The Integrated Design Process: an overview

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Specific barriers to the widespread adoption of sustainable building practices

- Limited market demand for high performance buildings;
- Difficulties in measuring environmental performance in an objective and reliable way;
- Separation between potential performance at design stage and actual performance during operations;

Specific barriers to the widespread adoption of sustainable building practices

- Increasing requirements for specialized skills and knowledge in the design process;
- Skills deficits in small design firms;
- Developers and investors with only short-term ownership plans.

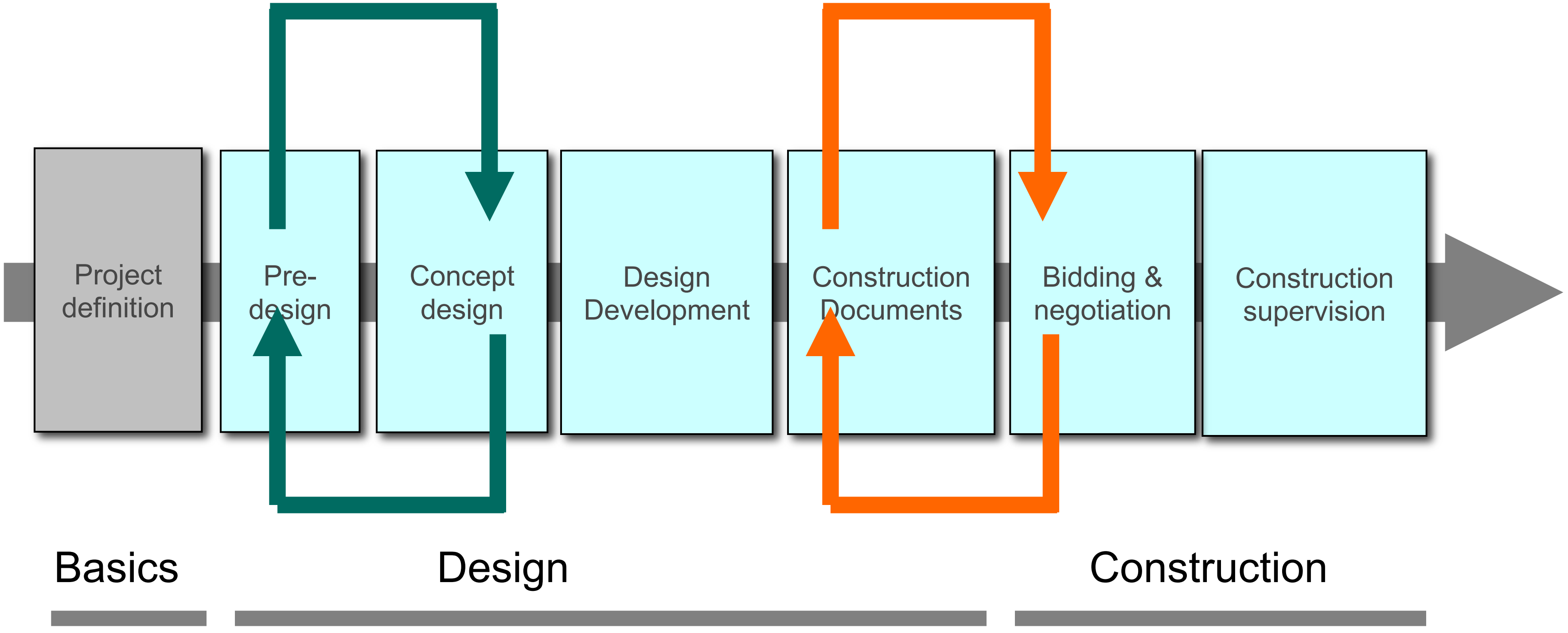
Problems in the Conventional Process

Problems in the conventional process

- The architect may develop a concept design that is agreed to by the client;
- After both parties are committed, then engineers and other consultants are brought in to optimise the design assumptions as much 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.

The Conventional Process

Design iterations are inevitable in any design process, but they only make a positive contribution if carried out early in the process.



MIT sues Gehry, citing leaks in $300m complex

Blames famed architect for flaws at Stata Center

MIT's $300 million Stata Center in Cambridge, designed by architect Frank Gehry, was completed in the spring of 2004. (mark wilson/globe staff/file 2007)

By Shelley Murphy
Globe Staff / November 6, 2007

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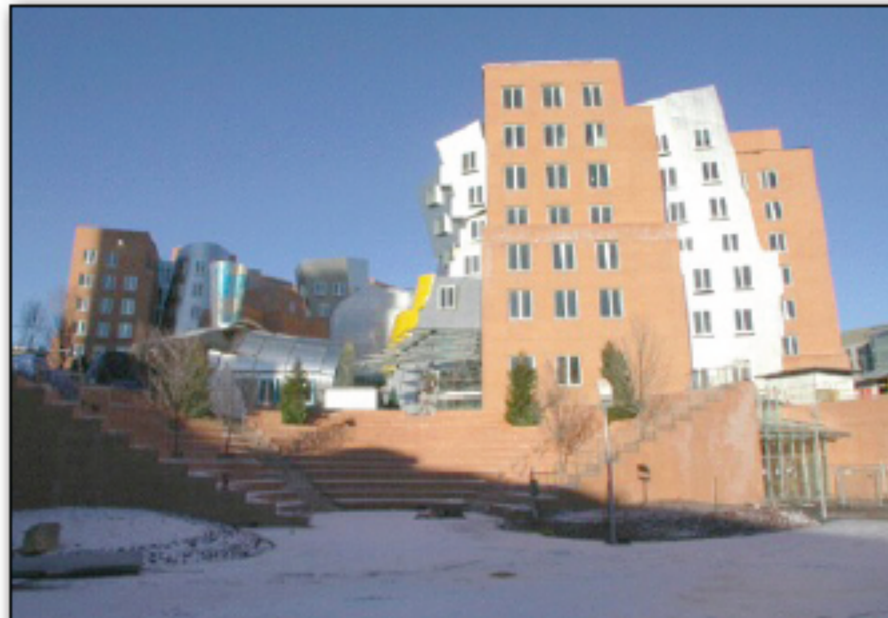
The Massachusetts Institute of Technology has filed a negligence suit against world-renowned architect Frank Gehry, charging that flaws in his design of the $300 million Stata Center in Cambridge, one of the most celebrated works of architecture unveiled in years, caused leaks to spring, masonry to crack,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

"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.

