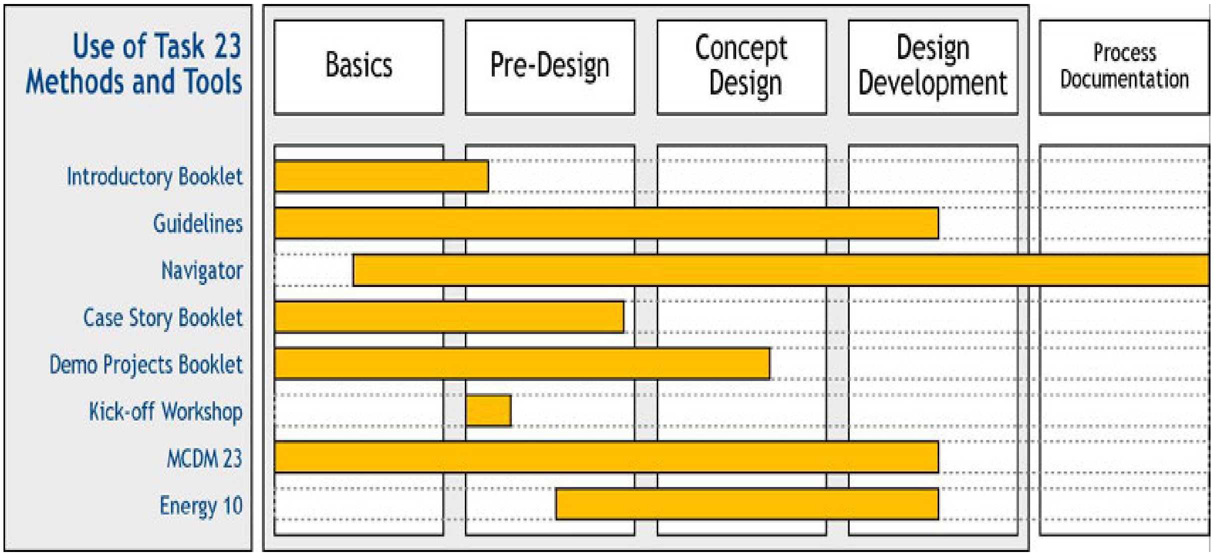
A collection of **Demonstration Projects** provide examples of design processes where some of the Task 23 methods and tools have been used to support the design process.

A **Blueprint for a Kick-off Workshop** as a basis for the orginisation of a design team workshop right at the beginning of the IDP. The main objective of the workshop is to create common understanding at the beginning of the design process with regard to three important notions: 1) knowledge about the integrated design process; 2) a clear perception of the design task; 3) a cooperative and open attitude towards the other members in the design team.

The **MCDM-23**, a Multi Criteria Decision Making method together with a software tool is intended for use in normal building design processes or competitions. The name reflects the fact that the evaluation of several design alternatives is a multi-criteria decision making process. The method assists the team to select and to prioritise amongst design criteria, and to evaluate alternative design solutions. In design competitions, the method can assist in developing the program and to select the best design amongst several alternatives. The MCDM-23 software tool automates many of the tasks involved in using the method, and also produces worksheets, bar charts and star diagrams.

Energy 10 is a user-friendly energy simulation system that provides predictions of operating energy performance and identifies the most effective design strategies in reaching this performance level. *Energy 10* is being continuously improved and now offers users an economical and highly effective simulation process for early design support.

The way these tools fit in to the phases of the design process is shown in the next scheme.



This booklet

This booklet describes five building design projects that demonstrate the integrated design process in practice. The focus is on the early design stages: the performance of the design team, the structure of the process and the tools applied. Experiences and lessons learned are presented and, whenever possible, formulated in a more general way. Chapter 2 gives an overview of the most important findings gained from the projects.
Chapter 3 presents the five demonstration projects from four different countries. Chapter 4 reviews the general experiences from the demonstration projects focussing on the composition of the design team, while chapter 5 deals with the process itself and its manageability.

2. Overview of findings

Considering the various demonstration projects some important experiences related to the Integrated Design Process (IDP) appear. A detailed description is given in chapter 4 and 5. In this chapter these findings are summarised in a more general way. Of course this chapter is not meant to be a complete set of points of attention regarding the IDP. The findings are limited to the evaluation of the five demonstration projects. Extensive information on IDP can be found in both the “Integrated Design Process Guidelines” and the “Navigator” developed within Task 23.

The design processes in the five projects show a rich variety, due to differences in the design task, the composition of the design teams and the specific context for each of the projects.
For instance:

- there were differences in the function of the building (one school, two offices, one community centre and one bank building);
- the size of the buildings varied from 1.000 m^2 floor area up to 66.000 m^2;
- two of the projects started as a design competition;
- there was a deviation in the level of the client’s expertise;
- some teams were familiar with IDP, for others it was their first experience;

General findings

The demonstration projects proved that an Integrated Design Process is considered to be very beneficial and can be managed successfully if integration aspects are dealt with in an explicit way. The products developed by IEA SHC Task 23 turned out to be very effective. The first stages of the design process may be a little more time consuming and costly, but inefficiencies in the following part of the design process will be avoided and the overall cost performance ratio of the building improves.

The demonstration projects in their diversity showed that the Integrated Design Process is a general approach for various design tasks in different contexts. This means that an IDP can be applied in a wide range of projects.
It is important to understand that IDP is not a rigid approach but should be adapted to the specific circumstances of a project, in fact a rigid attitude is in conflict with the basics of integrated design.
Crucial for a successful IDP is:

- an adequate composition and structure of the design team
- competent and motivated team members
- a clear design task
- a process structure that stimulates integration
- good project management

These points may seem trivial statements but they are not. The fact that we are dealing with an IDP and not with a traditional design process makes the difference. It means that the IDP opposes special requirements for the team, the description of the design task and the design process that are not obvious.

Findings regarding the design team

- In many cases the initiative for IDP is not taken by the client but by the architect or a consultant. Attention should by paid to the fact that the client has to understand the essence of IDP. The client has to be motivated and involved to use this approach and he should provide the conditions in terms of structure of the team and the process.
- A proper selection of the members of the design team is elementary (an incompetent member can frustrate the entire process). Discuss IDP with them in advance and assure that they are motivated and have an open attitude.
- If the team is not familiar with IDP it is recommended to add an IDP-facilitator to the team. The facilitator’s role can also effectively be combined with a consultancy role, like consultancy in the field of energy, comfort or sustainability.
- Changes to the team should be limited to those who are absolutely necessary. If changes are unavoidable, take good care of the new team member integrating well.
- It is important to have at least one or two inspiring core members in a team.
- The roles of the team members should be well defined; not in terms of separation but in terms of a mutual responsibility for an optimal end product.

- The client's representative should have a clear mandate, so decisions can be made without the risk that they are overruled.
- The fee structure of the team members and budget allocation of building cost should not block but stimulate integration. Shifting budgets from HVAC-systems to shading devices and low energy appliances, in order to avoid a cooling system must by inherently stimulated in the budget structure as well as in the fee structure.
- Quality of communication is of great importance for a successful IDP. Based on enthusiasm and an open attitude the actors in the team should learn to communicate actually beyond the borders of their own discipline; a common language will be developed.

Findings regarding process

- The Integrated Design Process typically consists of a number of design loops resulting in products that are milestones functioning as decision documents at transition moments in the design process from one phase to the next.
- Multidisciplinary work sessions are Central activities within a design loop, in order to generate, discuss and judge design options.
- Integration is a very important issue in the first stages of the design process. In the final design phase the process has a more conventional character. In case innovative technologies are part of the design, integration remains a strong issue up to the construction phase and exploitation.
- The design task should be clearly described but not in an unnecessary level of detail. It must be possible to discuss modifications that lead to a more optimal building. These discussions on the design task should be well located in the process in order to manage them effectively.
- After establishing the team, a Kick-off Workshop proved to be an effective way to make a sound start with the design process. A Kick-off Workshop can establish a clear understanding of the client's needs, a common view on IDP and at the same time it stimulates enthusiasm and makes expectations clear about the role of the different actors in the team.
- It is important to prepare the Kick-off workshop properly because it should be an inspiring event.
- A common understanding of the client's needs and expectations, is a necessary condition for an IDP and can even be considered as a preliminary design loop. Understanding the design task not only means studying the brief (program of requirements) but also discussing it together with the client and assimilating and commenting the client's expectations.
- Integration should be managed just like the conventional aspects such as activities, time, and cost. Special attention is needed for the exchange of information and the quality of communication.
- The MCDM 23 method turned out to be a powerful and effective means of evaluating and discussing whole building performance.
- Energy simulation tools like ENERGY 10 proved to be useful in judging energy concepts and measures in the early design stages, and it supported the communication between the members of the design team.

3. Five examples of integrated design

3.1 Introduction

The five demonstration projects evaluated within task 23 are presented individually in a two-page description. All projects aim for a better energy performance than usual, considering the use of solar energy, and most of the projects have the objective to design a sustainable building with extra attention for the indoor conditions. A common characteristic is also a very explicit choice for an Integrated Design Process (IDP), in line with the principles developed within IEA SHC task 23.
It is obvious that there is a rich variety between the projects. The projects differ in building size from 1.058 m^2 floor area for the Danish project up to 66.400 m^2 floor area for the German Post Tower. Accordingly the structure of the design team was more complex in the German case. Also the experience of the actors in the design teams with IDP showed a wide range. Both the Danish and the German design teams were already experienced in integrated design, while in the case of the Dutch project, the teams had little expertise and an IDP facilitator was added to the team.
Within the scope of IEA SHC task 23 special methods and tools were developed, to support the IDP. In three of the five demonstration projects described the design team used the design process guidelines and the MCDM and in two projects Energy 10 was used.
In some projects the IDP was supported by the use of other instruments, but with a similar function, because at that time the task 23 instruments were not yet available or actors were more familiar with these other tools that were a good alternative.
The differences between the design processes are of course related to the specific needs of the client and the expertise of the actors in the design team. Apart from that, also the national context differs from country to country. Especially regulations, building codes and the conventional way the design process is organised gives a diversity in the projects.

