Overview of the Integrated Design Process
Contents

- Introduction
- Buildings and Building Performance
- Basis of IDP
- What kind of process should be followed?
- Participants in the process
- Examining IDP steps in more detail
- Project examples
- Post Occupancy Evaluations
Introduction
The process was primarily developed in the NRCan C-2000 program during the 1994-2001 period; 

C-2000 was a demonstration program for very high performance commercial buildings; 

Program managers assumed that high performance would require leading-edge systems and heavy subsidies; 

It was found that design teams achieved the target performance levels, but avoided using leading-edge systems to avoid difficulties with untried systems; 

When interviewed, teams stated that the performance results were mainly due to the process requirements of the program.
Other initiatives related to IDP

- Bill Bordass and Adrian Leaman (UK) were co-parents of IDP, with their *Soft Landings* program;
- Task 23 of the International Energy Agency (IEA) had a focus on IDP;
- Sustainable Buildings Canada (SBC), an NGO in Toronto, has worked with Enbridge Gas to carry out many IDP projects across all building typologies;
- iiSBE was the technical advisor in a project to develop IDP for the Turkish government in 2016;
Task 23 “Optimization of Solar Energy Use in Large Buildings”

...has focused its work on exploring the nature of the IDP, an approach and design procedure that has proven to be highly effective in producing high-performance and environmentally-friendly buildings. Twelve countries were involved in this Task over a five-year period, putting together the expertise from researchers, architects and consultants in producing a practical approach towards IDP. The IDP approach has been applied in a number of real design processes, and the evaluation of this experience has provided valuable feedback.

The following countries participated in the task:
Austria Germany Spain
Canada Japan Sweden
Denmark Norway Switzerland
Finland The Netherlands USA

Multi-Criteria Decision-Making MCDM-23

A method for specifying and prioritising criteria and goals in design
Douglas Balcomb National Renewable Energy Laboratory Golden
CO, USA
Inger Andresen SINTEF Civil and Environmental Engineering
Trondheim, Norway
Anne Grete Hestnes NTNU Trondheim, Norway
Søren Aggerholm Danish Building and Urban Research Hørsholm,
Denmark

SOLAR LOW ENERGY BUILDINGS AND THE INTEGRATED DESIGN PROCESS

An introduction

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Task 23-Optimization of Solar Energy Use in Large Buildings
IDP benefits and costs

- High performance in a broad spectrum of parameters, including energy and IEQ;
- Higher quality;
- Appeals to an increasing market segment;
- Longer schematic design process, but a shorter contract documentation period and fewer change orders;
- Somewhat higher capital costs (0 to 10%), but lower operating costs;
- In any case, clients who have used IDP feel that any extra cost or time was worth it.
Buildings and Building Performance
Key issues in building design

20th Century
- Location and site
- Capital cost
- Operating cost
- Market appeal
- Beauty....

Added in 21st Century
- Vulnerability to climate change
- Energy and resource consumption
- Environmental impact
- Indoor Environmental Quality
- Functional / serviceability issues
- Social and perceptual factors
- Other...
Proportions of Total Building Stock, plus ou moin

- Total building stock 100%
- Existing buildings 94%-97%
- New buildings 3-6%
- Certified Buildings <1% ?? (for both new and existing buildings)

Performance certification requires availability of performance data for a reference building with the same type and general location.
Observations on building performance

Designers may estimate future performance to two decimal places, but often ignore some factors that have major impacts;

- There may be large differences in results based on simulations of future performance vs. monitored actual data;
- There are major differences in hours of use by occupancy type;
- In office occupancies, what assumptions should be made about changes in occupancy days due to working at home?
- Investors, operators, tenants, occupants and visitors are all involved over different time scales;
Diverse occupancy profiles and building configurations provide opportunities for synergies in renewable power, thermal energy, water consumption and parking area requirements.

Different occupancy types have different usage schedules.

Timescale: Design and Construction are relatively quick but pain or gain are long-term.