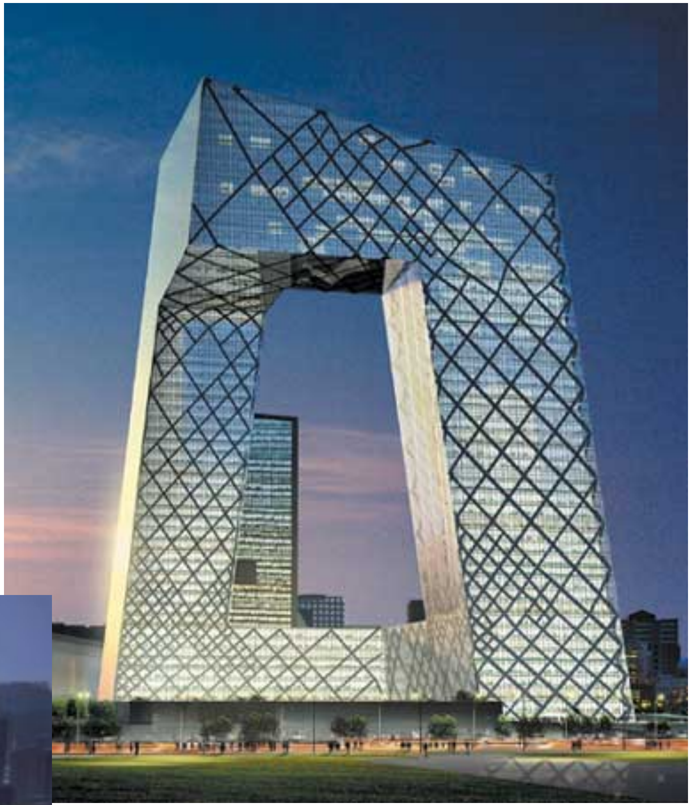


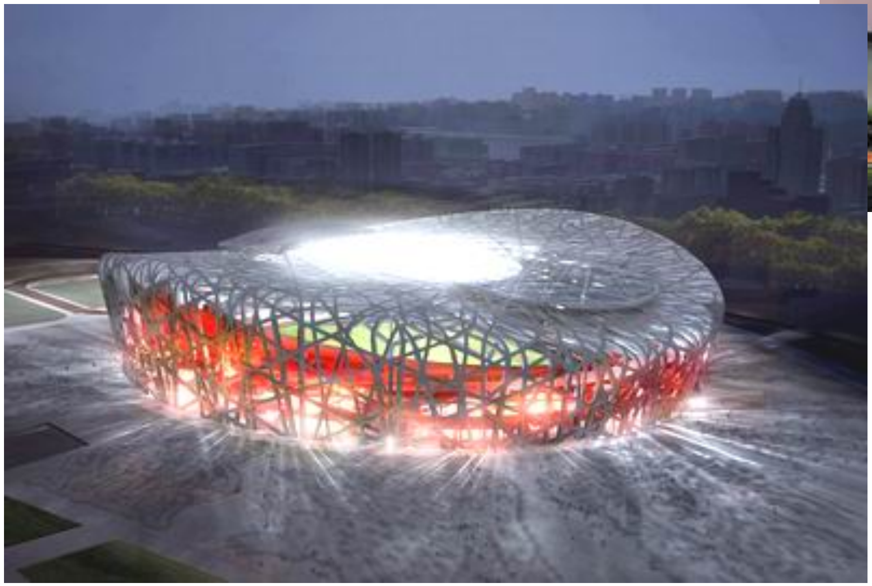
MIT Stata Center

Trouble at MIT

It is easy to make bad decisions early in the process

According to Jiang Yi, this design for the new CCTV building in Beijing resulted in the center of gravity of building outside the main body, thereby greatly increasing the structural complexity and first cost.





Also from Jiang Yi, this design for an Olympic stadium had “heavy steel consumption” for a movable roof and would cost 2 to 3 times more than similar stadia.

Really bad early decisions in the design of the Mitterand library in Paris: after completion, the fully glazed walls had to be provided with internal wood walls to protect users and books.

Progress in Dubai?

The Emirates Tower is newer and more fashionable, but does not perform as well as another tower that is 20 years older.

Dubai World Trade Center, 1979:

