The Integrated Design Process; History and Analysis

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The *Integrated Design Process* (IDP) is a method of intervention in early stages of the design process that supports the development and design team to avoid sub-optimal design solutions. IDP is not a new concept, and may in fact have been applied in the past by some design teams on an ad-hoc basis; but the formal implementation of the process is a development that has taken place over the past 15 years. This paper provides a partial history and some analysis of the characteristics of IDP.

The C-2000 Program

One source of specific information on a formal implementation of IDP is the experience gained from a small Canadian demonstration program for high-performance buildings, the C2000 program, which was developed and managed by Natural Resources Canada (NRCan), with the author as developer of the requirements and manager of the process. The C-2000 program was designed in 1993 and launched in 1994 and was formally operational until 1999, although some projects were not completed until recently[1]. Its technical requirements covered energy performance, environmental impacts, indoor environment, functionality and a range of other related parameters. Performance criteria included, *inter alia*, a 50% reduction in energy and greenhouse gas consumption, a 40% reduction in potable water consumption and a considerable increase in the air-tightness of the building envelope, relative to norms then current.

The ambitious performance goals of the program led its managers to believe that very sophisticated technical systems would be needed, including very high-performance chillers, glazing and lighting systems. It was therefore assumed that the incremental costs for design and construction of these projects would be substantial, and provision was made for support of incremental costs in both the design and construction phase, to a level of several hundred of thousand dollars per project. Initial budget allocations were sufficient to cover the anticipated costs of six projects, and were designed to cover extra system costs as well as short-term support by design facilitators and by specialists in areas such as glazing design, advanced HVAC systems and thermal storage.

After the first six projects were designed and two of them had been completed, it was found that that incremental capital costs were less than expected, partly due to the fact that designers used less sophisticated and expensive technologies than anticipated. Despite this, the initial projects more-or-less reached the required performance targets. This led the program managers to interview the design teams to ascertain what factors were responsible for this result.

The designers first outlined reasons why technologies were used that were somewhat more conventional than anticipated. These focused mainly on the fear of using systems that would result in operational problems that might force their eventual removal, resulting in dissatisfied clients and additional expenses. All agreed that application of the design process required by the C-2000 program was the main reason why high levels of performance could still be reached. It also appeared that most of the benefit of intervention was achieved during the early stages of the design process, during concept design. This was a surprising finding, and led to a restructuring of the program to include more projects on the basis of smaller financial contributions to support the design phase.

The design support process used in the C-2000 program came to be referred to as the *Integrated Design Process* (IDP), and all project interventions in the program came to be focused on providing advice on the design process at the very early stage of design. Eight projects were designed constructed on this basis, and all achieved the C-2000 performance requirements, or came very close, and capital costs were within

[1] The last project formally part of the program was a new headquarters building for Manitoba Hydro, which was just completed in 2008. The process was managed on behalf of NRCan by Stephen Pope, who replaced the author as Program Manager in 2000, and the process included international specialists.

a range of plus or minus 10 percent of base budgets. The most hopeful sign that the IDP approach was taking root was that several owners participating in the program subsequently used the same process for buildings that did not benefit from any subsidy.

Others have also adopted the IDP process as a way of supporting high performance. For example, the USGBC LEED program awards extra points for the use of IDP, and other U.S. agencies have developed support documents.

The CBIP Program

The findings within the C-2000 Program also influenced the design of a subsequent, large-scale program, called CBIP, the *Commercial Building Incentive Program.* CBIP was designed to focus on energy performance and to achieve its results to a broader segment of the Canadian industry without the major funding or intensive support that was provided in the C-2000 Program. The success of the design-stage intervention in C-2000 led the CBIP program designers to provide smaller contributions (varying from $60,000 to $80,000 CAD) to projects that reached an energy performance that would be at least 25% better than the *Model National Energy Code for Buildings* (MNECB). The IDP approach was recommended for all CBIP projects, but the lack of intensive participation in the projects by program managers did not ensure that comprehensive IDP procedures took place. Nevertheless, many CBIP project managers found it worthwhile to attempt either a full IDP or a quasi-IDP process. Several hundred projects were successfully completed, to a point where a new incoming government found it politically more astute to abandon the program, and then re-introduce a version of it under a new name.

Data on a few sample projects will serve to show the success of the IDP and quasi-IDP approaches.

Figure 1: C-2000 and CBIP Data

C-2000 Building Name	*Reference MNECB* ekWh/m² per year	*Design Performance* ekWh/m² per year	*Percent gain*
Bentall 8 & 2	348	174	50%
Green on the Grand	182	82	55%
Saskatoon Library	463	301	35%
Dundas Apartments	170	125	26%
CBIP Building Type[2]	*Reference MNECB* ekWh/m² per year	*Design Performance* ekWh/m² per year	
Health care (4)	427	247	42%
Office (14)	389	252	35%
School (20)	329	216	34%
Other (5)	546	325	40%
All CBIP (43)	383	243	37%

The Task 23 working group of the International Energy Agency

Task 23 was a project within the *Solar Heating and Cooling* (SHC) programme of the *International Energy Agency*. The title of Task 23[3] was T*he Optimization of Solar Energy Use in Large Buildings* and focused its work on exploring the nature of the IDP. 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 Task operated under the leadership of Dr. Anne-Grete Hestnes of NTNU, Norway, from 1997 to 2002[4]. The author represented Canada in the group.