- Risk and expense of initial investor
- Benefits to future owners and occupants
- Developer / Owner 1
- Owner 2
- Owner 3
- Owner 4
- Owner 5
- Operations
  - Pre-Design
  - Design
  - Construction
  - Refit
  - Renovate
- Demolition or Disassembly
- Perhaps 20 generations of occupants?
- 10
- 20
- 30
- 40...
- Years

Perhaps 20 generations of occupants?
Performance assessment, rating, certification & labeling

- **Assessment**: an evaluation
- **Rating**: a score or result relative to a norm or global benchmark. Ratings can be based on self-assessment or carried out by third parties.
- **Certification**: validation of rating or assessment results by a knowledgeable third party that is independent of both the tool developer and the developer/designer of the project.
- **Labeling**: proof of a rating or certification result, issued by the certifier.
Labels, or proof of certification

LEED® for Commercial Interiors

A-AS DESIGNED

Net-Zero Energy: A+  High Performance: A

Good: C  Fair: D  Poor: E  Unsatisfactory: F

ASHRAE: In order to best meet our current and future climate needs, we have
the potential to design and build a net-zero energy building, a building that
produces as much energy as it consumes, year-round.

BUILDING ENERGY QUOTIENT®

Environmental Assessment Award

This is a request for...

British Library Conservation Centre,
St Pancras, London, NW1

bre
Priorities, logical sequence and effectiveness

We are used to hearing the mantra *reduce, reuse and recycle*, and there is an equivalent in sustainable building design

1. Question the functional requirement in its totality and probe for waste and excess;
2. Renovate an existing building to meet the reduced needs;
3. Minimize gross energy requirements through passive and intelligent design;
4. Use renewable energy sources to meet as much as possible of remaining energy requirements;
5. Ensure that energy-using systems still required are as efficient as possible;
6. Re-use materials, or use renewable or recycled materials;

The first imperative is undoubtedly the hardest to control
Progress in Dubai?

1. Dubai World Trade Center, 1979

278 kWh/m²

Emirates Tower, 2000

560 kWh/m²

Source: Khaled A. Al-Sallal
Basis of IDP
What is IDP?

- IDP is a method to intervene in the design stage to ensure that all issues that can be foreseen to have a significant impact on sustainable performance are discussed, understood and dealt with at the beginning of the design process;
- IDP helps the client and architect to avoid a sub-optimal design solution;
- It enables the achievement of high levels of building performance through integrated design.
The logical basis of IDP

(Pareto Principle, 1896)

Max

Min

Schematic Design
Design Development
Contract Documentation
Construction
Commissioning
Operations

Increasing cost and disruption
Decreasing impact on performance

Effective Interventions
Specific barriers to sustainable building practices

- Limited market demand for high performance buildings;
- Actual or perceived cost of building to a high level of performance;
- Lack of simple funding mechanisms to pay for incremental performance;
- Difficulty of measuring environmental performance in an objective and reliable way;

Most Important:
- Increasing requirements for specialized skills and knowledge in the design process;
- Skills deficits in small design firms;
- Making bad decisions early in the design process.
Problems in the conventional process

- The architect may develop a concept design that is agreed to by the client;
- After both parties are committed, engineers and other key actors are brought in, to ensure that the chosen concept can perform as efficiently as possible;
- That is too late, and the design’s performance potential may be limited from its inception;
- There are also new specialties, such as daylighting, thermal storage etc. that require skills not often found in conventional design firms;
- At a later stage, there may be attempts to graft high-performance technologies on to the design, but that is usually an expensive failure.
Design iterations are inevitable in any design process, but they only make a positive contribution if carried out **early** in the process.
Problem buildings

- Same window specs for all orientations lacks logic.
- too much or too little glazing in the wrong places.
- This design became a solar oven and caused all occupants to move out.
- A lovely atrium but too hot on top floor and too noisy on all floors.
After the Mitterand library in Paris was completed the fully glazed walls had to be provided with internal wood walls to protect users and books, but it was too late to control solar heat gain.
MIT sues Gehry, citing leaks in $300m complex
Blames famed architect for flaws at Stata Center

"I still would prefer straight to slanted walls, so as to put up bookshelves and a blackboard." Noam Chomsky, who has an office in the Stata Center.

By Shelley Murphy
Globe Staff / November 6, 2007

The Massachusetts Institute of Technology has filed a negligence suit against world-renowned architect Frank Gehry, charging that flaws in his design of the $300 million Stata Center in Cambridge, one of the most celebrated works of architecture unveiled in years, caused leaks to spring, masonry to crack, mold to grow, and drainage to back up.