The following projects are included in this booklet:

Canada	School in Mayo	a one-storey building providing a high quality educational environment (floor area 3.400 m^2)
Denmark	Community Centre in Kolding	a sustainable community centre for all age groups and social stratums (floor area 1.058 m^2)
Germany	Headquarters Deutsche Post in Bonn	the headquarters of the Deutsche Post, a 43 storey building (floor area 66400 m^2)
The Netherlands	Brigade staff building 'De Ruijter van Steveninck' Barracks in Oirschot	a sustainable office building with a high level of functional flexibility(floor area 4.200 m^2)
The Netherlands	Bank office in Zierikzee	a flexible low energy building with two storeys, an inviting building for the public (floor area 1.950 m^2)

3.2 School in Mayo

Sketch by Kobayashi + Zedda Design Group - Whitehorse

Reasons for construction

The existing school was undersized, in a state of deterioration, and generally functional deficient. For the school in Mayo client needs were formulated like a high quality educational environment and a building adaptable to broader community needs e.g. community gathering and adult education. But also a high level of environmental and energy performance, which should be in accordance with the Canadian C-2000 Program for Advanced Buildings, and a fixed budget including site development were requested. So, the conventional construction budget asked for cost effectiveness.

Contracting

The core process for the development of a school in Mayo was normal, e.g. a client selected the architect and engineers on a semi-competitive basis, and the contractor was selected on a competitive cost basis. The energy engineer / design facilitator was retained directly by the owner.

Facilitator

The energy, comfort, sustainability and integrated design process consultant acted as the design facilitator in addition to his pure engineering task. The consultant had previous experience with the design team on a C-2000 project and was paid partly by the client and partly by the C-2000 program. The architect and the other consultants had successful previous experience with a C-2000 project as well.

Responsibilities

In Mayo, in accordance with IDP principles, the design team participated as a unit in high-level decision-making, although the owner was initially not fully integrated or on-side in this process. Once general design directions were determined, the team solved specific design issues within their disciplines, with iterative interdisciplinary consultation as required.

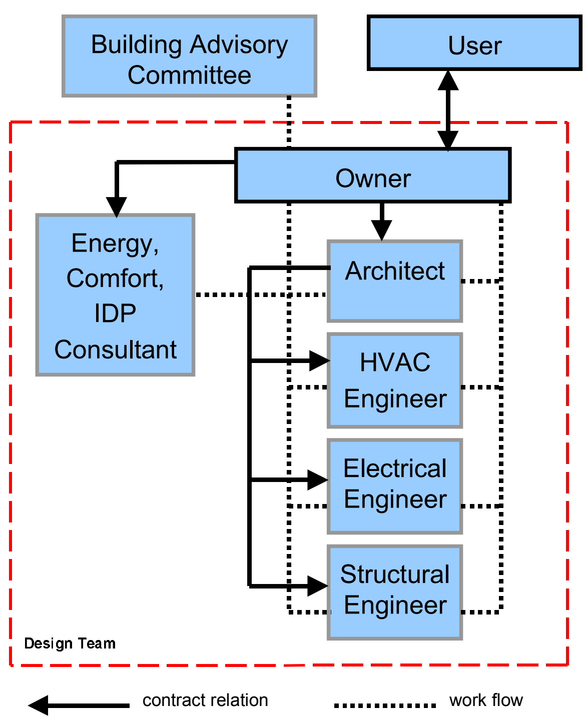
Actors relations

The client actually consisted of two entities: the owner, i.e. the Yukon Territorial Government (YTG), and the user, i.e. the Yukon Department of Education (DE). The Building Advisory Committee (BAC) was a local community group with individual knowledge of sustainability. The BAC was a key motivator in moving the project in the direction of sustainability. The architect was the lead consultant and he retained the structural -, the HVAC - and the electrical engineer.

The energy/comfort/IDP consultant was retained directly by the owner to work as an integral member of the design team, but at the same time was representing the owner's interests.

C-2000 Program for Advanced Buildings

C-2000 technical requirements cover energy performance, environmental impacts, indoor environment, functionality and a range of other parameters. In the C-2000 Program, financial and technical assistance is only provided for the design process. The C-2000 Program now focuses on providing advice on the design process at a very early stage.



Yukon - Canada

Experiences
The use of an integrated design process was initially requested by the owner in accordance with sustainability mandate, but the true initiative was provided by the architect and energy/comfort/integrated design process consultant. Through the integrated design process, they expected to enhance the probability of attaining functional and sustainability goals as well as cost management. An integrated design process was introduced during the schematic design stage. The expectations were high, based on previous experience, tempered in some cases by concerns regarding extra design effort. But the expectations were met. All project objectives were achieved within the design team tolerance levels for effort.

There was some initial resistance from the Department of Education. The primary argument was cost, complexity, and public perception of the building being too elaborate. But as the project progressed, the owner became more receptive. There were some initial conflicts between the owner and the design team, especially with respect to the disposition of an energy program performance incentive paid to the owner, but these were solved by ongoing management of the relationship. These problems were unique to the project and not related to the integrated design process. All C-2000 performance criteria were met, or a valid argument was presented for the modification of certain criteria from their original office-building-based framework. The project also met all project criteria for budget and function, and the completed building reflects a superior level of architectural quality.

Without the use of the integrated design process, the Department of Education would probably have implemented one of their “stock” building plans. After the initial resistance to the high-performance approach, the general trend was for enthusiasm to grow within the design team and the client. All actors were ultimately satisfied with the process, and the resulting building is definitely different, both in performance and appearance.

The design team remained committed throughout and, as a result, the team members will use an integrated design process definitely in their subsequent projects. The ultimate overwhelming success of the project resulted in a subsequent groundswell of sustainability initiatives within the owner’s organisation.

Tools
In Mayo the design team used the design process guidelines as specified by C-2000 criteria, including C-2000 process/decision reporting software, DOE 2.1e energy simulation and Superlite lighting/daylighting analysis software.

Location	Mayo, Yukon, Canada Latitude 63,30° North Longitude 135,90° East Altitude 504 m
Owner	Yukon Territorial Government
User	Yukon Department of Education
Architect	Kobayashi + Zedda Design Group, Whitehorse
Project manager	Yukon Territorial Government
Main contractor	Dowland Contractors Ltd, Whitehorse
Engineers	
. structural	Fast & Epp Partners, Vancouver
. HVAC	Northern Climate Engineering. Whitehorse
. energy / comfort	G.F. Shymko & Associates Inc, Calgary
. electrical	Dorward Engineering Services Ltd, Whitehorse

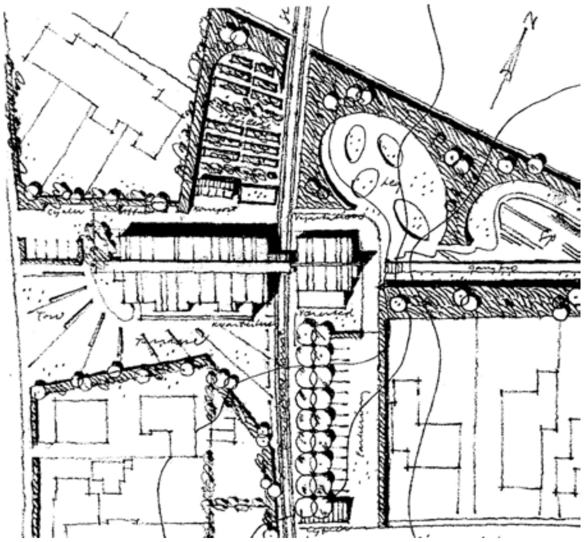
Photograph by Kobayashi + Zedda Design Group - Whitehorse

Time frame

Initiative	1999
Design completed	2001
Construction completed	2002
Hand over	2002

Trade-offs
In Mayo the management of the numerous performance trade-offs which arose during the design of a building in a cold climate, was an inherent part of the design process, with analysis provided predominantly by the DOE simulations. A typical 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. This trade-off is essential for IDP because it touches both building and system design and therefor enables whole building optimisation.

3.3 Community Centre in Kolding



Sketch by White Architects A/S - Copenhagen

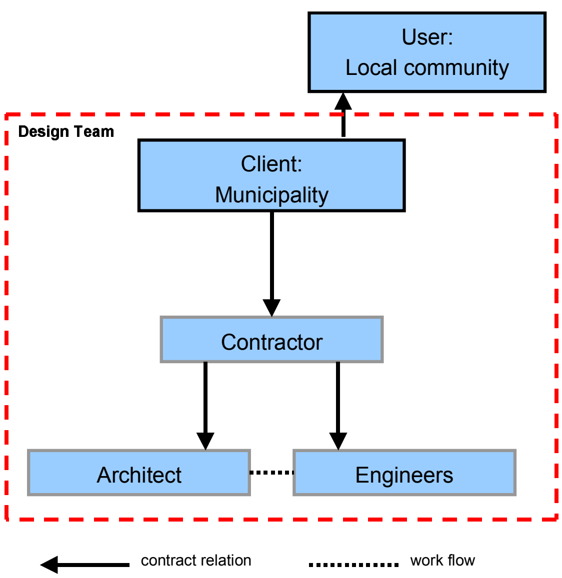
Reasons for construction
The main idea of the municipality of Kolding was to create an overall solution to be able to satisfy the objectives for future buildings for all age groups and social stratums. Furthermore the goal was to optimise the building in terms of resources used, soundness and ecology, both during construction and operation. Kolding required the energy consumption for heating to be 90% of the level in the Danish Building Code. This was realised with the use of solar energy and ecological measures. The Municipality has set up a comprehensive building program, where the main demands are ecological and energetic views and functional requirements also during operation.