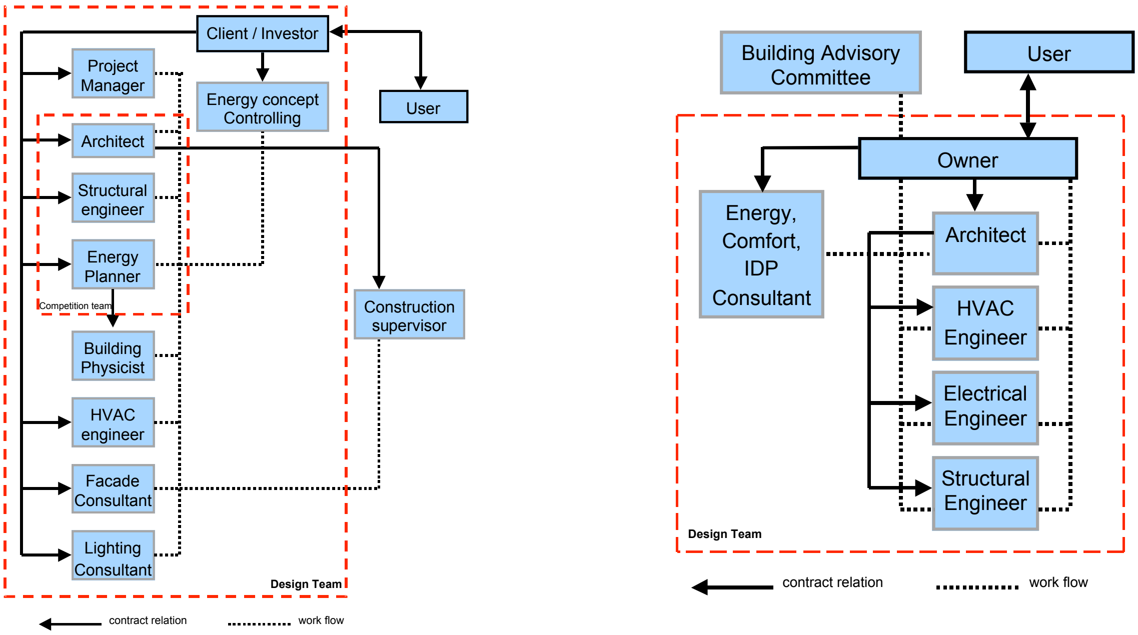
[2] Source: unpublished data from Office of Energy Efficiency, Natural Resources Canada, June 2001

[3] See www.iea-shc.org/**task23**

[4] The following countries participated in the task: Austria, Germany, Spain, Canada, Japan, Sweden, Denmark, Norway, Switzerland, Finland, The Netherlands and USA.

Task 23 resulted in the descriptions and analysis of case studies, as well as the development of guidelines and process descriptions, such as the one below, which illustrates the usefulness of providing comparable descriptions of management structure as well as the designs.

Figure 2: Two management structure diagrams for (left) Deutsche Post and (right) Yukon Territories administration.



Members of the Task also developed support tools[5], and the Task was important in bringing the benefits of IDP to the attention of an international audience, although the results and tools have unfortunately not yet gained wide currency.

The Conventional Design Process

In order to understand what the IDP is, it is useful to first characterize the more conventional design process. The process often begins with the architect and the client agreeing on a design concept, consisting of a general massing scheme, orientation, fenestration and, usually, the general exterior appearance as determined by these characteristics as well as by basic materials. The mechanical and electrical engineers are then asked to implement the design and to suggest appropriate systems.

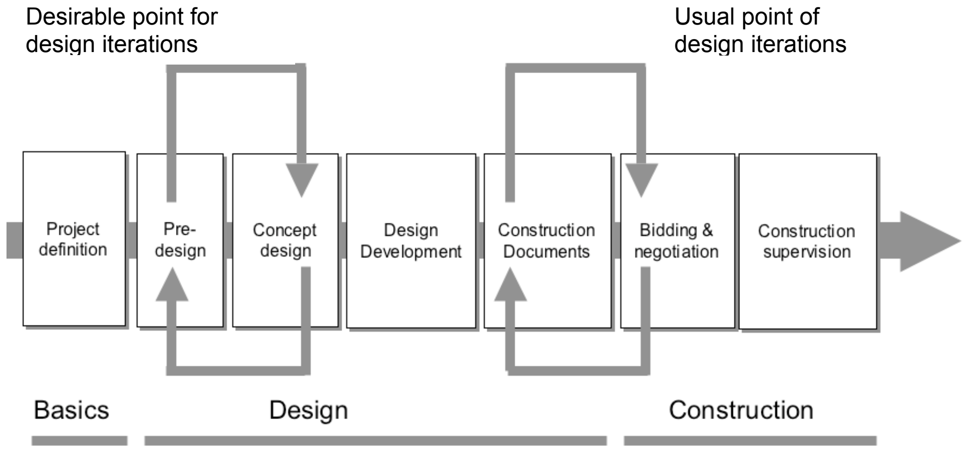
Although this is vastly oversimplified, such a process is one that is followed by the large majority of general-purpose design firms, and it generally limits the achievable performance to conventional levels. The traditional design process has a mainly linear structure due to the successive contributions of the members of the design team. There is a limited possibility of optimization during the traditional process, while optimization in the later stages of the process is often troublesome or even impossible. For example, little advantage may be taken of passive solar potential, there may be excessive exposure to high solar gain during the summer, and poor daylighting and discomfort for the occupants.

All these potential outcomes reflect a design process that appears to be quick and simple, but actual results are often high operating costs and an interior environment that is sub-standard; and these factors in turn may greatly reduce the long-term rental or asset value of a property. Since the conventional design process usually does not involve computer simulations of predicted energy performance, the resulting poor performance and high operating costs will most often come as a surprise to the owners, operators or users.

[5] One tool of interest is called MCDM-23, for *Multi-Criteria Decision Making*, intended to support the weighting of various performance issues. Another is the *Guideline for Sustainable and Solar-Optimized Building Design*, a large and interactive PDF file developed by Dr. Günter Löhnert (Berlin), his associates, and Dr. Werner Sutter (Zug). See the website for files.

If the engineers involved in such a process are clever, they may suggest advanced, high-performance heating, cooling and lighting systems, but their inclusion at a late stage in the design process will result in only marginal performance increases, combined with considerable capital cost increases. The underlying cause is that the introduction of high-performance systems late in the design process cannot overcome the handicaps imposed by initial incompatible or otherwise poor design decisions. A thick dossier could be compiled of examples of projects where clients and designers have been seduced by appealing forms, without investigating the performance implications.

Figure 4: A simplified representation of the conventional design process



The Integrated Design Process

The Integrated Design Process has impacts on the design team that differentiate it from a conventional design process in several respects. The client takes a more active role than usual; the architect becomes a team leader rather than the sole form-giver; and the structural, mechanical and electrical engineers take on active roles at early design stages. The team always includes an energy specialist and, in some cases, an independent Design Facilitator[6].