The suit says that MIT paid Los Angeles-based Gehry Partners $15 million to design the Stata Center, which was hailed by critics as innovative and eye-catching with its unconventional walls and radical angles. But soon after its completion in spring 2004, the center’s outdoor amphitheater began to crack due to drainage problems, the suit says. Snow and ice cascaded dangerously from window boxes and other projecting roof areas, blocking emergency exits and damaging other parts of the building, according to the suit. Mold grew on the center’s brick exterior, the suit says, and there were persistent leaks throughout the building.
What kind of process should be followed to ensure good results?
To be well suited to its climatic and functional needs, a design requires integrated thinking early in the design process.
Imagine if...

- ...key actors could examine elements of the functional program (client brief) to minimize grandiosity, illogicality and waste before the concept design is developed?
- ...we would use the experience and knowledge of engineers, building operators and even users, early enough to influence the design?
- ...the team develops at least one alternative schematic design?
- ...what if we use energy, IEQ modelling programs at the schematic design stage?
- All of this is common sense, but rarely followed.
How early is early intervention?

- Ideally even before functional requirements are defined and the location is fixed;
- Preferably before the design team is contracted, to ensure that they know the process will be different;
- Certainly before any schematic designs are agreed upon
IDP for a better design and development process

1. Consider program logic, renovation options and site issues
2. Set performance targets
3. Develop a building information model (BIM – a recent addition)
4. Undertake passive solar design and optimize envelope design
5. Maximize use of renewable energy
6. Use efficient systems to meet residual energy-using requirements
7. Construct and then commission key systems
8. Ensure effective operational management
### Generic Steps

The graphic shows the generic steps that are used in the XLS program that is available separately or as part of the SBTool framework. The text and order of these steps can be modified by users.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.0</td>
<td>Develop a functional program, examine assumptions and establish performance targets</td>
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<tr>
<td>2.0</td>
<td>Assess site characteristics and any existing structures</td>
</tr>
<tr>
<td>3.0</td>
<td>Assess any existing structures and materials that may be re-used</td>
</tr>
<tr>
<td>4.0</td>
<td>Assemble the design team</td>
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<tr>
<td>5.0</td>
<td>Develop Reference design and benchmarks</td>
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<tr>
<td>6.0</td>
<td>Hold an initial Design Workshop</td>
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<tr>
<td>7.0</td>
<td>Develop Concept Design</td>
</tr>
<tr>
<td>8.0</td>
<td>Consider site development issues</td>
</tr>
<tr>
<td>9.0</td>
<td>Determine building structure</td>
</tr>
<tr>
<td>10.0</td>
<td>Develop building envelope design</td>
</tr>
<tr>
<td>11.0</td>
<td>Develop preliminary daylighting, lighting and power system design</td>
</tr>
<tr>
<td>12.0</td>
<td>Develop preliminary ventilation, heating &amp; cooling and wet services designs</td>
</tr>
<tr>
<td>13.0</td>
<td>Decide on major design options for detailed development</td>
</tr>
<tr>
<td>14.0</td>
<td>Screen non-structural materials for environmental performance</td>
</tr>
<tr>
<td>15.0</td>
<td>Complete design and documentation</td>
</tr>
<tr>
<td>16.0</td>
<td>Develop QA strategies for construction and operation</td>
</tr>
<tr>
<td>17.0</td>
<td>Site takeover, existing building decontamination &amp; deconstruction, excavation &amp; foundations</td>
</tr>
<tr>
<td>18.0</td>
<td>Complete above-grade construction</td>
</tr>
<tr>
<td>19.0</td>
<td>Prepare a set of as-built construction documents</td>
</tr>
<tr>
<td>20.0</td>
<td>Operate and maintain the building</td>
</tr>
<tr>
<td>21.0</td>
<td>Carry out post-occupancy evaluation and monitor performance</td>
</tr>
</tbody>
</table>
**Generic IDP steps at detailed levels 1 and 2**

The graphic shows generic IDP steps 1 and 2 at a detailed level. The text and order of these steps can be modified by users.

### 1.0 Develop a functional program, examine assumptions and establish performance targets

1.01 Develop a functional program...
1.02 Review budget for compatibility with financial goals.
1.03 Assess the capacity of the program to support mixed uses and changes in future uses.
1.04 Ensure that the program is compatible with high performance and green operations.
1.05 Confirm client’s commitment to supporting measures required for high performance.
1.06 Retain the core design team, including at least the Architect and Energy Engineer (see also 4.01).
1.07 Carry out an initial study of the feasibility of using renewable energy systems (see www.RETSreen.net).
1.08 Develop an initial statement of performance goals, targets and supporting strategies.
1.09 Carry out an Environmental Impact Assessment, based on preliminary assumptions about the site characteristics, building program, size and location on the site.
1.10 Prepare a Functional Program and Performance Goals Report, including a completed File B of SBTool.