Support
The project received funding from the Danish Energy Agency, both for alternative insulation materials and for the photo-voltaic system. Also subsidies from the Danish Fund for Local Activity Centres were obtained.

Design process set-up
The project is a result of a competition in which a consortium of architects, contractors and engineers were involved. The initiative for the competition entry was taken by the architect and the initiative for an integrated design process was taken by the consulting engineers in co-operation with the Danish Building Research Institute in the very early stage of the design process. During the competition phase a brainstorm approach among architects and engineers was used to discuss and evaluate specific topics of integration. After the competition was won, the process went on with the detailed design phase, where the practical solutions for integration were discussed in the design team meetings.

Responsibilities
In general the main contractor also had the role of project manager and he was responsible for the project as a whole. This implied that the main contractor was responsible for all co-ordination of the design and the architect and engineers were responsible for their own part of the design work.

Actors relations
The main contractor, who got a total contract from the client (municipality), was also the project manager of the entire project, and thus played a central role in the project. The architect had the traditional role of designing the building. The installation and environmental engineer was in charge of all the features concerning PV-system, utilisation of day-light, the passive solar heating of the building, solar heating of domestic hot water, the usage of ecological insulation materials, the natural ventilation system and the usage of rainwater for flushing.



Denmark

Experiences
In Kolding the argument to choose for an integrated design process was to make a Danish pilot project. The design team was enthusiastic about the initiative for an integrated design process, but limitation of creativity was considered to be a risk.

During the design process no problems were registered. The design team was prepared to discuss and select criteria and weigh factors in order to judge and discuss the overall building performance. The decisions on criteria and weighs were taken in consensus by the team members after round table discussions.

Positive achievement of the integrated design process regards the efficiency of the process. The client considered a good indoor climate and reduced energy operation costs as a result of the integrate design process. The client is very satisfied with the new building and the team members will use an integrated design process in a new project.

Some mid-term meetings with the client were necessary for approval of the design project. Only some minor adjustments of goals were necessary.
Some conflicting goals occurred between building requirements and authorities regulations, e.g. the client asked for rainwater usage for toilet flushing, but environmental authorities, due to health concerns, turned this down. In a technical way, flax insulation in the roof construction was replaced by ordinary insulation material due to the risk of moisture damage of the non-ventilated roof construction.

Side effect
The municipality of Kolding has a reputation of taking the lead regarding environmentally sound, energy efficient and ecological issues. The building has once again proven that the municipality is not afraid to be a trend-setter when it comes to non-ordinary building solutions. The Kvarterhus has already received the Nordic Environmental label.

Tools
The team of Kolding used MCDM as well as thermal simulation and multi-zoning models during the design phase. The MCDM 23 tool was used to help identify the objectives, sort out poor solutions and to document the design. This tool contributed to smoothen the integrated design process, but many details were needed for the application. However, the participants liked the MCDM tool though several of the default criteria in the MCDM 23 were difficult to use (e.g. demolition and recycling in life cycle cost, land in resources use and integrity/coherence in architectural quality.) Thus it is important to choose design criteria for which the performances can be quantified or, if that is not possible, qualified in an unambiguous way.

Location	Kolding, Denmark Latitude 55,27 °North Longitude 9,28 °East Altitude 41 m
Client	Kolding Municipality, Kolding
Architect	White Architects A/S, Copenhagen
Project manager	Kolding Municipality, Kolding
Main contractor	NCC Denmark A/S, Kolding
Engineers	
. structural	Sloth Møller Consulting Engineers A/S
. HVAC	Esbensen Consulting Engineers A/S
. energy / comfort	Esbensen Consulting Engineers A/S
. electrical	Esbensen Consulting Engineers A/S

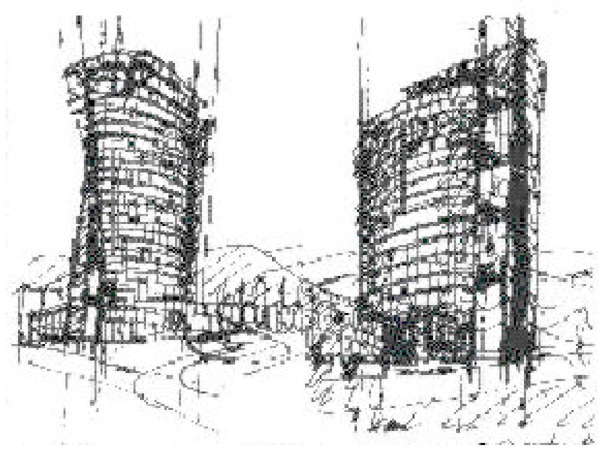
Photograph by Municipality of Kolding

Time frame

Initiative	2000
Design completed	2001
Construction completed	2001
Hand over	2001

Trade-offs
Some trade-off issues were addressed by using the MCDM 23. In Kolding special attention was paid to the risk of condensation at internal glazed surfaces in the unheated glazed spaces using thermal simulations. The condensation risks were calculated, resulting in the selection of glazing and profiles with improved U-values.

3.4 Headquarters Deutsche Post - Bonn



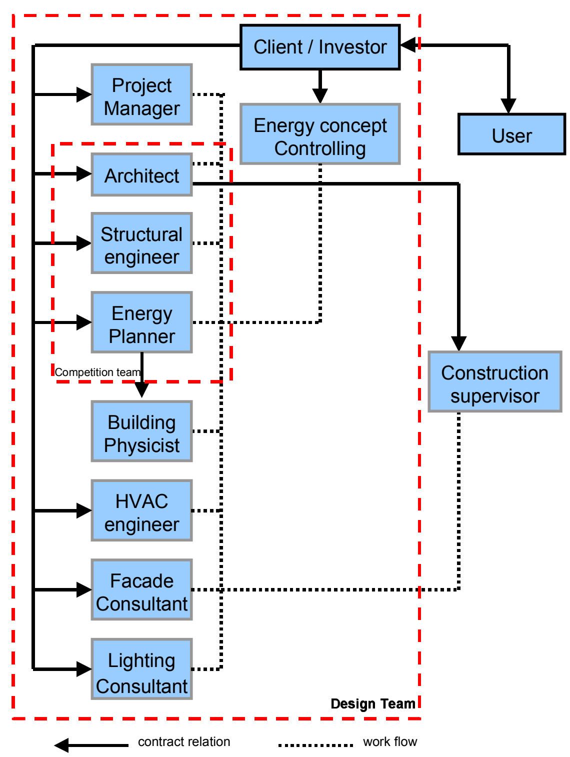
Sketches by Helmut Jahn (Murphy/Jahn Architects - Chicago)

Reasons for construction
The headquarters of Deutsche Post AG were already located in Bonn. 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. On the other hand public pressure was very high to build a low energy building, which already reaches future planned low energy standards. Therefore 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 25% below the existing code.

Contracting
The client retained project management and a concept controller to control the decisions of the complex organisation. The project management was helpful in engaging additional external experts.

Design process set-up
The project is a result of an international competition. The initiative for an integrated design process was taken by the architect and the energy consultant. The architect (and design team) had successful previous experience. The participants of the competition remained. In fact, the integrated design process started with a kick off workshop at the beginning of the competition. The design process of the competition was followed by the formal process of the project. Additional designers were introduced and had to become familiar with the effects like double use, reduced safety buffers, clear demands and expectations. The building would have become different without following the integrated design process (a standard central ventilation system, taking up an additional floor, would have been the result). Without these savings the screen facade would have been in danger to be cancelled for cost reasons.

Actors relations
Arthur Andersen got the project management. The architect was Murphy/Jahn architects based in Chicago. Since 5 years Mr. Jahn co-operates with some mainly Germany based engineering companies in the field of structure, energy concept and HVAC planning. This team was already entering the international, open competition. The structural engineer has been the design partner of Murphy/Jahn for several years. The climate engineer is a consulting company working for integrated energy concepts in building design for ten years. The building physicist is responsible for the thermal and acoustical building protection envelope and the room acoustics: a sensitive approach in this project with open concrete ceilings. The traditional HVAC engineer transforms the concept into pipes and ducts. The lighting consultant developed his proposals into light fixtures in close relation to Mr. Jahn and developed the lighting layout together with the architects. Because of the innovative ventilation and comfort concept, the client engaged an additional consultant, the concept controller, for a check of the proposed and evaluated concept. From weather data analysis, via simulation with Trnsys, Fluent and Radiance to component and 1:1 test, all different kinds of tools have been used during the integrated design process.



Experiences
In Bonn the team was motivated to develop a new type of high rise building, based on their earlier experiences in other common projects with integrated design. The architect and the energy consultants took the initiative. The integrated design process was already introduced in the competition. The reaction of the actors was mostly open-minded. If actors opposed they used objections like deviations to standard working methods, internal irritations and a more time consuming process. In those cases discussion and clear decisions are necessary.
The actors expected that integrated design would bring a synergy effect and as a result a low energy and high comfort building. These expectations have been mainly fulfilled with strong input of some participants, supported by the project management and the client. Developing a building for a known end user instead of an anonymous user, is always a better situation, because this end-user can decide to go new ways and to take some risks, an investor would not take risks for an unknown client. With a strong architect and an open-minded client the signals were positive in the beginning and were verified during the design process.