The IDP process contains no elements that are radically new, but integrates well-proven approaches into a systematic total process. The skills and experience of mechanical and electrical engineers, and those of more specialized consultants, can be integrated at the concept design level from the very beginning of the design process. When carried out in a spirit of co-operation among key actors, this results in a design that is highly efficient with minimal, and sometimes zero, incremental capital costs, along with reduced long-term operating and maintenance costs. The benefits of the IDP process are not limited to the improvement of environmental performance. Experience shows that the open inter-disciplinary discussion and synergistic approach will often lead to improvements in the functional program, in the selection of structural systems[7] and in architectural expression.

The IDP process is based on the well-proven observation that changes and improvements in any design process are relatively easy to make at the beginning of the process, but become increasingly difficult and disruptive as the process unfolds. Although this may seem obvious, it is a fact that most clients and designers have not followed up on the implications. As well, the existence of a defined roadmap gives credence and form to the process, making it easier to promote and implement. Typical IDP process elements include the following:

[6] The inclusion of a Design Facilitator is not always accepted. In Canada, there are many small design firms without specialized experts, and the C-2000 design teams generally welcomed the support of a facilitator; but the architects taking part in Task 23 were against it, arguing that it is the architect who should be the facilitator.

[7] In two C-2000 projects, construction costs were considerably reduced because of changes in structural systems that were suggested during initial IDP discussions.

1. inter-disciplinary work between architects, engineers, costing specialists, operations people and other relevant actors right from the beginning of the design process;
2. The addition of specialists in the field of costing, energy engineering and energy simulation;
3. The support of subject specialists (e.g. for daylighting, thermal storage, comfort, materials selection etc.) for short consultations with the design team;
4. in some cases, a Design Facilitator is added to the team to raise performance issues throughout the process and ensure specialist inputs as required.
5. Discussion of the relative importance of various performance issues and the establishment of a consensus on this matter between client and designers;
6. Budget restrictions are applied at the whole-building level, with no strict separation of budgets for individual building systems, such as HVAC or the building structure. This reflects the experience that extra expenditures for one system, e.g. for sun shading devices, may reduce costs in another systems, e,g, capital and operating costs for a cooling system;
7. There is a clear articulation of performance targets and strategies, to be updated throughout the process by the design team; and
8. Testing of various design assumptions is achieved through the use of energy simulations throughout the process, to provide relatively objective information on this key aspect of performance;

Based on experience in Europe and North America, an IDP is especially characterized by a series of design loops per stage of the design process, separated by transitions with decisions about milestones. In each of the design loops the design team members relevant for that stage participate in the process.

The design process for specific projects emphasizes the following broad sequence.

1. Review functional program and minimize waste;
2. Establish performance targets for a broad range of parameters, and develop preliminary strategies to achieve these targets that are suited to the region and building type. This sounds obvious, but in the context of an integrated design team approach it can bring engineering skills and perspectives to bear at the concept design stage, thereby helping the owner and architect to avoid committing to a sub-optimal design solution.
3. Make use of existing structures where possible;
4. Minimize heating and cooling loads and maximize daylighting potential through orientation, building configuration, an efficient building envelope and careful consideration of the amount, type and location of fenestration.
5. Meet heating and cooling loads through the maximum use of solar and other renewable technologies and the use of efficient HVAC systems, while maintaining performance targets for indoor air quality, thermal comfort, illumination levels and quality, and noise control.
6. Re-use existing materials if possible, and ensure that new materials are selected for low embodied energy;
7. Iterate the process to produce at least two, and preferably three, concept design alternatives, using energy simulations as a test of progress, and then select the most promising of these for final development.
8. Implement quality assurance for construction and undertake training of operating staff.

The process diagram and the outline of IDP steps shown in Appendices 1, 2 and 3, give some idea of how IDP may be applied to a typical design project in more detail.

Development of IDP tools

In 2005, funding was received[8] to implement some of the ideas for IDP into a simple management support tool, to be used by project managers to optimize the performance of their project. The tool is a very simple Excel spreadsheet that shows the generic steps outlined in the appendices, but in a form that may be adapted to suit regional conditions and project characteristics. The tool is now being integrated into the SBTool assessment system, but it is also available as a stand-alone system known as IDP-Tool.

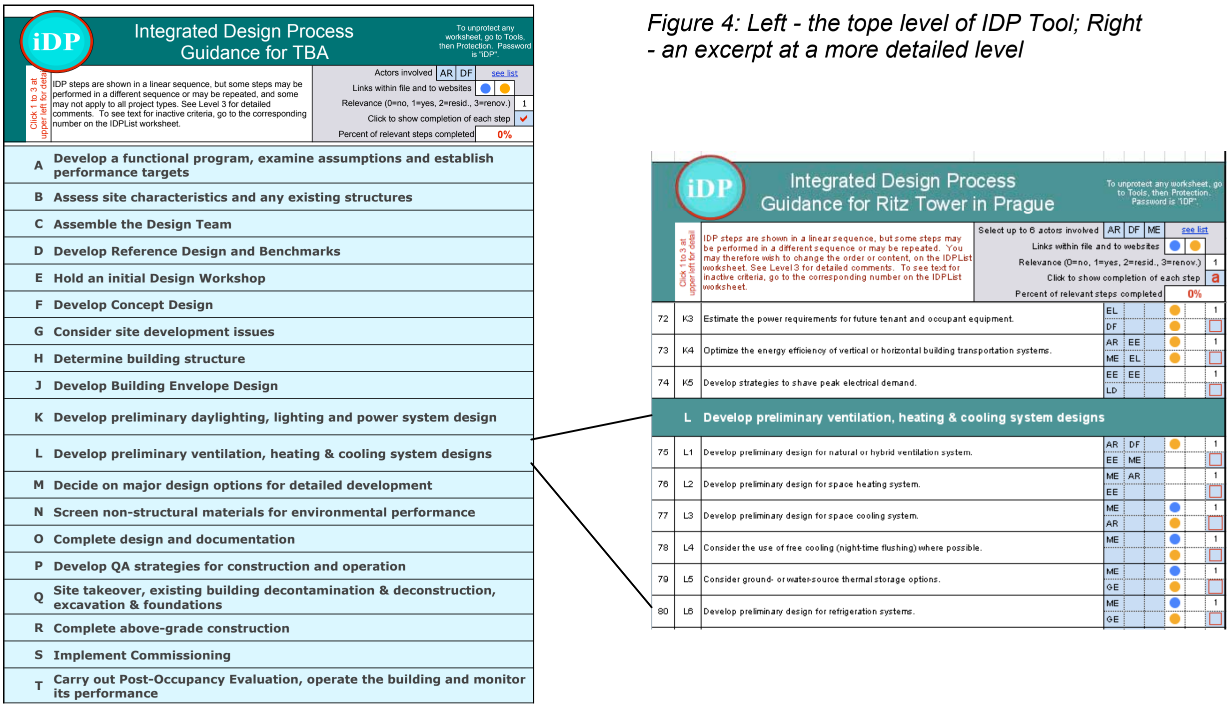


Figure 4: Left - the tope level of IDP Tool; Right - an excerpt at a more detailed level