### 2.0 Assess site characteristics and any existing structures

2.01 Assess the suitability of the site in terms of easy access to good public transportation services.
2.02 Assess the suitability of the site in terms of access to commercial and public services, recreation and public green space.
2.03 Pre-development agricultural value of land used for the project.; Pre-development ecological status of the site
2.04 Assess erosion potential of surface soils and soil stability and bearing strength of sub-surface soils.
2.05 Assess the ecological quality of the site. Report on results in ContextB worksheet.
2.06 This is a brownfield site, take steps to remediate conditions (see ContextB).
2.07 Examine soil for presence of radon.
2.08 Identify any features in adjacent properties that may place constraints on the design of the subject building.
2.09 Measure typical Sound Level (Leq) at the noisiest site boundary. Report on results in ContextB worksheet.
2.10 Prepare a Site Characteristics Report.
Generic IDP steps at detailed level 12

The graphic shows generic IDP step 12 at a detailed level.
Use the tool to identify actors

Blue clickable boxes are used to select actors to be involved in each step from list below;

Color circles can connect to relevant websites
Results

- IDP results in design integration, which provides better performance;
- For example, a design that maximizes daylighting will reduce the lighting load;
- Reduced cooling requirement will reduce duct sizes and chiller capacity needed;
- Current operating cost and future maintenance and replacement costs will also be reduced;
- And all this reduces life-cycle greenhouse gas emissions.
Another view of the process
High Performance Through Integrated Design

This chart shows only some major Decisions, Building Effects and External Impacts. Fuel-based heating and some electrically-powered mechanical cooling is assumed.

Blue box indicates a design decision
White box indicates an effect on building performance
Yellow box indicates an environmental or economic impact

Links between generic steps in the design and development process

Design landscaping and building for minimum water use
- Potable water consumption is minimized, sewage flow is reduced

Select a location that supports the use of public transport (high density, mixed uses)
- Commuting transport is reduced
- Use of land for roads & utilities is reduced

Avoid selecting a location that has high ecological or agricultural value
- Land of high ecological or agricultural value is preserved

Re-use existing structure and/or materials where possible
- Use of new materials is minimized

Locate building on site to take advantage of micro-climatic conditions
- Exposure to useful summer winds for natural ventilation is maximized & exposure to winter winds is minimized
- Provide natural ventilation wherever possible

Provide glazing and exterior shading that will maximize useful daylighting and minimize overheating
- Illumination needs are reduced during daylight hours

Orient and configure building on site to maximize passive solar potential
- Solar gain is maximized during heating season and minimized during cooling season

Provide a building envelope with low U value and air infiltration values
- Energy transfer through the building envelope is reduced

Use of land for roads & utilities is reduced
- Use of construction materials is reduced

Use materials with minimum VOC for interior use
- Fan power requirement is reduced

If air distribution is used for heating & cooling, duct sizes can be reduced
- Select efficient fans, drives and control systems

Transformer and distribution capacity may be reduced
- Use of land for roads & utilities is reduced

Transformer and distribution capacity may be reduced
- Smaller/less equipment reduces capital costs and replacement and maintenance costs.

Indoor Environmental Quality is enhanced
- Fan power requirement is reduced
- Select efficient fans, drives and control systems

Select efficient heating system; use heat recovery where applicable
- Select efficient heating system; use heat recovery where applicable

Space heating loads are reduced
- Space heating loads are reduced

Select efficient illumination systems
- Select efficient illumination systems

Minimize use of mechanical cooling; use advanced cooling methods
- Minimize use of mechanical cooling; use advanced cooling methods

Energy operating costs are reduced
- Energy operating costs are reduced

Energy transfer through the building envelope is reduced
- Energy transfer through the building envelope is reduced

Space cooling loads are reduced
- Space cooling loads are reduced

Minimize use of electrical loads
- Minimize use of electrical loads

Chiller can be eliminated or reduced in capacity
- Chiller can be eliminated or reduced in capacity

Energy consumption is reduced
- Energy consumption is reduced

Select efficient heating system; use heat recovery where applicable
- Select efficient heating system; use heat recovery where applicable

Space heating loads are reduced
- Space heating loads are reduced

Select高效 fans, drives and control systems
- Select efficient fans, drives and control systems

Transformer and distribution capacity may be reduced
- Transformer and distribution capacity may be reduced

Embodied energy and emissions from initial production of materials are reduced
- Embodied energy and emissions from initial production of materials are reduced

Smaller/less equipment reduces capital costs and replacement and maintenance costs.
- Smaller/less equipment reduces capital costs and replacement and maintenance costs.