Intensive exchanges in the early planning phases have led to irritations with the client and project management. After explaining the backgrounds this problem has been solved. However, the result has been: longer discussions about additional planning costs and a low acceptance of integrated design. With strong support of the architect, and by convincing the project management it resulted into a finally good process. This kind of problems are related to the integrated design process. Not the experimental character but this planning philosophy needs additional explaining.

The specific achievements of the integrated design process in this project are a final concept with the integration of the ventilation concept already in the building form. This could only be achieved by an integrated design process. In addition, 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 integrated design process. Parts of the concept 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.

The client is satisfied with the process and the building performances of low energy use and high comfort. The team has learned about the potentials of the integrated design process. In spite of the additional time needed the team members definitely will use the integrated design process in further projects.

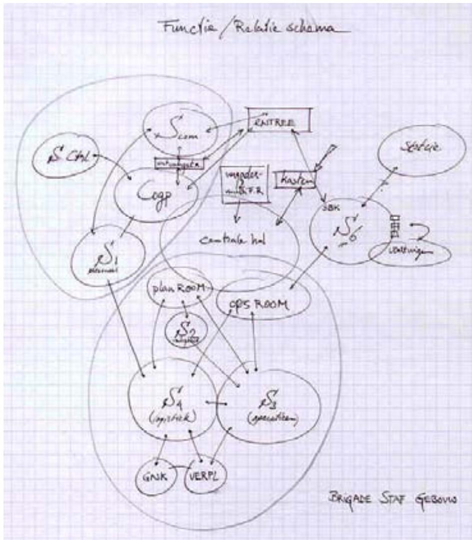
Location	Bonn, Germany Latitude 50,48 °North Longitude 7,17 °East Altitude 64 m
Client	Deutsche Post AG, Bonn
Architect	Murphy/Jahn, Chicago, USA
Project manager	Andersen Consulting, Frankfurt
Main contractor	Hoch-Tief, Essen
Engineers	
. structural	Werner Sobek Ingenieure, Stuttgart
. HVAC	Brandi Consult, Köln-Berlin
. energy / comfort	Transsolar Energietechnik, Stuttgart
. electrical	Brandi Consult, Köln-Berlin

Photograph by Anja Thierfelder - Stuttgart

Time frame

Initiative	1997
Design completed	2001
Construction completed	2002
Hand over	2002

3.5 Brigade Staff Building ‘De Ruijter Van Steveninck’ Barracks in Oirschot



Sketch by DGW&T

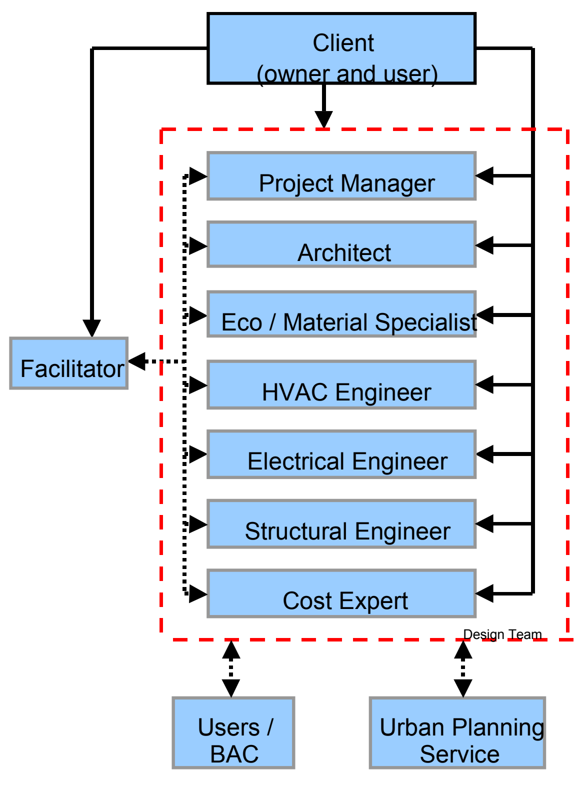
Reasons for construction
Reorganisation within the Royal Dutch Army showed the need for a new building. The client, the Royal Dutch Army, wants a building with an energy efficiency higher than usual, a low environmental load and architectural quality. The building also needs to be flexible and a part of the building will be used for innovative and flexible workspace. In comparison to a reference building, the client wants to improve the standard for energy efficiency, decrease the environmental load with about 15% and special attention for architectural quality. There is an integrated focus on the use of materials, energy and an efficient way of designing a comfortable working environment.

Contracting
The building will be built on a compound of the Royal Dutch Army. The Department of Buildings, Works and Sites (DGW&T) of the Ministry of Defence is responsible for the design and the construction of the building.

Facilitator
The facilitator was added to the design team just after the brief and program of requirements were finished. Intentionally the role of the facilitator only is to stimulate the integrated design process and to assist the design team when applying the IEA Task 23 methods and tools. He also takes the lead in the kick-off workshop at the start of the design process. He is paid partly by the client and partly by a funding agency.

Team setting
The client is represented by a captain of the Royal Dutch Army. He communicates and controls the wishes of the client during the process, but he is not a ‘professional in building’. A wider reflection of the future users is represented in the Building Advice Commission (BAC), in which officers of the Royal Dutch Army and the central building staff of the army are represented. Most of the design team members (except for the client and the facilitator) are engineers from DGW&T, the army’s building and construction service. In the past these engineers have worked together designing and renovating buildings in different team settings. The communication between them is therefore efficient and informal. The risk, however, of this longstanding co-operation is the settlement for easy solutions and set thinking patterns.

Actors relations
The project manager chairs the design team meetings. The architect has the traditional role of designer. Together with the project manager he presents the progress of the design to the Building Advice Commission, and takes care of the feedback information from the BAC to the design team. All engineers have a discipline defined role in the process and most of them have little or no experience with integrated design. The mechanical engineer has practical experience with some new energy efficient HVAC systems and therefore he has an important vote in the design proposals during the design team meetings, though a threat may be to choose for proven methods too easily. The eco / materials specialist supports the architect in environmental load aspects of the building. At several sub-meetings the design team members were assigned to prepare for the design team meeting. E.g. the weighing of the (sub)criteria was prepared and discussed in the team to get one final team-weigh-factor for each design criterion.



Experiences
Since the start of the process the architect was very enthusiastic about integrated design. He tries to realise a demonstration project to create a better design process. The other team members were a bit reserved in their reaction. They were not yet convinced that the possible results of the process equal out the extra time that is planned for the integrated process. Although the actors did not oppose to this initiative of the architectural central department, they were not that enthusiastic either. The integrated design process has been introduced from the start of the project.

It was unclear for the team how the necessary decisions should be made. The facilitator had too little power to give direction to the process. The major part of the problem was based on the novelty of the method: all actors had to learn to work with integrated design. During the process they became more familiar with IDP. It turned out to be crucial to have an actor in the team fulfilling an inspiring role.

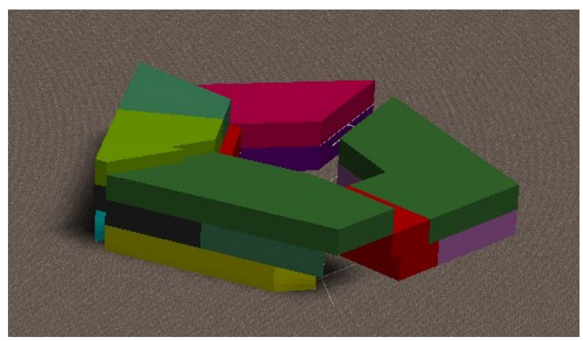
During the pre-design phase, five building shapes were considered and presented to the building advice commission. The pro's and con's on the criteria 'architectural quality' (surrounding area, location, ambition) and 'functionality' (flexibility, comfort and energy use) were made visible for the client. These criteria were considered as central themes and were selected by the team by using MCDM. The scores of the five designs on the criteria seemed to have a lot of influence on the decision of the building advice commission.

At the beginning of the design process a brief and program of requirements were available. These were clear and usable for the design team. At the start of the design process, the client's organisation had to choose the preferred type of office concept: conventional or innovative. During the design process it became obvious that the decision for one of these two possibilities took more time than planned for. This indistinctness influenced both the design decisions (finally the width of the building is chosen such that both types of accommodation are possible) and the planning of the design process. Clear starting points are important. The available budget puts a limitation to the use of non-conventional energy efficient measures, architectural tour de forces and extreme HVAC system solutions. But there have not been any real conflicts between the design goals.

Tools
The design process guidelines were used implicitly, and only by the facilitator. The MCDM was used extensively in several sessions. Energy 10 was used several times to make quick analyses whether certain measures would provide energy savings and a comfortable working space or not. This helped the systems engineer to move in a certain direction.

Location	Oirschot, The Netherlands Latitude 51,30 °North Longitude 5,00 °East Altitude 15 m
Client	The Royal Dutch Army
Architect	DGW&T*- District West
Project manager	DGW&T*- District Gelderland
Main contractor	DGW&T*- District Gelderland
Engineers	
. structural	DGW&T*- District Gelderland
. HVAC	DGW&T*- District Gelderland
. energy / comfort	DGW&T*- District Gelderland
. electrical	DGW&T*- District Gelderland

** DGW&T = Department of Buildings, Works and Sites of the Ministry of Defence*



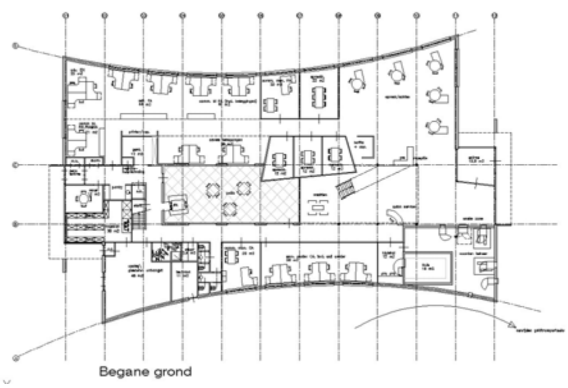
Drawing by DGW&T

Time frame

Initiative	2001
Design completed	2002
Construction completed	2002
Hand over	2003

Trade-offs
MCDM 23 facilitated the trade-offs regarding building performance, while Energy 10 enabled optimisation between building and HVAC-systems.
An atrium was considered for energetic and functional reasons. The compact building shape required daylight to enter the centre of the building. An atrium was, for functional reasons (shorter passages between rooms), preferable to a courtyard. The atrium was judged on its energy performance by using Energy 10. Heating and cooling of the atrium is prevented by using the atrium only as a passage, at the most containing a small reception.