278 kWh/m2

Emirates Tower, 200

560 kWh/m2

Source: Khaled A. Al-Sallal

Problematic buildings

with too much glazing in the wrong places

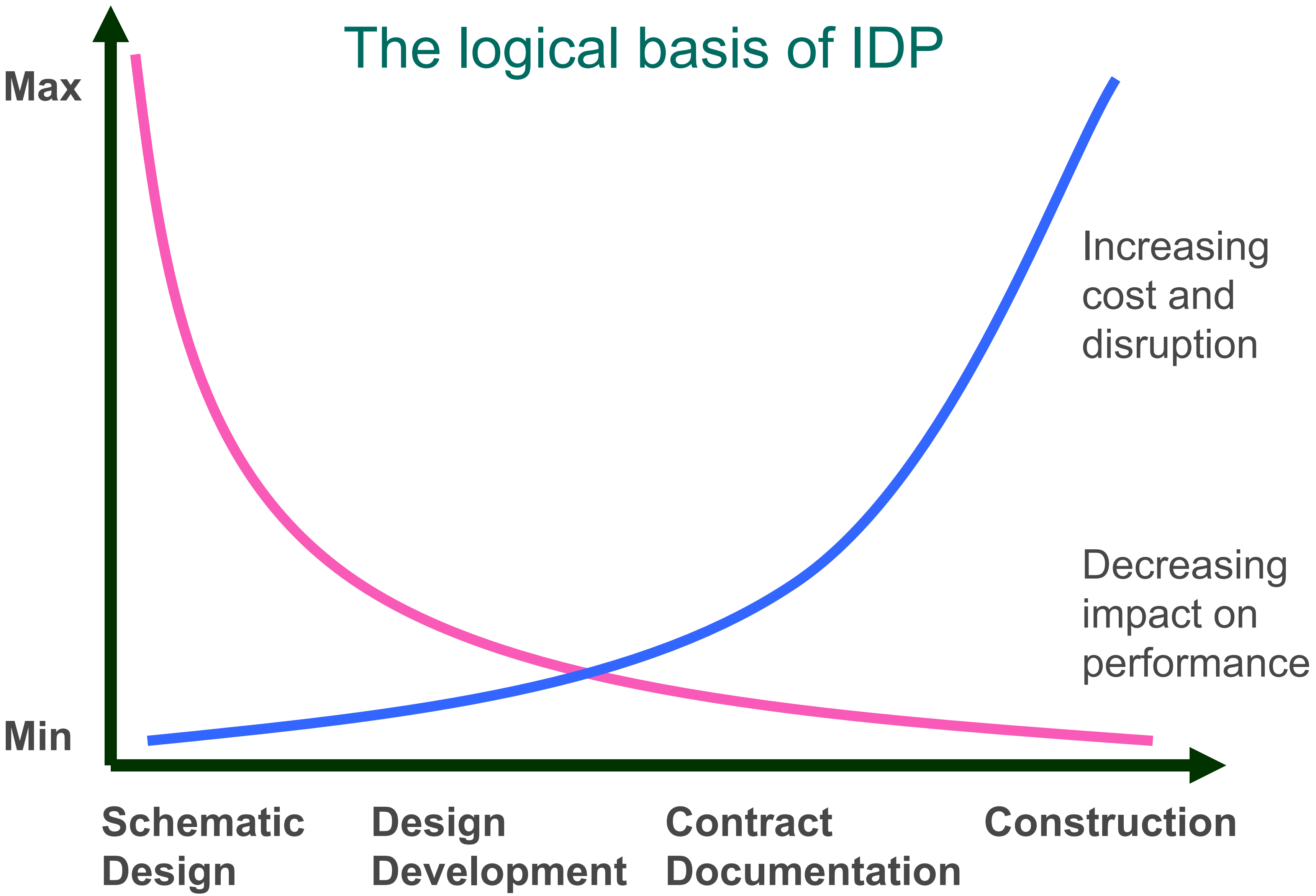
The Integrated Design Process

Integrated Design Process

- Changes in the design process can make major contributions to the performance of buildings;
- Bill Bordass in the UK developed some of these ideas in his *Soft Landings* program;
- In Canada, IDP was primarily developed in the NRCan C-2000 program during the 1994-2003 period;
- International IDP guidelines were developed in IEA Task 23;
- A successful IDP program is run in Ontario by Sustainable Buildings Canada (SBC), financed by Enbridge Gas;
- iiSBE was the technical advisor in a project to develop IDP for the Turkish government in 2016;

What is IDP and why can it be helpful?

- IDP is a method to intervene in the design stage to ensure that all issues that are likely to have a significant impact on sustainable performance are reviewed and understood at the *beginning* of the design process;
- IDP can help the client, architect and building operator to avoid a sub-optimal design solution;
- It enables the achievement of high levels of building performance through integrated design;
- Reaching high performance in practice is only possible if there is a smooth transition between design, construction, commissioning and operating phases.


The logical basis of IDP
Max
Min
Increasing cost and disruption
Decreasing impact on performance
Schematic Design
Design Development
Contract Documentation
Construction

Integrated Design Process

- The IDP process was primarily developed in the NRCan C-2000 program during the 1994-2003 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.

IDP: a definition

- IDP is a method to intervene early in the design stage to ensure that all issues that are likely to have a significant impact on sustainable performance are reviewed and dealt with at the *beginning* of the design process;

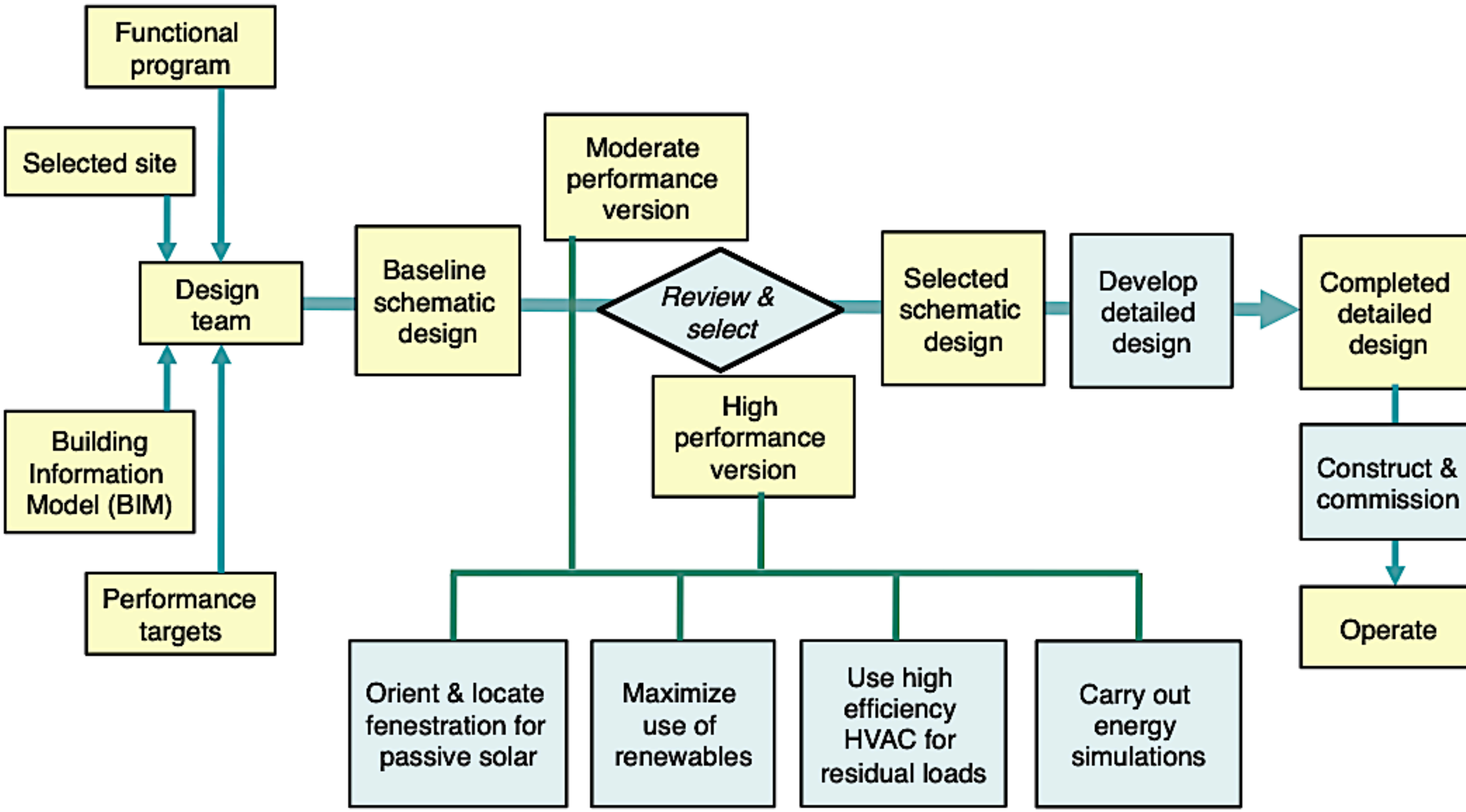
Priorities, logical sequence and effectiveness