Future embodied energy and emissions from eventual replacement is reduced
- Future embodied energy and emissions from eventual replacement is reduced

Scarc fossil fuels are conserved for other uses.
- Scarce fossil fuels are conserved for other uses.

GHG emissions from electrical generation are reduced, lower atm.c emissions provide public health benefits.
- GHG emissions from electrical generation are reduced, lower atm.c emissions provide public health benefits.

Percent of GDP spent on energy is reduced.
- Percent of GDP spent on energy is reduced.

Public and private environmental, social, health and economic benefits

Scarce fossil fuels are conserved for other uses.
- Scarce fossil fuels are conserved for other uses.
Participants in the process
Who is involved in IDP?

- It is essential to have a client who wants high performance or is at least open to the idea, and who is willing to pay full design fees and a slight (2% to 10%) increase in capital costs;

- An inter-disciplinary team is needed, and the available level of skills and knowledge should be augmented if necessary by contracting additional specialists;
Key actors – it’s a team

- Investor
- Client
- Local government planner
- Tenants and occupants
- O&M manager
- Architect
- Energy engineer
- Soils / foundations engineer
- Civil/ services engineer
- Structural engineer
- Mechanical engineer
- Electrical engineer
- Lighting designer
- Landscape designer
- Interior designer
- Materials specialist
- Acoustics specialist
- Costing specialist / QS
Other key actors

- Involve an energy specialist and carry out simulations at several key points;
- Retain a specialist to calculate embodied energy and emissions using an LCA-based calculation program;
- Involve other specialists (e.g. materials, daylighting, etc.) for short and focused consultations.

Design Facilitation

- Where possible, provide a Design Facilitator.
- The DF should have a broad knowledge of performance issues and should also be sensitive to the need not to undercut the authority of the architect;
- The DF should act as a bridge between the design team and the client and should manage design workshops and the introduction of specialists;
Examining IDP steps in more detail
Simplified overview of an IDP process for a new building

1. Functional program
2. Selected site
3. Design team
4. Baseline schematic design
5. Moderate performance version
6. Review & select
7. High performance version
8. Selected schematic design
9. Develop detailed design
10. Completed detailed design
11. Construct & commission
12. Operate

- Performance targets
- Building Information Model (BIM)
- Orient & locate fenestration for passive solar
- Maximize use of renewables
- Use high efficiency HVAC for residual loads
- Carry out energy simulations
Links between generic steps ... a specific example

Hypothetical and simplified example Part 1

Legend

- **Major step(s)**
- **Direct effect(s)**
- **Final Impact(s)**

- **Major step(s):** Locate building on site to take advantage of micro-climatic conditions

- **Direct effect(s):** Exposure to useful summer winds for natural ventilation is maximized & exposure to winter winds is minimized

- **Final Impact(s):** Provide natural ventilation wherever possible

- **Fan power requirement is reduced**

- **Select efficient fans, drives and control systems**

- **Space cooling loads are reduced**

- **Select efficient illumination systems**

- **Illumination needs are reduced during daylight hours**

- **Waste heat generation from lighting is reduced**

- **Select efficient heating system; use heat recovery where applicable**

- **Energy transfer through the building envelope is reduced**

- **Space heating loads are reduced**

- **Provide glazing and exterior shading that will maximize useful daylighting and minimize overheating**

- **Provide natural ventilation wherever possible**

- **Fan power requirement is reduced**

- **If air distribution is used for heating & cooling, duct sizes can be reduced**
Embodied energy and emissions from initial production of materials are reduced if air distribution is used for heating & cooling; duct sizes can be reduced.

Floor-to-floor heights can be reduced, or daylighting enhanced.

Indoor Environmental Quality is enhanced.

Occupant health, comfort and productivity is improved.

Floor-to-floor heights can be reduced, or daylighting enhanced.

Transformer and distribution capacity may be reduced.

Smaller/less equipment reduces capital costs and replacement and maintenance costs.

Future embodied energy and emissions from eventual replacement is reduced.

Select efficient fans, drives and control systems.

Transformer and distribution capacity may be reduced.

Smaller/less equipment reduces capital costs and replacement and maintenance costs.