3.6. Bank office in Zierikzee



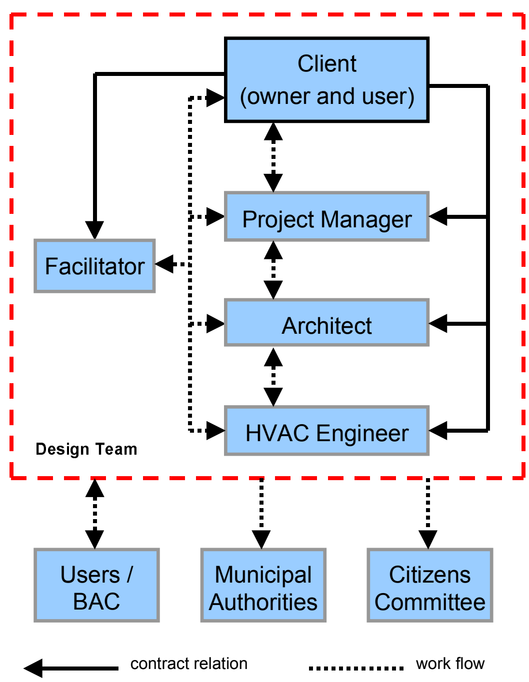
Drawing by Archikon bv - Goes

Reasons for construction
The client, Rabobank Schouwen-Zierikzee, requires the new office building to be sustainable and comfortable within the financial targets (simple payback time on energy measures of seven years). The building design should show attention to diminishing the environmental impact for the total life cycle of the building. The design has to be smart (clever) and 'surprisingly better' than the traditional buildings in the Netherlands, with an optimal integration in the urban context. It has to be a flexible building: both expansion and disposal of the building should be possible.

Design process
The initiative for an integrated design process was taken by both the project manager and the facilitator. The facilitator was added to the design team just after the brief and program of requirements were finished. The intention was that the only role of the facilitator is to stimulate the integrated design process and assist the design team when applying the IEA Task 23 methods and tools.

Responsibilities
The project manager chaired the design team meetings. The facilitator took care of the integrated character of the design process. The architect and the systems engineer worked very closely together to get the energy concept right, but eventually the systems engineer is responsible for the quality of energy efficiency and comfort.

Actors relations
The client Rabobank is represented by the head of the department of 'Operational management'. This person is the liaison between the design team and several building advice commissions (BAC), representing the users and the owner. He emphasises the importance of integrated design. The project manager (a representative of the Building Service of the National Rabobank Organisation) supports the client in the design and building process. He is a professional in building and building design and he has written the brief and the program of requirements. He also supports the client in selecting the design team, chairs the design team meetings, assists the client in contacts with (municipal) authorities and arranges subsidies (whenever relevant). The architect has the role of designer. He got involved just after the brief and the program of requirements were finished. The systems engineer (energy/comfort) got involved just before the actual design started. The facilitator took the lead in the kick off workshop at the start of the design process. The facilitator has been paid partly by a funding agency and partly by the client's national organisation.



Since the planned site is located in a relatively green and open area and a high building on that site could disturb part of the skyline of the historical city, a committee of citizens follows the activities of Rabobank with respect to the new building quite closely.

The Netherlands

Experiences

In Zierikzee the argument to choose for an integrated design process was to create a more optimal and more efficient building at no extra cost. All actors were informed about the integrated design process before the process started. They showed enthusiasm and willingness to work according to the integrated design process.

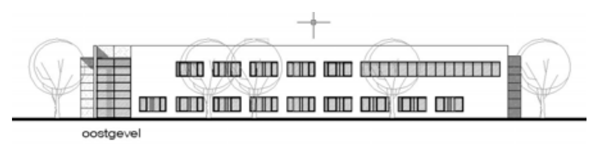
The actors believed in the integrated design process, though expectations with respect to the tools did not always meet reality. However, most important is that the integrated design process has to offer benefits at little or no extra costs. Several tools were used: a kick off workshop, MCDM and Energy 10. All the tools used contributed to the integrated design process positively.

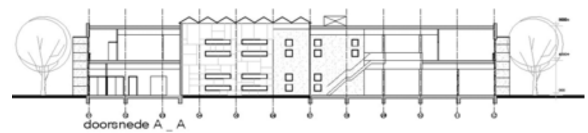
The Kick off Workshop provided a sound basis for a common understanding of the IDP, the design task with and the preferences of the client. The workshop included the first MCDM-session. In this first session (sub)criteria were determined based on the brief and the program of requirements. It was regarded as ‘not yet very clear what the benefits for the design process will be’. This was due to the fact that for this building an extensive brief and program of requirements was available and thus the selection of criteria was not really bringing new insights in the design task.
Both client and project manager agreed that MCDM is especially beneficial for projects that have a less elaborated brief and requirements.
After gaining the results of the MCDM-session in the third team meeting the members were much more positive. Deviations in the performance of the design between the different members of the design team caused a useful discussion about the quality of the design.
Based on this experience, the client regards MCDM as a useful communication means for the design team, making clear which trade-offs are possible. Results from MCDM should be available very quickly to avoid disturbance in the dynamics of the process. MCDM also can serve as a kind of checklist of items or criteria that the design has to be tested for. The architect regards MCDM as a good feedback instrument, though the arguments for certain decisions should be kept in mind (not only the single weigh factor or score). He does not consider MCDM as a threat to his freedom of design, but as a tool that offers support.

Tools

The design process guidelines were used by the facilitator. The MCDM was used extensively in several sessions. Energy 10 was used to make quick analyses of the performance of concept and components and to optimise between building and HVAC-systems.

Location	Zierikzee, The Netherlands Latitude 51,39 °North Longitude 3,46 °East Altitude 1 m
Owner / user	Rabobank Schouwen-Zierikzee
Architect	Archikon bv, Goes
Project manager	Rabobank Nederland Capabel, Rijen
Main contractor	Not yet decided
Engineers	
. structural	Archikon bv, Goes
. HVAC	Huisman & van Muijen, ’s Hertogenbosch
. energy / comfort	Huisman & van Muijen, ’s Hertogenbosch
. electrical	Archikon bv, Goes





Drawings by Archikon bv - Goes

Time frame

Initiative	2000
Design completed	2001
Construction completed	2003
Hand over	2003

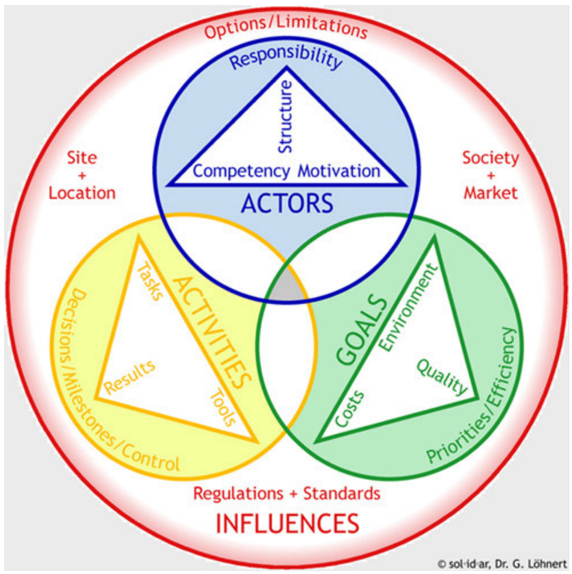
Trade-offs

part from trade-off issues that were dealt with by using the MCDM 23 there was a special focus on minimising the HVAC-systems by an adequately designed building envelope. Furthermore an atrium was considered for energetic and architectural reasons. However it appeared not to be very energy efficient (Energy 10 calculation). Its function in building use was not quite clear either and therefor it was decided not to have an atrium.

4. The design team

4.1 Introduction

The demonstration projects showed that an Integrated Design Process (IDP) is not a rigid approach and can be applied in a wide range of projects. An overview of the overall notions concerning the design team and its actors derived from practice is described in this chapter.
Crucial for an IDP is a competent design team and a clear design task. This can easily be understood as a trivial statement but the fact that we are dealing with an IDP and not a traditional design process makes the difference. This means that the IDP opposes special requirements for the team and the description of the design task that are not obvious. All the elements of the IDP and there interrelations are presented in the graph. They are discussed extensively in the “Integrated Design Process Guideline”. As far as the design team is concerned the evaluation in this chapter is structured according to the elements addressed in the subcircle of the actors.



It is important that the actors of the design team have an open attitude concerning integration and are motivated to participate in an IDP. Also the clients needs (brief, program of requirements) should facilitate an integrated approach. This implies a clear but not an unnecessary detailed description and the possibility to accept modifications that lead to a more optimal end product.
The way the role of the actors in the IDP is structured as well as the individual competence and motivation of the actors is crucial for a successful integrated design process. In the demonstration projects all of these aspects played an important role.