Integration of IDP into assessment systems

Assessment or rating systems are an important element in modern building design and assessment. Most rating systems, such as LEED or BREEAM, began their existence as checklists of guidelines for designers, and they still play an important role in this respect, although the emphasis has shifted towards a more objective assessment of performance.

Meanwhile, researchers associated with iiSBE have been working on their own method and tool, called SBTool[9]. This system does not aim for a large role in labeling buildings, but is more focused on being an R&D platform for researchers. During the last year, in developing a concept for an improved version, iiSBE researchers have realized that its own system, as well as most other rating systems, have not made a sufficient distinction between parameters designed to assess performance, and others that play a role as guidelines for better performance. In the new 2010 version of the SB Method, therefore, a clear distinction has been made between these two types of criteria. It has become apparent that the IDP guidelines developed over the past 15 years could serve well for the guideline component of the SBTool, and that is now the basis being used to finalize development of the system. Figure 5 below shows the relationship between the two elements in the new system.

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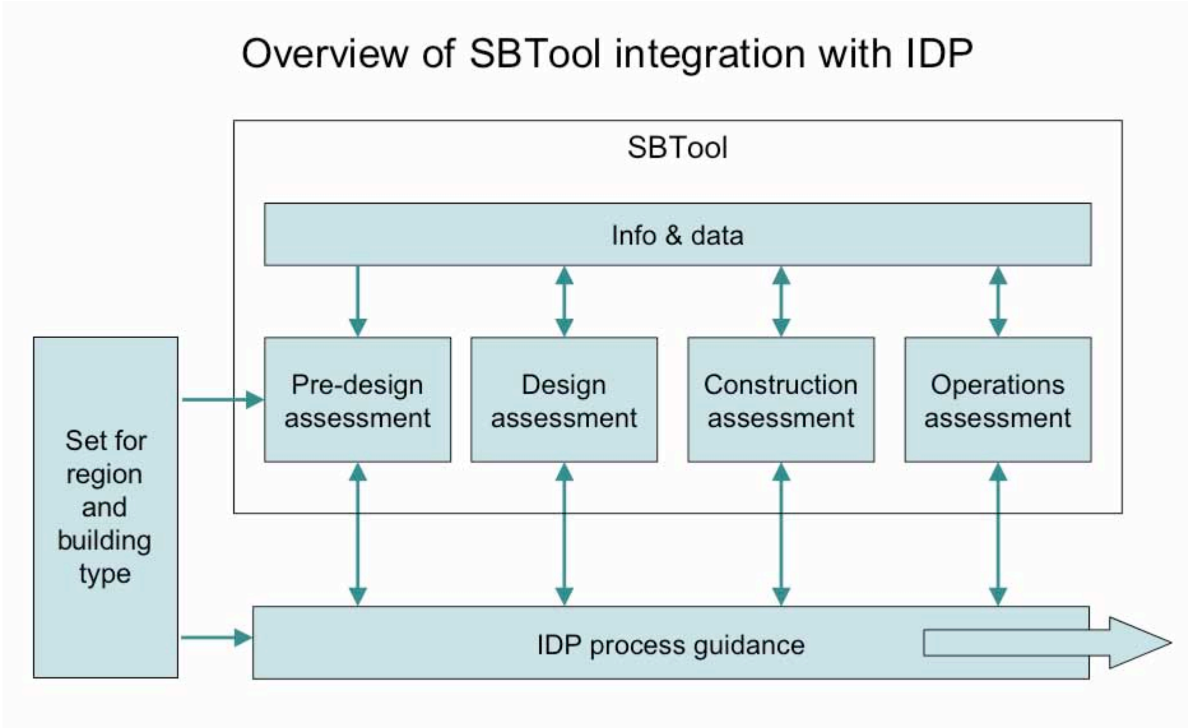
[8] Funding was received from UNEP-DTIE and NRCan for the project.

[9] The head of the Technical Committee is Manuel Macias of UPM, Madrid. Dr. Macias and the author have been responsible for most of the developmental work on the new version of the SB Method and Tool.