Select efficient heating system; use heat recovery where applicable.

Select efficient heating system; use heat recovery where applicable.

If air distribution is used for heating & cooling, duct sizes can be reduced.

Select efficient illumination systems.

Electrical loads are reduced.

Use renewable energy for DHW, air preheating and electrical suppl. (PV).

GHG emissions from electrical generation are reduced, lower atm. c emissions provide public health benefits.

Scarce fossil fuels are conserved for other uses.

Percent of GDP spent on energy is reduced.

Future embodied energy and emissions from eventual replacement is reduced.

Energy operating costs are reduced.

Fuel-based energy consumption is reduced.

Select efficient fans, drives and control systems.

Select efficient heating system; use heat recovery where applicable.

Minimize use of mechanical cooling; use advanced cooling methods.

If air distribution is used for heating & cooling, duct sizes can be reduced.

Select efficient heating system; use heat recovery where applicable.

Minimize use of mechanical cooling; use advanced cooling methods.

Select efficient fans, drives and control systems.

Select efficient heating system; use heat recovery where applicable.

Minimize use of mechanical cooling; use advanced cooling methods.

Select efficient fans, drives and control systems.

Select efficient heating system; use heat recovery where applicable.

Minimize use of mechanical cooling; use advanced cooling methods.

Select efficient fans, drives and control systems.

Select efficient heating system; use heat recovery where applicable.
Overview of a rational renovation process

Existing building

- Suited only for demolition/dismantling

- Building not suited for renovation, but some materials OK

- Suitable for renovation

Inspect & Assess

Suitable for renovation

- Set performance targets

Establish process

- Construct and commission

Acceptance

Bundle renovation tasks and consider a floor-by-floor approach to minimize disruption to existing operations.

Relocate tenants in adequate temporary accommodation.

Re-use existing materials and components if sound (may need review by engineer).
Review requirements and the functional program

- The program may reflect design expertise, but some input may be lacking, for example from operating and maintenance staff;
- Ensure there is some flexibility to convert part or all of the building to other uses in the future;
- Can parking requirements be reduced?
- But the architect is often not allowed to question the program.

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<td>S</td>
<td>Implement Commissioning</td>
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<tr>
<td>T</td>
<td>Carry out Post-Occupancy Evaluation, operate the building and monitor its performance</td>
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Establish Reference and Target Benchmarks

- The design team needs performance benchmarks to define both minimum acceptable and target values;
- The Architect should produce a schematic design for a conventional design, to facilitate comparisons and to support energy simulations;
- Benchmarks of local industry values for other parameters, such as water consumption, materials use, IAQ, solid waste handling etc., are also needed.
- Some of these found as standards referred to in municipal regulations, ASHRAE,CIBSE, etc.;

- If time and budget permits, a wide spectrum of benchmarks should be defined. This may not be worth it for a single building, but may be for a group of buildings.
Develop and test alternative designs

- Develop at least two design upgrade packages, using the Reference Design as a starting point: a moderate and a very aggressive improvement case;
- Carry out simulations for all variants;
- Compare the upgrade packages with the Reference case and select one that is achievable within the budget, but considering also operating savings;
- Do not follow the Value Engineering approach of discarding upgraded systems one by one; consider them as whole packages only (..neither value nor engineering..).
Design options

- Base case or Reference model
- Moderate upgrade
- Aggressive upgrade

Pick one, based on cost v. benefit
Design Charrette(s)

- Hold a design charrette, an intensive but short workshop;
- Specialists can present new ideas that the owner and designers may not be aware of;
- The feasibility of adopting one or more performance upgrade options can be considered;
- A charrette can be one or two days in length;
- We recommend holding a major initial charrette, plus one or more additional shorter sessions, depending on the size and complexity of the project.
The Design Charrette(s)

**Actors involved**
- AR
- DF

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| IDP steps are shown in a linear sequence, but some steps may be performed in a different sequence or may be repeated, and some may not apply to all project types. See Level 3 for detailed comments. To see text for inactive criteria, go to the corresponding number on the IDPList worksheet. |

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**Links within file and to websites**

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**Relevance (0=no, 1=yes, 2=resid., 3=renov.)**

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**Integrated Design Process**

**Guidance for TBA**

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**iDP**

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**Develop a functional program, examine assumptions and establish performance targets**