4.2 Motivation and expectations

The client

The motivation to start an integrated design process hardly ever came from the client. In most cases the architect and energy consultant or facilitator took the initiative. In many cases the client has to be introduced into IDP and the advantages and risks have to be discussed. If the client has a clear understanding of the IDP approach and chooses to follow this road, the next important step is to discuss and agree upon the basic condition for a successful process. If the intention of the client is not clear from the very beginning the process will be negatively influenced. A motivated and active client is very important.

To clients, the best ambassadors for an IDP are good examples and positive experiences from other clients regarding IDP. It is important to distinguish between IDP and technically integrated buildings that were developed by means of a traditional design process. In many cases the latter is wrongly characterised as IDP, in fact the traditional design process is often an inefficient approach although the end product may be satisfying. Negative experiences with those processes may be an obstacle for the client and the other actors to adapt IDP.

In Mayo the owner was initially motivated solely by a mandate from superiors to pursue sustainability. The architect and energy/comfort/IDP consultant were the major motivators. They had experience with an integrated design process before. However, the latter person has been contracted by the client -separated from the selection of participants by the architect- and represents the clients interests. This person acted as design facilitator in addition to fulfilling pure engineering roles. This implies an ambiguous design process. But as the project progressed, the owner became more receptive to the project. The design team remained committed throughout. The ultimate overwhelming success of the project resulted in a subsequent groundswell of sustainability initiatives within the owner's organisation.

In both Dutch projects there was an intense discussion with the client on the ins and outs of IDP in order to assure a realistic expectation about IDP. This resulted in a positive attitude from the client prior to the start of the project. IDP was not only introduced to the actor operating as a delegate from the client in the design team but also to other key-persons in the clients organisation. This turned out to be of great importance during the whole process. It is important that the mandate of the clients delegate in the team is legitimised by the organisation so decisions can be made in the design team without the thread that they are overruled later by the client. Developing a building in case the client is the future end user, gives an other setting, because this end user can decide to go new ways and to take some risks. An investor deals with a more anonymous user and will choose a different approach concerning risks.

The team

For a successful design process the whole team has to have a positive attitude towards IDP. To establish this one needs at least one motivated and enthusiast person as a driving force during the design process and in case of innovative technologies also during the realisation process. This person needs the confidence of the design team and in particular of the client.

Sometimes a competition is the start of a design process. It is not unusual that the participants of such a design team have worked together in earlier projects in an integrated design setting. It is preferable that the client contracts the team as a whole to develop the design, as was the case in Kolding and Bonn.
In Kolding all actors agreed from the very start of the competition that the Kvarterhus was a mutual responsibility to create a building where the overall solution meant that the objectives for future community buildings for all age groups and social stratums were satisfied.
In Bonn the client actively participated in the integrated design process and the team was very motivated to develop a new type of high rise building, based on their prior experiences in other common projects. With a strong architect and an open client the conditions were positive from the start and this continued during the entire design process. This process resulted in several innovations in the Post Tower regarding the building and the indoor climate.

Photograph by Damen Consultants - Arnhem

In case a competition is not the starting point of the design, the selection of the members of the design team needs special attention. Since the architect is one of the first actors to get involved in the project and integration originally is part of architectural design, it is logical to involve the architect in the selection process. The most appropriate choice is not necessarily a consultant known from an earlier project.

In the Dutch project Oirschot too many people were involved in the design team in the very beginning of the process. This led to some disturbance of the process. The negative effects where limited due to the fact that on a natural way the most relevant actors in the team were the most active. Nevertheless it is important to define the adequate composition and structure of the team.
After establishing the team a Kick-off Workshop, proved to be an effective way to make a sound start with the design process. Such a Kick-off Workshop serves a number of objectives like a clear understanding of the client's needs and a common view on IDP, but at the same time it stimulates enthusiasm and makes expectations clear about the role of the different actors in the team as was experienced in most of the projects.

4.3 Competence

The need for a facilitator

Many clients are not professionals in building and construction and as a result are team members with limited skills. Of course there are also very professional client's in the field of traditional design processes who only have limited expertise In IDP. In both cases a facilitator with experience in integrated design can be part of the design team. The role of the facilitator can be defined depending on the specific situation. The facilitator may have a more passive role and provide information and support the process. An other option is a more active approach were he is responsible for process management activities or design activities. In this case the step towards a regular member of the design team (e.g. a consultant or the architect) with an additional task as a facilitator is only a minor step. It is important that the competence of the facilitator matches the responsibilities.

In Zierikzee and in Oirschot the facilitator was added to the design team just after the brief and programme of requirements were finished. The intention was that the role of the facilitator only is to stimulate the integrated design process and assist the design team when applying the IEA SHC Task 23 methods and tools. In practice it was difficult for the facilitator to decide whether or not to interfere with design issues, and in fact, the client and project manager wanted the facilitator (from background an energy consultant) to interfere, whenever this would make the design better. These interferences however should not result in a gradual shift of responsibilities. The facilitator can not take over the responsibilities of the other actors. This implied constant consideration of the role of the facilitator in the interest of the design process.
In the Canadian project the consultant on energy, comfort, sustainability acted as facilitator on IDP. This combination turned out to be very effective.

Communication

The projects stressed that communication problems and different work routines of actors due to different background experience and knowledge needed attention. First of all it is crucial that the members of the design team have an open attitude towards each other. Based on this open attitude and enthusiasm it is possible and necessary to develop a common language during the project especially by means of work sessions.
Different languages, vocabulary, understanding and interpretation among the actors can lead to misunderstanding. For example "transparency of the building envelope" has a completely different meaning for the architect as for the engineer.
At the start of the Zierikzee-project the architect and the systems engineer had to get used to formulate and exchange their ideas on a conceptual level. There was a tendency to discuss design options in terms of technical solutions instead of concepts. In the later stage of the process it also turned out to be difficult to define which information they needed from each other to further elaborate on integration. E.g. if one wants to refrain from a cooling system: what does that mean for the envelop design in relation to internal heat load. Extra attention of the facilitator resolved this issue. Especially the systems engineer had problems because he was not used to participate in the early design process.

In a team, the project manager, architect or facilitator must have the expertise to discover the source of misunderstandings and solve these points. Well-prepared project meetings will settle misunderstandings. In Mayo the communication between design team and owner was problematic at times, largely due to the inexperience of the owner as well as preconceptions regarding a process based on conventional tenets. In Oirschot some of the team members were having difficulties with integrated design. Their contribution therefore was minimal. Because of this, the design proposals were sometimes a bit one-sided and the team members sometimes settled for the easy and already proven methods.

A positive effect of earlier experience of the team members is shown in the project the Headquarters of Deutsche Post in Bonn. In the design team the collaboration experiences from other projects had already led to a basic understanding of who is doing what, which saved time in the beginning of the process. Therefor the communication in the team was mostly problem solution oriented and therefore effective. For the client it was a new experience that all members of the design team were contributing to building concept decisions and that often components are influenced by more than one discipline, what makes it more sensitive for changes.

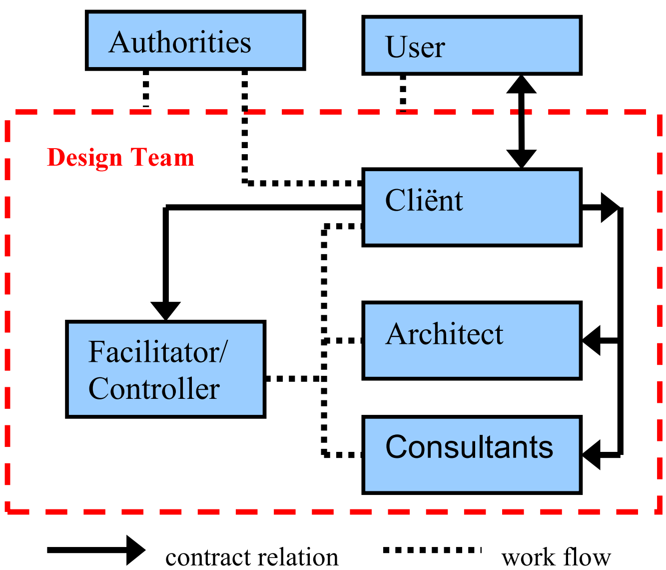
However the main communication channels are often between the architects and the engineers. An important part of the process is by informal discussion between architects and engineers, either on the phone, or in regular meetings.

In those projects were the MCDM 23 was used (Kolding, Zierikzee and Oirschot) the participants were positive about the communication and mutual understanding of the intended performance of the building and the weighing of the performances by the members of the design team. In that sense communication is a main achievement of using the MCDM 23 and of more importance than the determination of an objective measure for the performance of the building.

4.4 The structure of the team

The structure of the design teams in the demonstration projects is plotted in the actor relation charts in chapter 3. From those charts it becomes clear that many constellations of the formal structure within the design team allow an IDP. In that sense there are few limitations, as long as some basic conditions are taken care of.

As an example of an actor relation chart a simplified structure of the design team from the Zierikzee project is shown.



Essential for an IDP is the fact that the client is an active member of the design team especially in the first stage of the design process. Sometimes the client is represented by a professional like the architect or a project manager. It is important that the client gives a clear mandate to his representative in the design team in order to avoid unclear decision making processes.
In the case of the Dutch Army building in Oirschot the client is supported by the project manager to fulfil his role. In the Canadian project the client had an energy, comfort and IDP consultant represent his interests and the architect had a powerful role as the lead consultant who retained the other consultants. Also in the Danish project the main contractor acted as project manager for the entire project and contracted the rest of the design team.

The facilitator or the actor in charge of quality control regarding the energy concept was retained directly by the client. Although in several projects this was also the case for other members of the design team, in the chart the facilitator and controller are always positioned apart from the other members of the design team in order to express the special status of this actor. In the project in Oirschot the facilitator was even positioned outside the design team as an external support. Practice showed that a consultant having also the ability to perform as a facilitator can be very effective. A facilitator doesn't always have to be an additional actor.