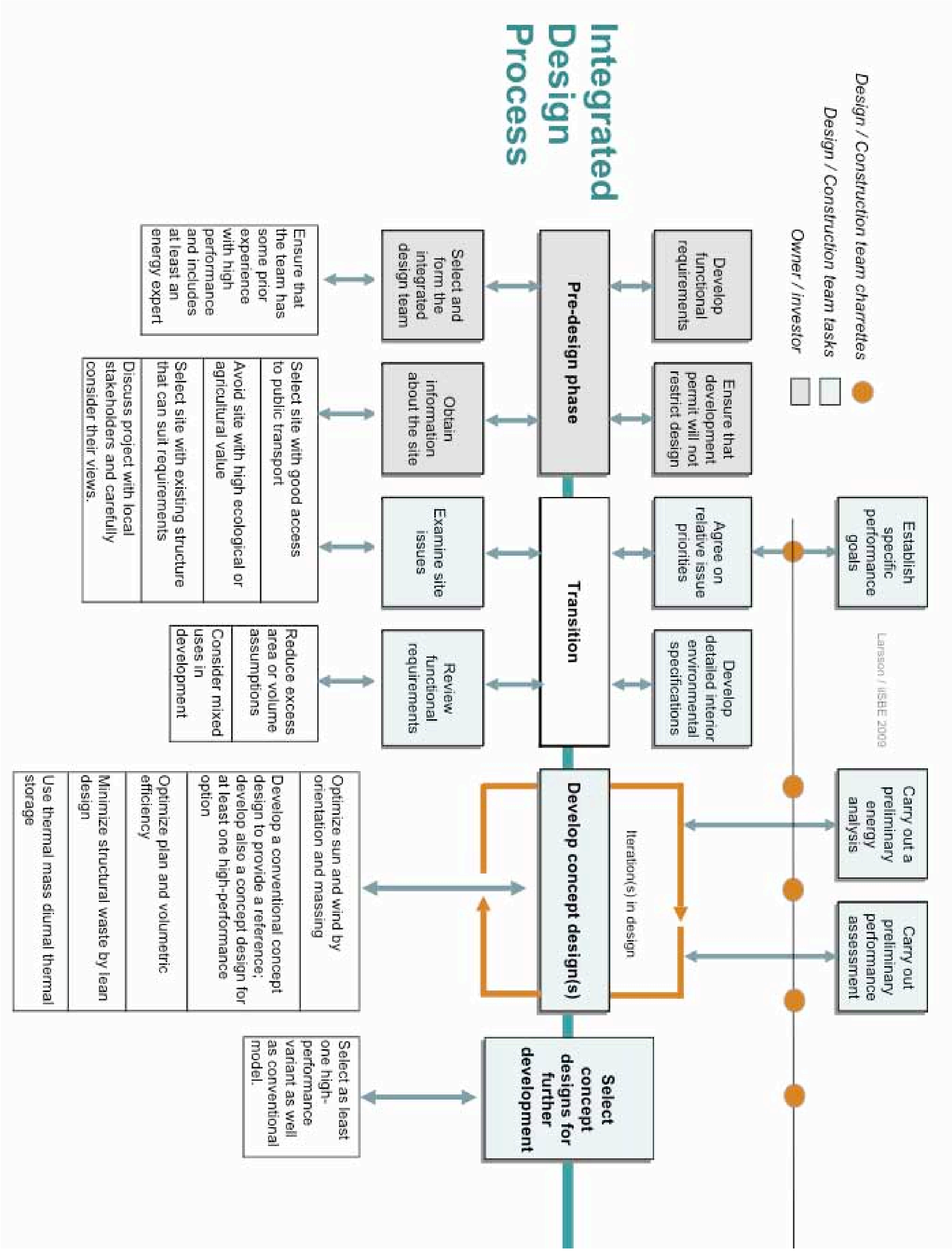
Figure 5: Relationship between assessment and guideline components in the SBTool for 2010.



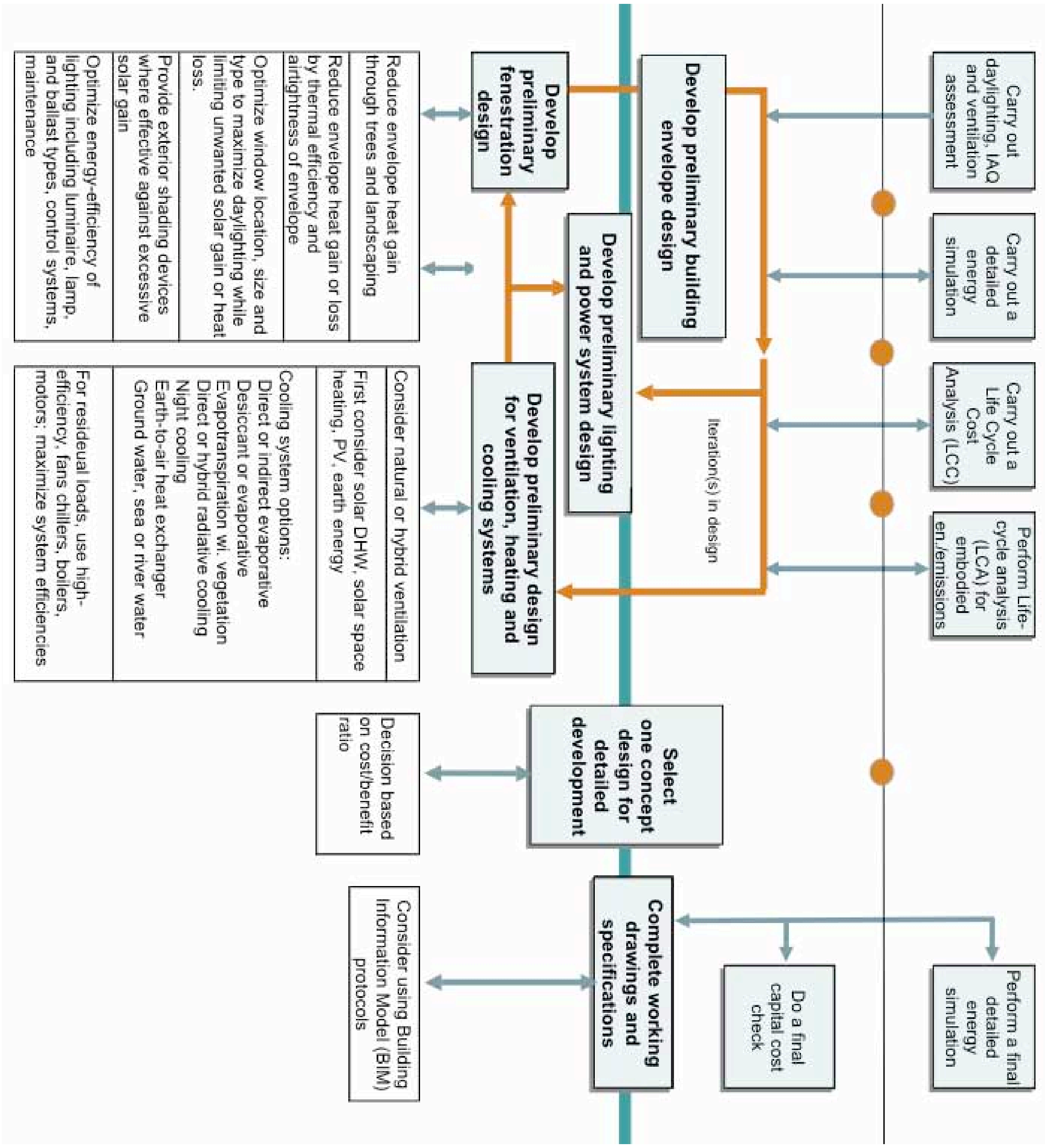
Future applications of IDP

One of the interesting lessons of using IDP is that, unlike many other design support methods or systems, it is applicable to a wide range of situations and building types. Thus, even though IDP was developed for a few building types and assumed new construction, the approach has now been applied to a wide variety of building types and to renovation projects. We foresee a wide application of the IDP around the world. A logical next step would be to integrate IDP with *Building Information Modeling* (BIM), to provide a solid bridge to the world of CAD.