**Assess site characteristics and any existing structures**

**Assemble the Design Team**

**Develop Reference Design and Benchmarks**

**Hold an initial Design Workshop**

**Develop Concept Design**

**Consider site development issues**

**Determine building structure**

**Develop Building Envelope Design**

**Develop preliminary daylighting, lighting and power system design**

**Develop preliminary ventilation, heating & cooling system designs**

**Decide on major design options for detailed development**

**Screen non-structural materials for environmental performance**

**Develop Commissioning**

**Complete design and documentation**

**Develop QA strategies for construction and operation**

**Site takeover, existing building decontamination & deconstruction, excavation & foundations**

**Complete above-grade construction**

**Implement Commissioning**

**Carry out Post-Occupancy Evaluation, operate the building and monitor its performance**
Preventing chaos

- Involving everyone in all decisions would cause chaos;
- The process can be managed in a disciplined way, with inputs from relevant actors obtained at various definite points in the process;
- Thus, benefits of additional views can be usefully integrated into the design process;
- Which actors are relevant at certain stages depends partly on the nature of the project (e.g. simple and small v. specialized and large building);
- Think of it as conducting a small orchestra.
A Large Design Charrette
Examples of projects
This was the first retail building in Canada to comply with the C2000 Green Building Standards and the focus on re-use and recycling of materials was also part of MEC’s marketing strategy;

Over 56% of the materials of this two storey, 2,484 m$^2$ building are composed of recycled content or salvaged items;

Energy modeling was used throughout the design process and was crucial to the achievement of a 55% reduction in energy consumption relative to the MNECB;

The completed building cost 10% more than standard retail construction costs, a small part of the MEC marketing budget.
Setting Goals: an example, MEC Ottawa

- Achieve a LEED “Gold” rating.
- Use a C&D waste management plan for reuse and recycling & zero land fill.
- Maximum use of salvaged rather than new materials
- Minimum of 80% of all materials must be from within 500 km of the site.
- Minimum of 10% of the energy requirements from renewable energy sources.
- Reuse a minimum of 75% of the existing structure and shell.
- Integrate a maximum number of native & drought tolerant trees and plantings.
- A water conservation plan to be developed.
- High reflective surfaces (albedo) to be used for roofs & parking lots.
- Lighting load at 22 Watts/m² or less.
C-2000: Mountain Equipment Coop, Winnipeg, Canada

- 95% of materials in 2 existing structures were re-used;
- >50% energy reduction
- About 10% incremental cost (but less than annual marketing budget)
- IDP process used
- The client was key
■ 48 units in six floors
■ Annual energy consumption 137 kWh/m², >35% reduction from MNECB
■ Annual water consumption 0.5 m³/m², 25% of normal
A new school had to meet C-2000 performance standards (50% energy reduction) on a fixed budget. The IDP process was used.
C-2000: Red River College, Winnipeg, Canada

- A complex community college project, involving restoration, renovation and new construction
- The architect stated that completion on time and budget was “only possible through IDP”.
Manitoba Hydro Head Office, Winnipeg, MB, Canada

60% energy efficiency in an extreme climate, which is almost double the efficiency of any office tower in Canada; targeting LEED Platinum; over 94% of the city is accessible by public transit from the site; urban catalyst with the influx of 2000 employees to downtown
Intelligent facades integrate climate responsive technologies, like solar shading, humidification, radiant heating and passive solar collection.

High Performance Double Facades
Energy Consumption – 60% Savings

Building Type/Use:
Corporate Headquarters/Commercial Work Space

Approximate gross area:
64,810 m² (690,000 Ft²)

Number of floors above ground:
23 (including penthouse)

City, Country:
Winnipeg, CANADA

Year of completion:
2008

Client:
Manitoba Hydro

Architects:
Kuwabara Payne McKenna Blumberg
Architects (design architects)
Smith Carter Architects & Engineers
(architects of record)
Prairie Architects Inc.
(advocate architects)

Energy analysis:
Transsolar
(Energy/Climate Engineers)

Full natural ventilation mode
Ventilation is completely driven by solar-augmented thermal buoyancy and wind, through the exhaust chimney. Since the air is not conditioned, it can enter through large openings in the facade rather than the restrictive heating coil, cooling coil, or heat exchanger in an air handling unit. Thus air movement requires much less power, so that the pressure differences generated by the chimney are sufficient.