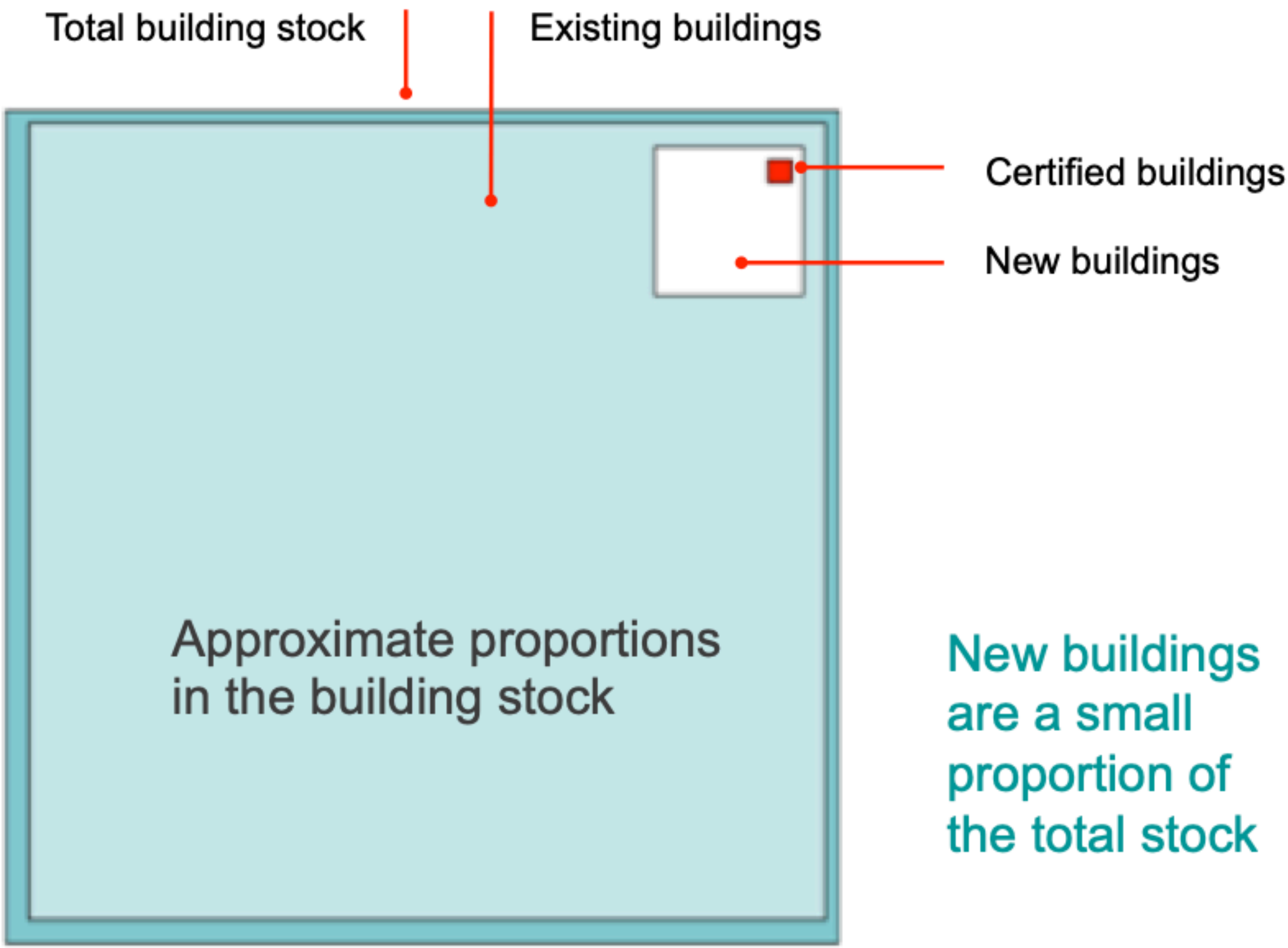
- We are used to hearing the mantra *reduce, reuse and recycle*, and there is an equivalent in sustainable building design

  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;