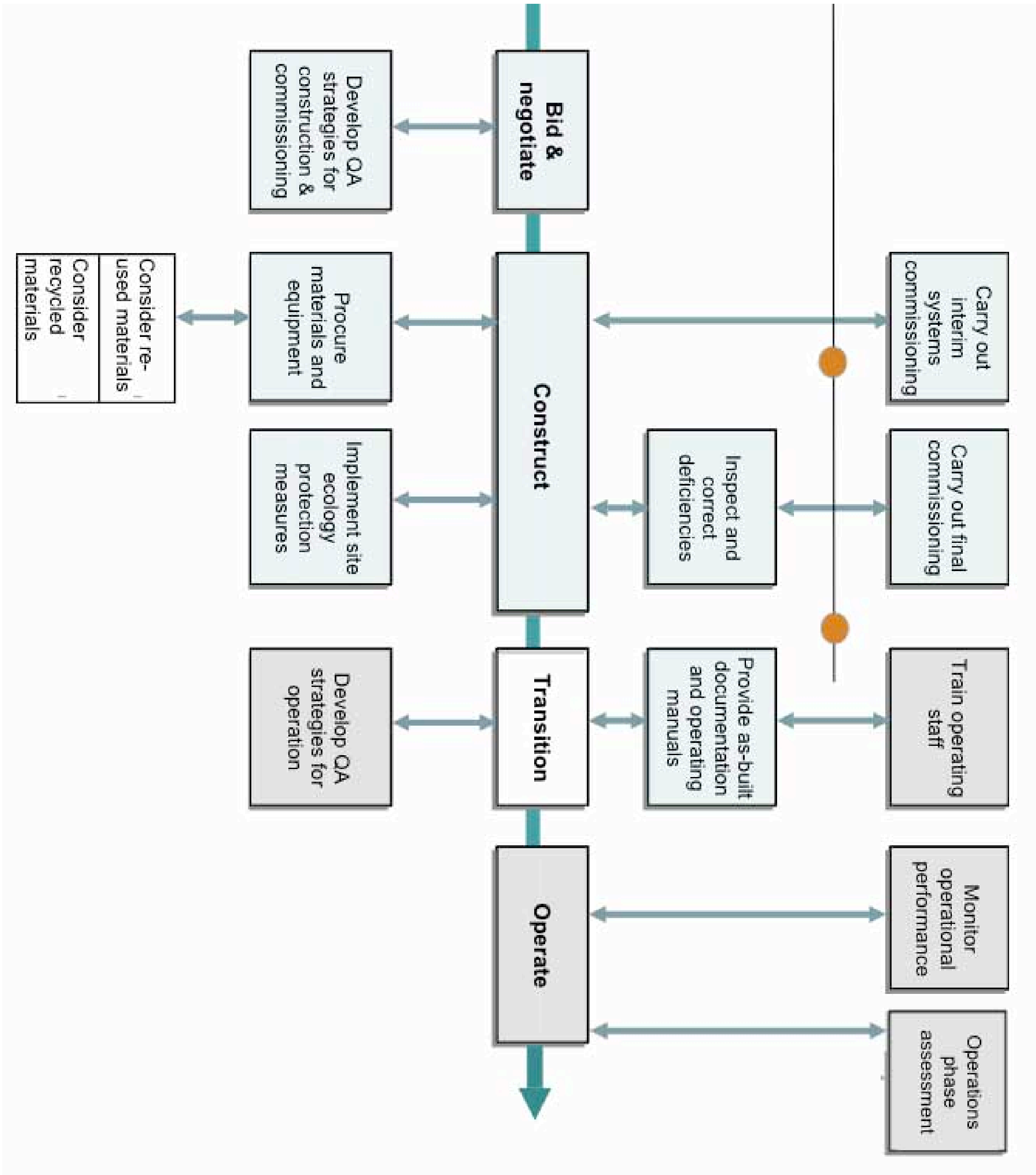
Appendix 1: Graphic representation of the IDP Process, part 1