A final modelling predicted a 64.5% reduction
Energy use intensity (EUI)

- Reference EUI - typical for building type (kWh/m²/yr)
- Predicted EUI - modelled (kWh/m²/yr)
- Actual EUI - metered (kWh/m²/yr)
Conclusions

- IDP is based on a powerful logic: involve the people who matter and do so early in the process;
- Assess the predicted performance as the process evolves and revise the emerging design as needed;
- It is not a recent invention, but recent work has given it a more coherent and complete basis;
- It results in buildings that perform to a higher level, and it reduces the risk of unpleasant and costly surprises;
- Process integration and Systems integration are both key factors in achieving very high levels of performance.
Appendices
Appendix:
Post-occupancy Evaluations
Post-Occupancy Comparative Evaluations

- The promotion of this type of analysis is an effective way of improving building performance;
- The establishment of public databases of building performance is a complementary activity that can increase effectiveness even more.
Post-Occupancy Comparative Evaluations

- POE focuses on comparisons of the performance of Reference buildings, Predicted performance at the design stage and Actual performance after two years of operation;
- iiSBE Canada carried out post-occupancy evaluations on 9 Canadian case study projects with researchers from 3 universities;
- The analysis is limited to a small number of Key Performance Indicators (KPI);
- Two levels of POE protocols were developed.
Canadian buildings selected for POE

Five academic, three offices plus one community building
Energy use intensity (EUI)

- Reference EUI - typical for building type (kWh/m²/yr)
- Predicted EUI - modelled (kWh/m²/yr)
- Actual EUI - metered (kWh/m²/yr)
Appendix:
Process Flow Charts
Establish specific performance goals

Carry out a preliminary energy analysis
Carry out preliminary performance assessment

Develop detailed interior environmental specifications

Agree on relative issue priorities

Develop concept design(s)

Select concept designs for further development

Optimize sun and wind by orientation and massing
Develop a conventional concept design to provide a reference; develop also a concept design for at least one high-performance option
Optimize plan and volumetric efficiency
Minimize structural waste by lean design
Use thermal mass diurnal thermal storage

Select site with good access to public transport
Avoid site with high ecological or agricultural value
Select site with existing structure that can suit requirements
Discuss project with local stakeholders and carefully consider their views.

Reduce excess area or volume assumptions
Consider mixed uses in development

Transition

Review functional requirements
Examine site issues
Obtain information about the site
Select and form the integrated design team

Owner / investor

Design / Construction team charrettes
Design / Construction team tasks

Pre-design phase

Develop functional requirements
Ensure that development permit will not restrict design

Larsson / iSBE 2009

A linear representation of the IDP process (1 of 3)
Carry out daylighting, IAQ and ventilation assessment

Carry out a detailed energy simulation

Carry out a Life Cycle Cost Analysis (LCC)

Perform Life-cycle analysis (LCA) for embodied en./emissions

Perform a final detailed energy simulation

Do a final capital cost check

Select one concept design for detailed development

Complete working drawings and specifications

Develop preliminary building envelope design

Develop preliminary lighting and power system design

Develop preliminary fenestration design

Develop preliminary design for ventilation, heating and cooling systems

Iteration(s) in design

Reduce envelope heat gain through trees and landscaping

Reduce envelope heat gain or loss by thermal efficiency and airtightness of envelope

Optimize window location, size and type to maximize daylighting while limiting unwanted solar gain or heat loss.

Provide exterior shading devices where effective against excessive solar gain

Optimize energy-efficiency of lighting including luminaire, lamp, and ballast types, control systems, maintenance

Consider natural or hybrid ventilation

First consider solar DHW, solar space heating, PV, earth energy

Cooling system options:
- Direct or indirect evaporative
- Desiccant or evaporative
- Evapotranspiration wi. vegetation
- Direct or hybrid radiative cooling
- Night cooling
- Earth-to-air heat exchanger
- Ground water, sea or river water

For residual loads, use high-efficiency, fans chillers, boilers, motors; maximize system efficiencies

Consider using Building Information Model (BIM) protocols

Decision based on cost/benefit ratio
Consider re-used materials
Consider recycled materials

IDP 3

Bid & negotiate
Develop QA strategies for construction & commissioning
Procure materials and equipment
Implement site ecology protection measures

Construct

Transition
Develop QA strategies for operation

Operate
Monitor operational performance
Implement site ecology protection measures
Provide as-built documentation and operating manuals

Carry out interim systems commissioning
Carry out final commissioning
Train operating staff

Operations phase assessment

Monitor operational performance

Appendix:
UN Sustainable Development Goals (SDGs)
An idea to link all SDGs related to the built environment via an algorithm.