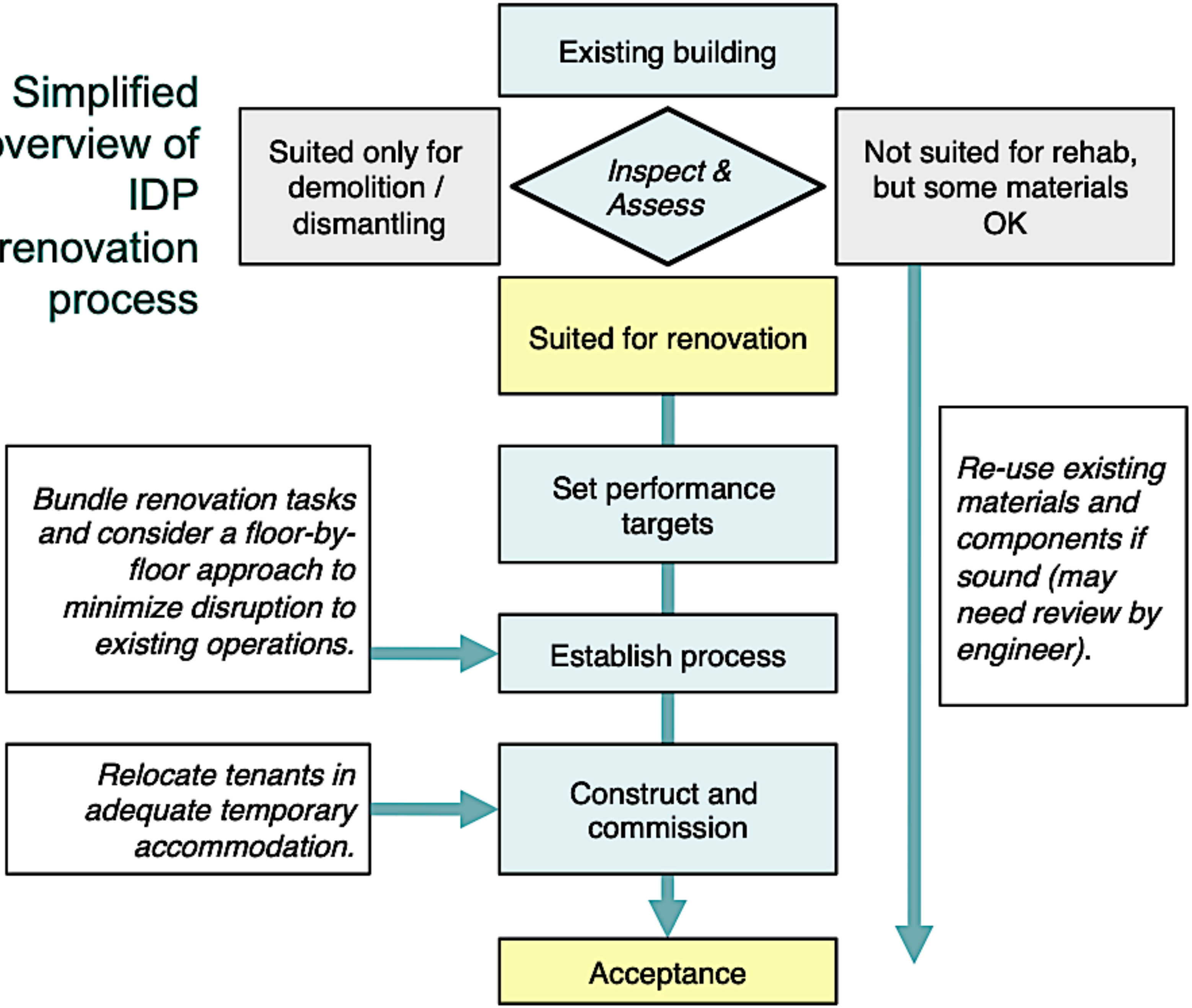
- The first imperative is undoubtedly the hardest to control

Graphic view of IDP steps in new buildings




Total building stock
Existing buildings
Certified buildings
New buildings
Approximate proportions in the building stock
New buildings are a small proportion of the total stock

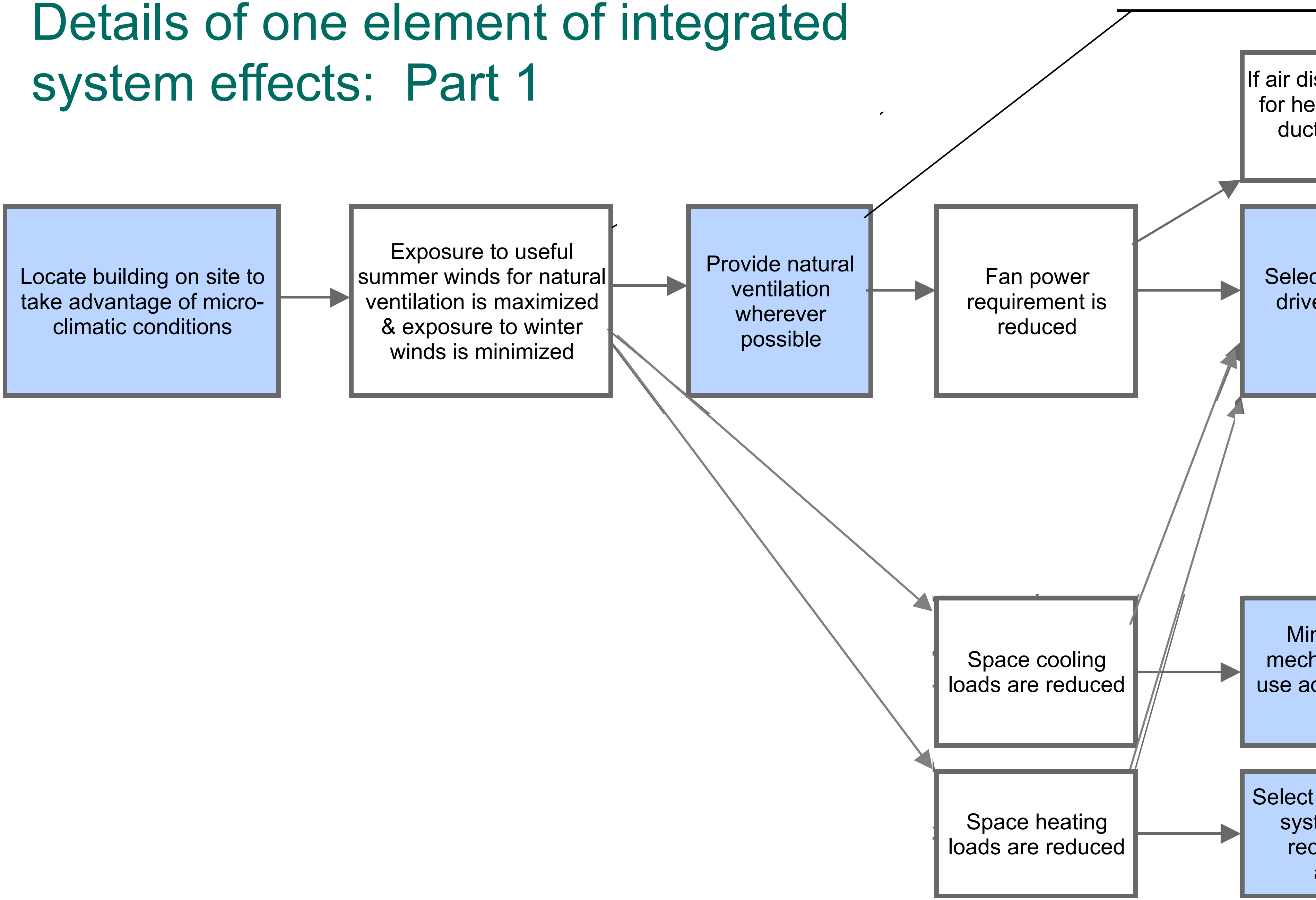
Simplified overview of IDP renovation process