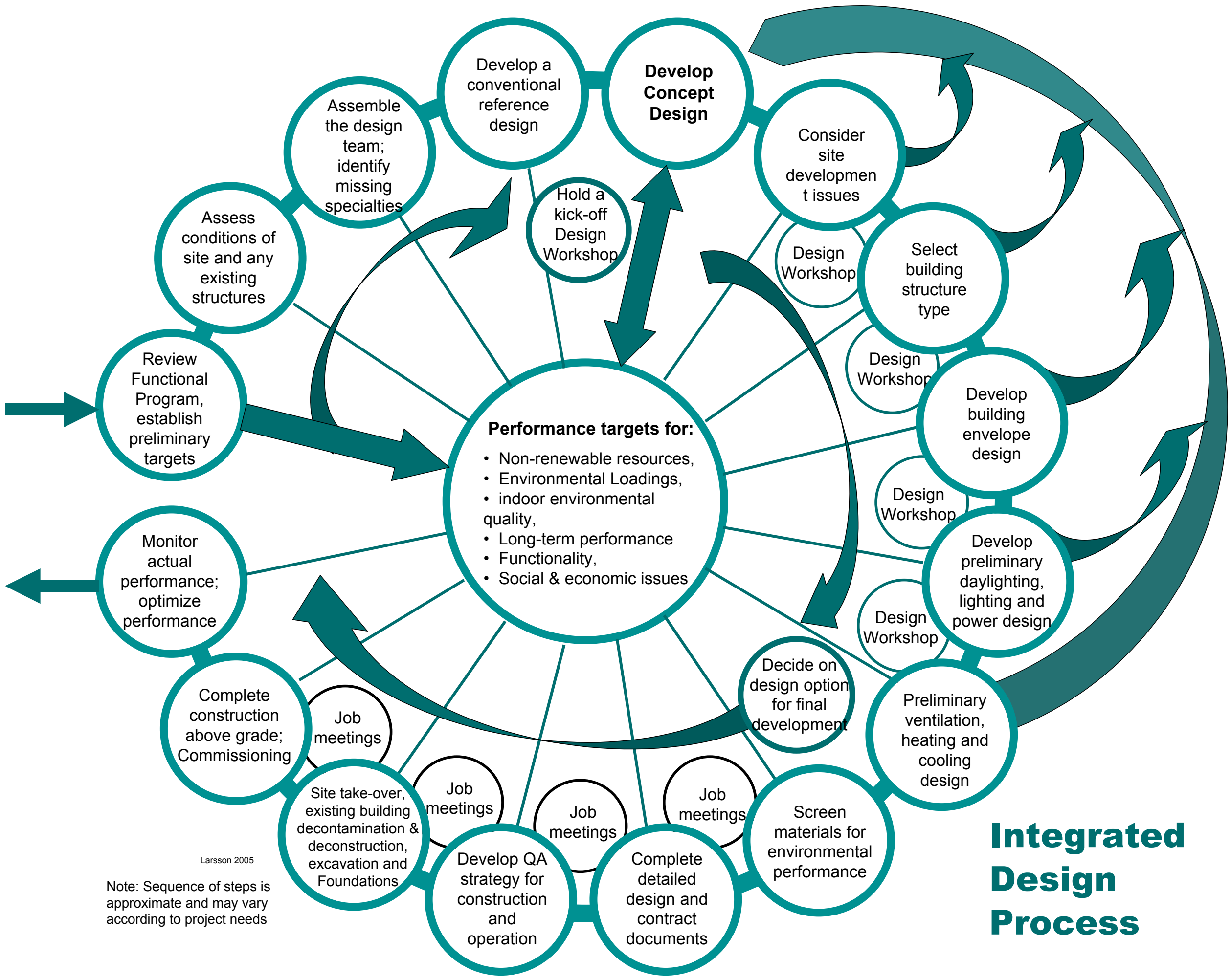
Appendix 1: Graphic representation of the IDP Process, part 2



Appendix 1: Graphic representation of the IDP Process, part 3



Appendix 2: Another graphic representation of the IDP Process



Note: Sequence of steps is approximate and may vary according to project needs

Appendix 3: Generic steps in the IDP Process

	These steps are meant to indicate a generally logical sequence in project development, and the sequence and/or text shown may therefore be modified for different project types in different regions. Steps listed in this worksheet are copied into a similar worksheet in the SBT-B File, which is used to record project-specific information.
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 capable of supporting 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 25 / C4).
1.07	Carry out an initial study of the feasibility of using renewable energy systems.
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 Module A 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	Assess erosion potential of surface soils and soil stability and bearing strength of sub-surface soils.
2.04	Assess the ecological quality of the site.
2.05	If a brownfield site, take steps to remediate conditions.
2.06	Examine soil for presence of radon.
2.07	Identify any features in adjacent properties that may place constraints on the design of the subject building.
2.08	Assess suitability of any existing structure(s) on the site for adaptation to the new uses planned for the site.
2.09	Assess suitability of materials in an existing building on the site for use in a new building.
2.10	Measure typical Sound Level (Leq) measured at noisiest site boundary.
2.11	Prepare a Site Characteristics Report.
3.0	**Assemble the Design Team**
3.01	Identify and retain design team members (beyond the architect and energy engineer) with skills and experience related to the program
3.02	Ensure that the proposed design team is aware that the project has high-performance goals
3.03	Ensure that contract conditions do not create a disincentive for the design team, especially the mechanical engineer
3.04	If the budget permits, include performance incentive payments in contracts for the principal designers

4.0	**Develop Reference Design and Benchmarks**
4.01	Develop a sketch design for a simple and cheap new Reference building fulfilling the functional requirements.
4.02	Develop a version of the Reference Design to fulfil requirements of Energy Code reference building.
4.03	Develop benchmarks for minimally acceptable performance for parameters not covered by D1 or D2, using SBTool as a framework.
5.0	**Hold an initial Design Workshop**
5.01	Prior to the workshop, carry out energy simulations for the reference building (see D2).
5.02	Invite design workshop participants, including the client, design team and specialists.
5.03	Use the Vote Tool to allow key actors to indicate their preliminary performance priorities
5.04	Table the energy simulations of the reference building to provide a starting point for discussion
5.05	Develop one or two schematic options for improved performance, such as a hybrid ventilation option, a fully air-conditioned option, a daylighting emphasis option etc.
5.06	Hold an open discussion on schematic options relative to performance priorities and targets, cost and other implications
5.07	Carry on with more detailed development of the most attractive option after the workshop, including more detailed estimates of embodied and operating energy, cost estimates and risk assessments.
5.08	Add new talent to the design team if necessary.
5.09	Make plans for additional future workshops
5.10	Summarize the results of the first workshop in a Kick-off Design Workshop Report,and distribute to all stakeholders
6.0	**Develop Concept Design**
6.01	Finalize performance targets, using SBTool or other suitable tool as a framework, and including consideration of Planning, Energy and Resource Consumption, Environmental Loadings, Indoor Environmental Quality, Service Quality and Social and Economic Issue
6.02	Develop a concept plan, using functional requirements, the Reference design (D) and performance targets as a starting point.
6.03	Orient the building to optimize passive solar potential, and relate fenestration requirements to orientation.
6.04	Establish configuration & floor plate depth to balance daylighting & thermal performance.
6.05	Consider the possible roles of natural, hybrid or mechanical ventilation systems.
6.06	Consider whether mechanical cooling will be needed.
6.07	Examine the most efficient forms of mechanical cooling and ventilation systems.
6.08	Assess the costs and benefits of specific renewable energy systems, if the site does offers good potential.
6.09	Determine floor-to-floor heights, taking into account possible future uses.
6.10	Carry out a first set of energy simulations or energy analysis on the proposed design.
6.11	Prepare a Concept Design Report.