To achieve integration it is important that the fee for the members of the design team is not strongly related to the building cost or the size of the HVAC-system (the higher the cost, the higher the fee). This is counterproductive and an obstruction for integration. In many countries there are examples of other fee structures that award reduction of building cost.

Another obstacle for integrated design is a rigid budget allocation that makes a strict division between investment cost for the building structure and for the HVAC-system. Such a structure is mostly motivated because of cost control, but actually it is an obstacle for cost reduction by integrated design.
This was experienced in the Zierikzee project. Minimising the HVAC-system by carefully designed building envelope, implied a budget shift from the system to the building structure, resulting in an overall cost reduction. There was a hesitation by the HVAC-consultant because part of his budget was reduced. This problem was solved easily by a short discussion with the client.

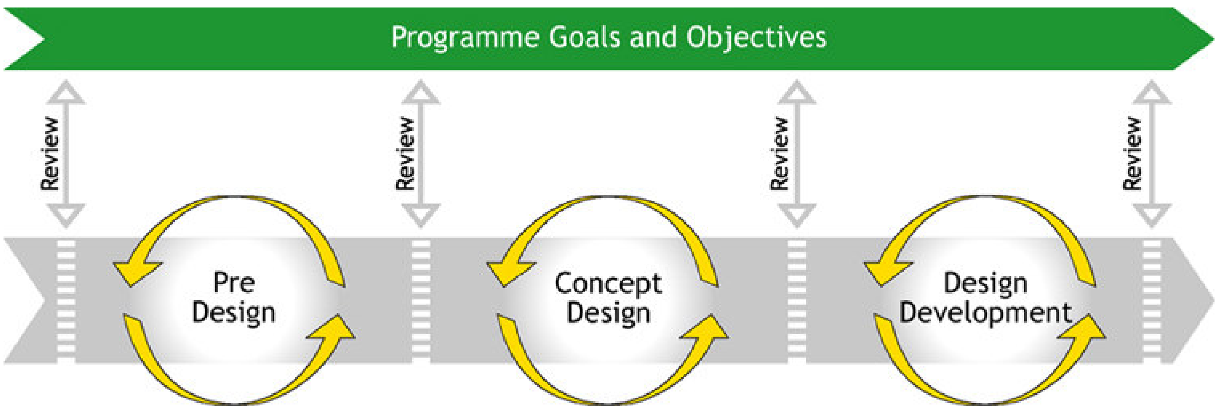
A third cost issue is the fact that it is sometimes hard to justify investments in e.g. energy measures based on future savings during the exploitation of the building. It is important to discuss this issue in advance with the client and to decide upon a certain approach to solve the separation between investments and benefits. In both Dutch projects it was decided that measures with a payback time of seven years or less were acceptable. Of course this problem is easier to solve if the client is also the future user of the building, because in that case he himself benefits from the investment.

In general the structures within the design team with regard to responsibilities, fees, and cost should be modelled in such a way that separation is avoided and integration is stimulated. In order to support the development of an optimal building instead of a building as a combination of sub-optimal systems.

5. The process

5.1 Introduction

Compared to a conventional design approach, the IDP is characterised by integration. This implies that in the early stages of the design process several disciplines (client, architect, project manager, consultants in the field of energy, comfort, sustainability, etc.), are involved right from the beginning of the design or even before that, when the brief is defined.
The Integrated Design Process itself typically consists of a number of design loops resulting in products that are milestones that function as decision documents at transition moments in the design process from one phase to the next. The experiences with the design process gained from the different demonstration projects are highlighted in this chapter.



5.2 The structure of the process

The first design loops start before the actual design activities begin. For many of the projects the design process started with informal discussions and Kick-off Workshops in the phase of initiative and preparation. This approach can be seen as a first design loop in the sense that a clear understanding of the design task is achieved. The projects showed that even the client redefines some of his needs based on the discussions in the Kick-off Workshop. In that case this is an important contribution to a satisfactory end product.

In general the design loops consisted of a mix of activities. The central actions within a design loop are multidisciplinary work sessions where design options are discussed and judged related to the overall performance of the building. Dependencies between different subsystems of the building are addressed and through trade-off analyses the team makes design decisions aiming to avoid sub-optimisation (e.g. in the Zierikzee project it was possible to minimise the HVAC-system by tuning the building envelop properties adequately). In preparation for those work sessions or resulting from them, al kinds of individual or bilateral activities are necessary.
The efficiency of the work sessions is highly dependent on a good preparation of the actor in charge and a clear perception of the goals by the team members is very important. Another factor of success is the motivation and enthusiasm of the team to get involved in this process. Lack of team spirit and communication problems can be a serious obstacle. It will be clear that the Kick-off Workshop can prevent those problems.

Especially in the first stages of the design process integration is a very important issue and adding a facilitator to the team is recommended if the team is not familiar with IDP. In the final design phase the process has a more conventional character. In case innovative technologies are part of the design, integration remains an important issue up to the construction phase and exploitation.
The first stages of the design process may subsequently be a little more time consuming and costly, but a more consistent integrated pre-design prevents inefficiencies in the following part of the design process and results in a better cost-performance ratio of the building.

The Kick-off Workshop in the Dutch projects was organised by the facilitator to start up the design process. ‘It was very effective in stimulating a quick start. In the beginning it was clear that the participants were searching for their position and they were somewhat reserved. The facilitator managed the workshop and drew conclusions

from time to time to point out the function and results of the workshop. At the end the workshop appeared to have been very functional since team members focussed in the same direction. During the workshop the IDP has been introduced, tools, brief and programme of requirements have been discussed, criteria were assessed and a first brainstorm on design directions took place. This workshop took half a day.
In the case of the Zierikzee project, after the Kick-off Workshop, five design team meetings took place until the final design was ready (by January 2002). During these meetings the architectural design and the energy concept developed from the very first conceptual ideas to a more elaborated level. The integrated character of the process was put forward mainly in the meetings (by discussing the results of MCDM and Energy 10), but the team members also had to take it home, since input for MCDM and Energy 10 was to be prepared at the office.
A similar process took place in the Oirschot project except for the fact that a part of the design process takes place outside the design team meeting, without the facilitator being present. In this way it is not always easy to control the process adequately.
In both Dutch projects MCDM 23 was used throughout the process as a help to stimulate communication and discussion. The team members prepared input for the MCDM-sessions at their office, and then, at the meetings, they used this to come to a common understanding on the various design aspects. The facilitator chaired these sessions, which were an important binding element of the integrated design process.

In Mayo the structure was adequate, but could have been better. The design team had previous experience with a C-2000 project, and subsequently had a clear vision of many of the characteristics and features of the building from the outset. Consequently many of the decision-making processes with a less experienced team would go through were circumvented or greatly compressed or accelerated. The owner however chronically regressed into an adversarial mindset regarding the design team. This was mitigated to some extent by the relationship between the energy/comfort/IDP consultant, who had been retained directly by the owner to work with the design team, and generally had the owner's confidence. In accordance with IDP principles, the design team participated as a unit in high-level decision-making. Unfortunately the owner was not always fully integrated or on side in this process. More emphasis on introducing IDP to the client in the very beginning of the process and discussing the expectations and motivation together with the team members could possibly have reduced this effect.
Once general design directions were determined, the team solved specific design issues within their disciplines, with iterative interdisciplinary consultation as required.

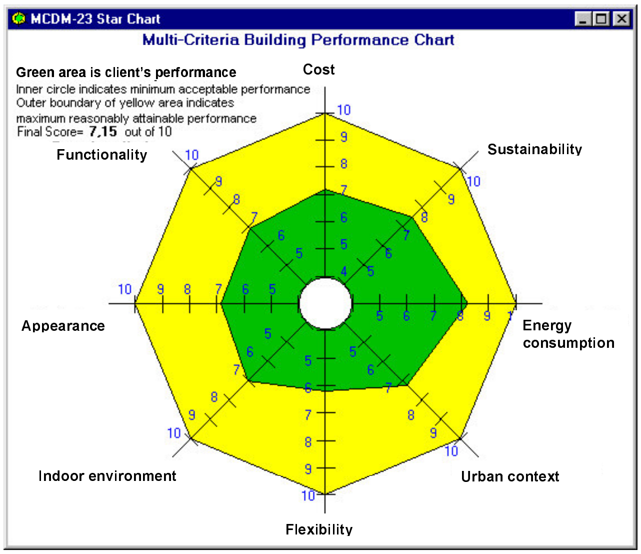
In other projects multidisciplinary work sessions concentrated in the competition phase as in Bonn where the overall design of the building was outlined and determined, taking into account various measures regarding renewable energy, sustainability and energy efficiency. So in the final design phase a detailed design has been made with drawings, specifications, quality assurance and client's approval.
In Kolding during the competition phase a brainstorm approach among architects and engineers has been used to discuss and evaluate specific topics of integration. During the detailed design phase the practical solutions for integration were discussed during the design team meetings.