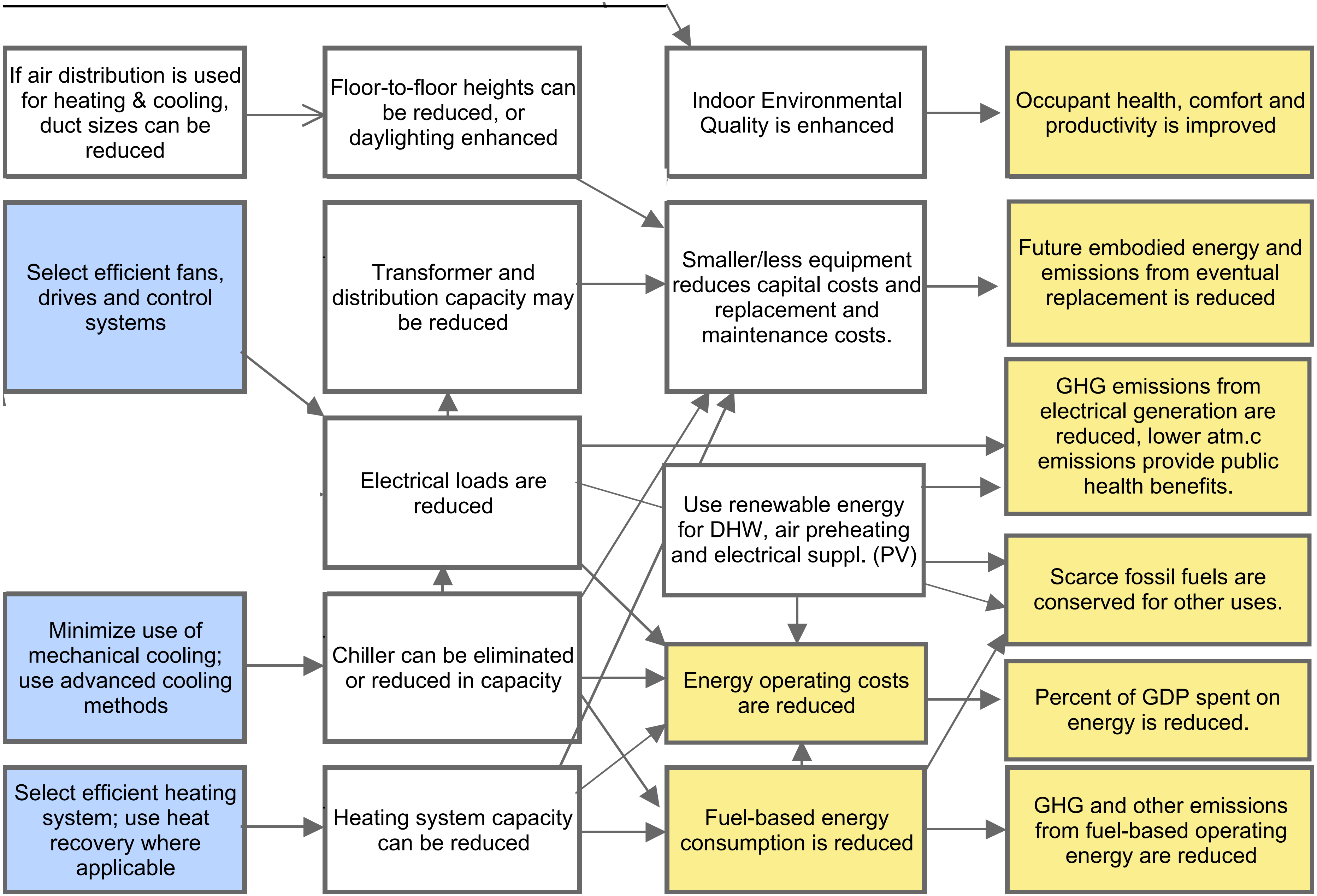
Results

- IDP results in design integration, which results in 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 greenhouse gas emissions.

Details of one element of integrated system effects: Part 1



Details of one element of integrated system effects: Part 2



Examples of IDP projects

Mountain Equipment Co-op, Ottawa

- The first retail building in Canada to comply with Canada's C2000 Green Building Standards;
- 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 56% reduction in energy consumption relative to the MNECB;
- The completed building was achieved by a modest 13% increase in the capital cost budget from standard retail construction costs;
- Substantial operating cost savings are expected.