7.0	**Consider site development issues**
7.01	Establish the building footprint to make efficient use of the site.
7.02	Minimize loss of solar or daylight potential of adjacent property due to design assumptions for placement and size of building elements.
7.03	Consider placement of building elements to minimize impacts on subsurface ecology and aquifers.
7.04	Determine measures for on-site storm-water retention, using retention ponds, permeable paving, green roofs or other measures.
7.05	Develop preliminary landscape plans to provide windbreaks and shading, to minimize water demand and to retain existing features and biota to the extent possible.
7.06	Develop a vehicle access and parking plan that minimizes impervious paved areas, preserves site ecosystems, and maximizes outdoor space for building users.
7.07	Ensure that the building will form a visual positive contribution to the streetscape, if applicable.
7.08	Summarize site development issues in a Draft Site Impact Plan.
8.0	**Determine building structure**
8.01	Consider column spacing and core position that will balance maximum usable and functional area with structural efficiency.
8.02	Consider measures to reduce embodied energy of the structure.
8.03	Consider thermal storage options using the structure as a heat sink.
8.04	In residential occupancies, consider appropriate balcony design.
8.05	Decide on building structure type taking into account the considerations above
9.0	**Develop Building Envelope Design**
9.01	Select basic exterior wall and roof systems
9.02	Assign fenestration on each orientation to optimize daylighting and thermal benefits
9.03	Optimize the daylighting and thermal performance of fenestration.
9.04	Consider the use of operable windows.
9.05	Consider measures to reduce the embodied energy of the building envelope.
9.06	Optimize envelope detailing and thermal performance
9.07	Carry out a second set of detailed energy simulations
10.0	**Develop preliminary daylighting, lighting and power system design**
10.01	Develop preliminary lighting system design.
10.02	Develop preliminary lighting control system.
10.03	Estimate the power requirements for future tenant and occupant equipment.
10.04	Optimize the energy efficiency of vertical or horizontal building transportation systems.
10.05	Develop strategies to shave peak electrical demand.

11.0	**Develop preliminary ventilation, heating & cooling system designs**
11.01	Develop preliminary design for natural or hybrid ventilation system.
11.02	Develop preliminary design for space heating system.
11.03	Develop preliminary design for space cooling system, if applicable.
11.04	Consider the use of free cooling (night-time flushing) where possible.
11.05	Consider ground- or water-source thermal storage options, if applicable.
11.06	Develop preliminary design for refrigeration systems, if applicable.
11.07	Develop preliminary CENTRAL PLANT design for ventilation, heating, and cooling systems, if applicable.
11.08	Develop preliminary design for ventilation, heating, and cooling DELIVERY systems, if applicable.
11.09	Develop preliminary design for ventilation, heating, and cooling CONTROL systems, if applicable.
11.10	Carry out a third set of energy simulations
12.0	**Decide on major design options for detailed development**
12.01	Review concept design options with respect to performance gains v. cost, using SBTool and/or LEED to provide comparative assessments.
12.02	Hold a second design workshop to select one of the alternative design solutions for detailed design development.
13.0	**Screen non-structural materials for environmental performance**
13.01	Minimize use of non-structural materials or components that use scarce material resources.
13.02	Select materials that balance durability and low embodied energy.
13.03	Consider re-use of components and use of recycled materials.
13.04	Design assemblies and their connections to facilitate future demountability.
13.05	Select indoor finishing materials to minimize VOC and other emissions to the indoor environment.
14.0	**Complete design and documentation**
14.01	Complete site development and landscaping design to minimize potable water consumption.
14.02	Design plumbing and sanitary systems to minimize water consumption.
14.03	Complete detailing for appropriate rain screen and pressure equalization envelope.
14.04	Finalize electrical and lighting system design.
14.05	Finalize ventilation, heating, and cooling system designs.
14.06	Confirm that adequate space exists for data and communications systems.
14.07	Select building energy management control systems.
14.08	Review the use of materials in non-structural applications to minimize waste.
14.09	Carry out a final set of energy simulations.
14.10	Produce a Building Design Report

15.0	**Develop QA strategies for construction and operation**
15.01	Develop a Quality Assurance Plan for Construction
15.02	Develop a Commissioning Plan for all major systems.
15.03	Appoint a Commissioning Agent to implement the Commissioning Plan
15.04	Develop a Quality Assurance Plan for Building Operations
15.05	Develop lease instruments with tenant incentives to operate space efficiently, or equivalent occupant instructions for owner-occupied building.
16.0	**Site takeover, existing building decontamination & deconstruction, excavation & foundations**
16.01	Take over site from previous owner, and ensure that surface and subsurface conditions are as per previous information.
16.02	If there are existing surface or sub-surface structures, inspect and decontaminate if necessary.
16.03	Deconstruct any existing structures on the site that will not be re-used, sorting and saving all materials that can be re-used or recycled.
16.04	Excavate and prepare foundations as per contract documentation.
17.0	**Complete above-grade construction**
17.01	Complete above-grade construction, as per contract documentation and requirements of P1.
17.02	In accordance with P1, sort all construction waste and re-use or recycle wherever possible.
17.03	In accordance with P1, maintain protocols to minimize ecological damage to site and surroundings.
17.04	In accordance with P1, maintain protocols to minimize risk to safety or health of on-site workers and neighbouring residents.
17.05	Prepare a set of as-built construction documents
18.0	**Prepare a set of as-built construction documents**
18.01	Implement commissioning procedures as per 15.02
18.02	Not yet developed
18.03	Prepare a Commissioning Report and distribute to key actors.
19.0	**Operate and Maintain the building**
19.00	Train operating staff and ensure that they have access to a full set of as-built documents and system manuals.
19.02	Operate the building, maintaining QA procedures established in P4.
19.03	Carry out maintenance and system upgrades or replacements as needed.
19.04	Educate building occupants to use the facilities efficiently.
20.0	**Carry out Post-Occupancy Evaluation, operate the building and monitor its performance**
20.01	Carry out a Post-Occupancy Evaluation (POE) study
20.02	In accordance with P4, carry out periodic monitoring of IAQ and occupant satisfaction.