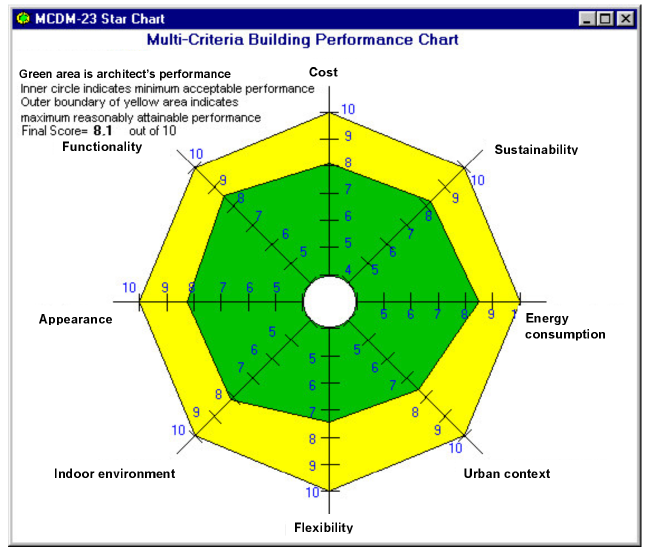
5.3 The manageability of the IDP

Manageability of the activities in the integrated design process is a precondition. From the demonstration projects it became clear that a number of aspects need attention in process management.
In addition to a conventional process especially the integration should be managed, addressing not only activities, time and cost but explicitly managing the quality of communication and the information exchange. The process needs to be managed in such a way that the actors co-operate in an open and enthusiastic atmosphere. This is a specific aspect of IDP that should be organised instead of leaving it up to the actors and the circumstances whether integration occurs or not. This implies a constant attention and management of the dynamics within the team. If an actor is too passive and input from him is required he should be activated. If, at the other hand, a member of the team is too dominant in a counter productive way this should be dealt with adequately.
The Bonn project, with so many members of the design team in such a complex process, showed that the structure becomes quite complicated. Typically no responsible manager for the design process was named. The classical project management does not take this responsibility and the architect is not equipped to do it. So such a large design team needs a special function for co-ordination of the activities to support the management or the architect. In Bonn the classical design process was mainly led by the architect, who was supported in the interdisciplinary approach by the climate engineer and the structural engineer. Experience in Bonn underlines the importance of good communications in the design team : 'The activities were manageable mainly because of the good communication in the design team'.

In order to make the process manageable it is important to concentrate creativity, exchange and integration in those activities that form the design loop. The results of the design loops need to be of high quality in the sense

that it is a sound starting point for the next design loop in the process. This enables a good quality transition from one phase of the process to the other. During this transition the quality of the design related to the expectations of the client is evaluated and made clear to all the actors. During this evaluation deviations in perception of the design performance may occur and need to be clarified, before entering the next phase.
In the Zierikzee project for instance, the preliminary design was evaluated against the Program of Requirements using MCDM 23. On the axis in the star-diagram the performance aimed for in the Program of Requirements was set to a score of eight. A better performance gives a higher score and a under-performance results in a score lower than eight. The difference in judgement between the architect and the client is shown in both star diagrams generated with MCDM 23.





Star-diagram Zierikzee project (client's score) *Star-diagram Zierikzee project (architect's score)*

The scores of the architect are close to eight showing that he considers the design to be close to the expectations. The client is less positive especially with regard to flexibility. After discussion in the team there was a better understanding of the clients needs and the performance of the design.

Especially in the earlier stages of the design process there is a significant difference between IDP and a conventional approach. Later in the process (final design) both approaches are more alike. Actors are moving into activities of dimensioning components which is a more discipline defined task as long as conventional systems or components are involved. If innovative technologies are considered the integration aspect remains important even during realisation and use of the building. This was obvious in the Kolding project where most of the integrated design activities were carried out as part of the competition by a team experienced with integrated design. During the detailed design phase a traditional straightforward approach was used. In this last stage of the process the main contractor was responsible for all co-ordination of the design and the architect and engineers were responsible for their own part of the design work.

The need for coaching and managing the integration aspects is of course much more evident in case of a design team with little or no experience with IDP. If IDP becomes a more common approach, managing IDP will integrate in the roles of the different actors, as was the case in the Danish and German projects. In practice the common situation is that a team has only limited experience with IDP. Therefore in many cases additional management and coaching is necessary. This support is of course dependent on the nature of the design task and the composition of the team and should be organised depending on the specific project.
By adding an IDP-facilitator to the team coaching and managing can be provided under the conditions that the responsibility of the facilitator is covered with a matching mandate from the client. This is crucial in order to enable the facilitator to enforce those actions necessary to fulfil his task.
The role of the facilitator varied in the projects from an external actor providing information and leading work sessions with limited power (project Oirschot and Zierikzee) to a combined role of consultant and facilitator as in the Canadian project.

The IDP aspects of the process in Oirschot were sometimes hard to manage. Because the members of the design team belong to the same organisation, a large part of the design process in Oirschot took place on an informal basis outside the official team meetings and outside the facilitator's field of vision. It therefor was sometimes hard to steer the processes optimally and prevent a tendency towards a conventional approach. The facilitator tried to manage those activities in the process by providing the team with general design (process) guidelines in order to support the informal team meetings without the participation of the facilitator. Although this way the problem was tackled, a higher level of involvement of the facilitator is recommended. In the Zierikzee project a similar situation occurred but since the members of the design team were not in the same company bilateral meetings were officially planned and thus the facilitator was able to participate if necessary. In this way the activities in Zierikzee were well manageable.

The level of involvement of the facilitator is an important issue to decide upon (see also chapter 4.2). A combination of the facilitation task with for instance consultancy in the field of energy, comfort and sustainability, seems to work effectively. In that case it is important that the double role of the facilitator is dealt with in a proper way.
If the attention for IDP is decreasing during the process the actors tend to return to their conventional roles. This was a point of attention in the project Oirschot.
In Bonn, the client hired an expert who controlled the concept to ensure the functionality of the innovative energy concept. By introducing the client step by step into the concept, by verification through tests, and by involving industrial partners to realise the concept and its components the design was verified and accepted by all that were involved in the project.

The demonstration projects proved that an Integrated Design Process can be managed successfully if integration aspects are dealt with in an explicit way. To structure the process according to the specific design task, composition of the team and the external influences, the products developed by IEA SHC Task 23 turned out to be very effective.

Appendix 1: Building parameters

The table below provides technical characteristics of the demonstration project buildings.

Projects	Mayo Canada	Kolding Denmark	Bonn Germany	Zierikzee The Netherlands	Oirschot The Netherlands
Type of building	school	community centre	office	office	Office
Number of persons	390	100	2.500	70	200
Number of floors	1	1-2	43	2	3
Typical running hours	8 am - 10 pm	8 am – 10 pm	8 am – 10 pm	8 am – 6 pm	7 am – 9 pm
Construction type	Wood	Steel, concrete, wood	Concrete with glazed facades	Concrete with brick facade (outer cavity wall)	Steel, concrete
Type of solar shading	External shades, louvered to provide snow shedding capacity Interior blinds	Integrated PV panels in the south facade	Venetian blinds in double facade, movable, user controlled	External, moveable, user controlled	User controlled

Energy consumption (total for heating and electricity – net, secondary energy)

Expected (calculation)	KWh/m²	266	< 100	100	< 100	< 100
Typical for building type	KWh/m²	500 - 600	120	170 - 300	100	120

Building costs per m² floor area (gross)

Actual	€	1.330	1.350	2.300	1.500	1.250
Typical for building type	€	800 - 900	1.100	2.000-3.000	1.350	1.250

Size and height

Floor area	m²	3.400	1.058	66.400	1.950	4.200
Heated floor area	m²	3.200	1.058	45.000	1.860	3.700
Glazed spaces	m²	2.970	200	3.000	90	200
Height floor to ceiling	m	2,7 – 5,0	3,05 – 4,5	3,0	3,5	2,9
Height gross	m	3,5 – 5,8	3,4 – 4,8	3,5	4,0	3,2

Insulation (U-value)

Wall	W/m².K	0,16	0,21	0,22	0,27	0,30
Roof	W/m².K	0,09	0,12	0,15	0,19	0,30
Floor	W/m².K	1,90	0,17	0,40	0,27	0,30
Glazing	W/m².K	0,77	1,10	1,1 0,8 (double facade)	1,20	1,40

Window fraction wall

North	%	18	44	100	28	30
East	%	4	22	100	35	30
South	%	28	91	100	28	30
West	%	5	23	100	15	30

Appendix 2: Applied technologies

The table below provides information about energy efficient and sustainable technologies applied in the demonstration project buildings. (N.Y.D. = not yet decided)

Technologies	Mayo Canada	Kolding Denmark	Bonn Germany	Zierikzee The Netherlands	Oirschot The Netherlands
Type of building	school	community centre	office	office	office
Passive solar	Yes	Yes	Yes	Yes	Yes
Active solar	No	Yes	No	Yes	N.Y.D.
Daylight	Yes	Yes	Yes	Yes	Yes
Glazed spaces	No	Yes	Yes	Yes	Yes
Photo-voltaic panels	No	Yes	No	Yes	No
Solar hot water system	No	Yes	No	No	N.Y.D.
Vent. System with recovery	No	No	Yes	Yes	Yes
Energy efficient lighting	Yes	Yes	Yes	Yes	Yes
Heat pumps	No	No	Yes	Yes	N.Y.D.
Combined heat & power	No	No	No	No	No
Building management syst.	Yes	Yes	Yes	No	Yes
Environmentally friendly materials	Yes	Yes	Yes	Yes	Yes
Use of rainwater	No	Yes	No	No	Yes
Sorting of waste	No	Yes	Yes	Yes	Yes
Groundwater	Yes	No	Yes	Yes	No

Heating system	Hot water boilers Four pipe fan-coil	Local district heating Radiators and floor heating	Building integrated heating/cooling panels in ceiling + individual convector	Air heating	Not yet decided
Ventilation	Mechanical with heat recovery	Hybride natural ventilation	Natural + individual mechanical ventilation	Mechanical with heat recovery	Mechanical with heat recovery
Climate control		Central computer based (BEMS)	Individual with central overwrite	Computer based, central control with limited, individual control	Central mechanical ventilation with cooling and heating. Individual natural ventilation and heating