C-2000: Mountain Equipment Coop, Winnipeg, Canada

- 95% of materials in 2 existing structures were re-used;
- >50% energy reduction
- 13% incremental capital cost
- IDP process used
- The client was key

C-2000 Condominium in Dundas, Ontario

- 48 units in six floors
- Annual energy consumption 137 kWh/m2, more than 35% reduction from MNECB (the Canadian energy code)
- Annual water consumption 0.5 m3/m2, 25% of normal

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.

Corbett Cibinel Architects

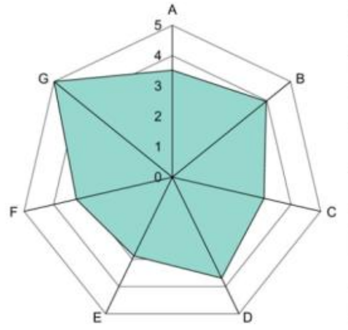
Manitoba Hydro Head Office, Winnipeg, MB, Canada

Design target scores for Manitoba Hydro HQ, Winnipeg, Canada

Predicted performance results based on information available during Design Phase	*Active Phase (set in Region file)*	Design Phase

Relative Performance Results

0 = Acceptable Practice; 3 = Good Practice; 5 = Best Practice



Performance Issue Areas

Design Phase scores indicate Potential Performance as predicted by an assessment of building features and plans for construction and operation that are developed during the design process.

Project Information

This is a New construction project with a total gross area of 64810 m2. It has an estimated lifespan of 75 years, and contains the following occupancies: Office and Retail and is located in Winnipeg, Canada. The assessment is valid for the Design Phase.

Assumed life span is 75 years, and monetary units are in CD	Amortization rate for embodied energy of existing materials is set at 0 %		
	Design target scores		
With current context and building data, the number of active low-level parameters is:	97	Max. potential low-level parameters:	115
The number of active low-level mandatory parameters with a score of less than 3 is:	3	Active low-level mandatory parameters:	9

To see a full list of Issues, Categories and Criteria, go to the Issues worksheet.	Active Weights	Weighted scores
A Site Selection, Project Planning and Development	10%	3.5
B Energy and Resource Consumption	21%	4.0
C Environmental Loadings	20%	3.1
D Indoor Environmental Quality	21%	3.7
E Service Quality	20%	2.9
F Social and Economic aspects	7%	3.2
G Cultural and Perceptual Aspects	2%	5.0
Total weighted building score		3.4

Absolute Performance Results

Relative performance level is Good Practice or better

	These data are based on the Self-Assessment values	By area	By area & occupancy	
1	Total net consumption of primary embodied energy for structure and envelope, GJ/m2	1	0	GJ/m²*maph
2	Net annualized consumption of embodied energy for envelope and structure, MJ/m2*yr.	18	1	MJ/m²*maph
3	Net annual consumption of delivered energy for building operations, MJ/m2*year	299	14	MJ/m²*maph
4	Net annual consumption of primary non-renewable energy for building operations, MJ/m2*yr.	336	16	MJ/m²*maph
5	Net annual consumption of primary non-renewable energy per dwelling unit in project, MJ/m2*yr.	N.A.	N.A.	MJ/m²*maph
6	Net annual consumption of primary non-renewable energy per dwelling unit in residential element, MJ/m2*yr	N.A.	N.A.	MJ/m²*maph
7	Net annualized primary embodied energy and annual operating primary energy, MJ/m2*yr.	353	17	MJ/m²*maph
8	Total on-site renewable energy used for operations, MJ/m2*yr.	314	15	MJ/m²*maph
9	Net annual consumption of potable water for building operations, m3 / m2 * year	1.0	0.0	m³/m²*maph
10	Annual use of grey water and rainwater for building operations, m3 / m2 * year	20	1	m³/m²*maph
11	Net annual GHG emissions from building operations, kg. CO2 equivalent per year	18	1	kg/m²*maph
12	Total present value of 25-year life-cycle cost fot total project, CD per m2.	8,951		
13	Proportion of gross area of existing structure(s) re-used in the new project, percent	0%		
14	Proportion of gross area of project provided by re-use of existing structure(s), percent	0%		

60% energy efficiency in an extreme climate, which is almost double the efficiency of any office tower in Canada; targetting LEED Platinum; over 94% of the city is accessible by public transit from the site; urban catalyst with the influx of 2000 emplyees to downtown

Manitoba Hydro | KPMB | Smith Carter | PRAIRIE ARCHITECTS INC. | TRANSSOLAR

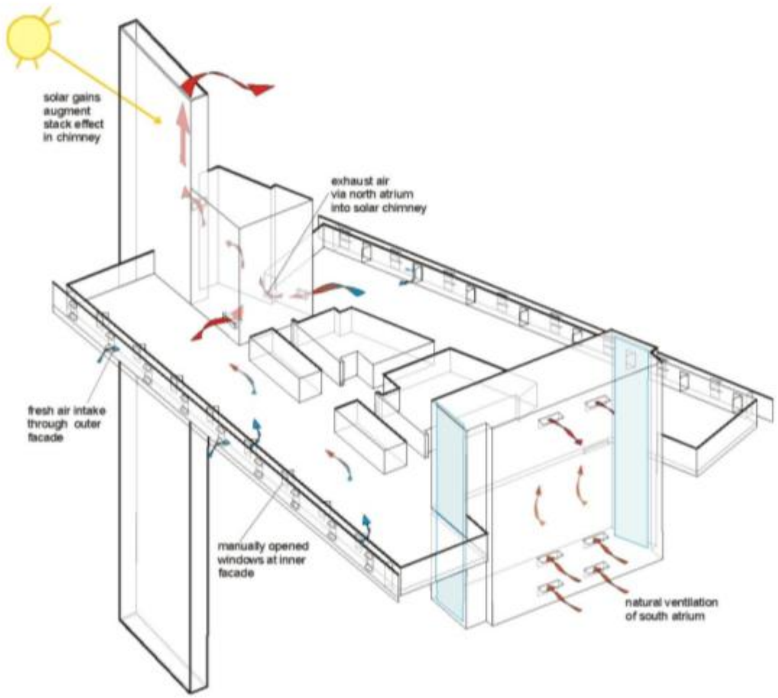
CLIENT: MANITOBA HYDRO DESIGN ARCHITECTS: KUWABARA PAYNE MCKENNA BLUMBERG AR
ARCHITECTS OF RECORD: SMITH CARTER ARCHITECTS & ENGINEERS ADVOCATE ARCHITECTS:
ARCHITECTS INC. CLIMATE ENGINEERS: TRANSOLAR ENERGY KLIMA ENGINEERS

Integrated Building Systems

Intelligent facades integrate climate responsive technologies, like solar shading, humidification, radiant heating and passive solar collection

High Performance Double Facades

Energy Consumption – 60% Savings



Intermediate season concept, tower floor isometric

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.

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)

Recent modelling predicts a **64.5% reduction**.

IDP support tool

An IDP Support Tool

- We developed a simple IDP support tool for project managers;
- It was developed under contract to Natural Resources Canada and UNEP (Paris);
- It is a simple checklist on an Excel spreadsheet;
- It is available as a stand-alone tool, or as integrated in the SBTool performance assessment tool.

IDP Support

Highest Level

Change level of detail at left	Integrated Design Process: Guidance	Enter Project name here

A	**Develop a functional program, examine assumptions and establish performance targets**
B	**Assess site conditions and existing structures**
C	**Assemble the Design Team**
D	**Develop Reference Design and Benchmarks**
E	**Hold an initial Design Workshop**
F	**Develop Concept Design**
G	**Consider site development issues**
H	**Determine building structure**
J	**Develop Building Envelope Design**
K	**Develop preliminary daylighting, lighting and power system design**
L	**Develop preliminary ventilation, heating & cooling system designs**
M	**Decide on major design options for detailed development**
N	**Screen non-structural materials for environmental performance**
O	**Complete design and documentation**
P	**Develop QA strategies for construction and operation**
Q	**Site takeover, existing building decontamination & deconstruction, excavation & foundations**
R	**Complete above-grade construction**
S	**Implement Commissioning**
T	**Carry out Post-Occupancy Evaluation, operate and the building and monitor its performance**

The tool is used to find actors who are relevant to each step

Change level of detail at left	Integrated Design Process: Guidance	Enter Project name here

IDP

List of Actors:

AR = Architect
AS = Acoustic specialist
BP = Building Product rep
CL = Client
CM = Construction manager
CV = Civil/services engineer
DF = Design faciltator
DS = Daylighting specialist
EC = Ecologist / Env. eng

List of Actors:

GE = Geotechnical engineer
ID = Interior designer
LA = Landscape architect
LD = Lighting designer
MS = Materials specialist
ME = Mechanical
OP = Operator of building
ST = Structural engineer
TN = Tenant
$$ = Costing specialist

Actors involved: AR DF

See relevant methods & tools

Click to show completion of steps

The steps outlined here form part of the IDP Process, and following them is likely to result in improved environmental performance. Althought they are presented in a linear sequence, some steps may be performed in a different sequence or may be repeated, and some may not be applicable to all project types or sizes. See Level 3 for detailed comments.

34	E8	Make plans for additional future workshops	CL	
			DF	
35	E9	Summarize the results of the first workshop in a Kick-off Design Workshop Report,and distribute to all stakeholders	DF	
	F	**Develop Concept Design**		
36	F1	Finalize performance targets, using GBTool as a framework.	DF	AR
			CL	
37	F2	Develop a concept plan, using functional requirements and Reference design (D) as a starting point.	AR	
			EE	
38	F3	Orient the building to optimize passive solar potential, and relate fenestration requirements to orientation.	AR	EE
			DS	
39	F4	Establish configuration & floor plate depth to balance daylighting & thermal performance.	AR	
			EE	
40	F5	Consider the possible roles of natural, hybrid or mechanical ventilation systems.	ME	AR
			ID	
41	F6	Consider whether mechanical cooling will be needed.	ME	AR
			DF	

What’s involved in IDP ?

- It is essential to have client who wants high performance or is at least open to the idea, and who is willing to pay a small increase in design phase costs and time;
- An inter-disciplinary team is needed, and the available level of skills and knowledge should be augmented if necessary by contracting additional members;
- The integrated team should be involved from the first day of design;

Establishing Performance Targets & Benchmarks

- The client and the team should first discuss performance priorities and establish performance targets and strategies;
- This may be as simple as establishing LEED Gold as a target, but usually this is not precise enough;
- The client may want to have specific targets with respect to operating and embodied energy and emissions, and may also want so specify some urban design, social and economic targets and benchmarks;
- SBTool can be used to define the client’s performance requirements.

Establishing Reference Design and Criteria

- The team should establish a reference design (the one your accountant wants you to build), to facilitate comparisons;
- A reference design is needed for energy simulations, but the project also needs reference benchmarks for other parameters, such as water consumption, materials use, IAQ, solid waste handling etc.
- Some of these found in standards, but others are not;
- If time and budget permits, it is worthwhile to define a wide spectrum of benchmarks. This may not be worth it for a single building, but may be for a group of buildings.

Key actors

- Investor
- Client
- 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

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 orchestrate the design workshops and the introduction of specialists;

Other key actors

- Involve an energy specialist and carry out simulations at various 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.

The 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.

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 chamber orchestra.

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 energy 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, but consider them as whole packages only.

A Large Design Charrette

IDP benefits and costs

- High performance in a broad spectrum of parameters, including energy and IEQ;
- Higher quality;
- Appeals to an increasing market segment;
- Somewhat longer schematic design process, but a shorter contract documentation period and fewer change orders;
- In some cases, somewhat higher process costs (up to 10%);
- Reduced number of change orders
- In some cases, reduced construction costs;
- In all cases, lower operating costs;
- Clients who have used IDP feel that any extra cost or time was worth it.

Conclusions

- IDP is based on a powerful logic: involve the people who matter and review design options early in the process;
- 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.

Contacts & Info

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