Energy Answers
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What is an Integrated Design Process (IDP)?

Here is a definition that hopefully captures the essence of IDP: “An IDP is a design process in which all major components of the building are considered and designed as a totality. Components are not designed in isolation of their effects on other components and systems.”

Two centuries ago, the building process for larger buildings was very simple. An owner would contact an architect/designer who would design almost everything for the building, and then a builder would construct the building. Buildings often had no mechanical systems other than a wood or coal stove; electrical systems such as lighting, telecoms, etc. were nonexistent, interior decorating was done by the architect, as was the landscaping. An architect could do the entire design process himself, and there really was no problem of communication amongst the design staff. If you think about this, many of the great buildings of the world were designed and built this way. I recently visited the Pantheon in Rome, finished in the second century AD, and it and most of the memorable buildings of Rome were likely built with a single designer.

In block diagram form, it worked like this.

Owner ----->	**Architect/Designer ------>**	**Builder ------>**	**Site Crew**

Figure 1. Building Construction circa 200 years ago

Fast forward to the present era. Because of the complexity of building systems the flow now often goes something like this:

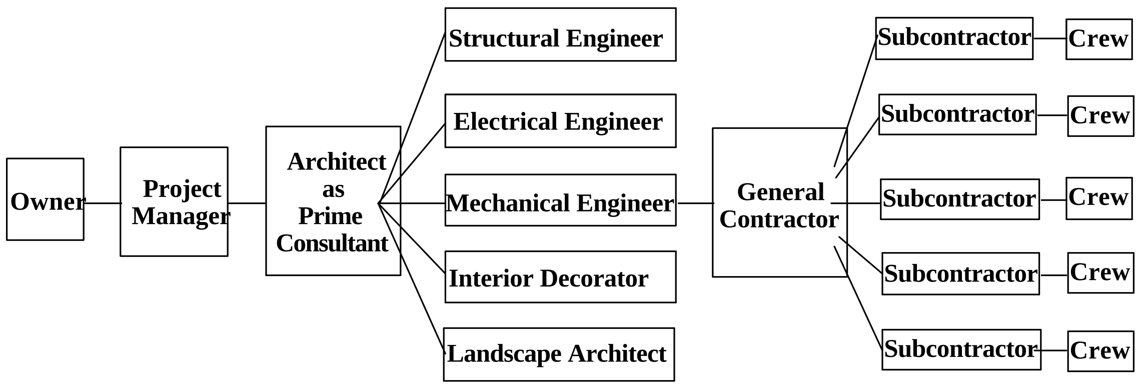

Figure 2.

Building Construction in Current Times

Other specialists, such as computer modelers, control systems specialists, code review consultants, cost accountants, elevator specialists, kitchen specialists, internal traffic specialists, etc. can also be involved in the process, further adding to the complications.

As you can see by comparing the block diagrams, the task of building a great building these days is much more complicated. No one designer is an expert in all phases of building design; thus, communication amongst all the designers is now a crucial element in good design.

The basic idea of the integrated design process is to use a single design desk approach in which all the design team members are involved from the beginning of the process. The following diagram shows schematically how this would work.

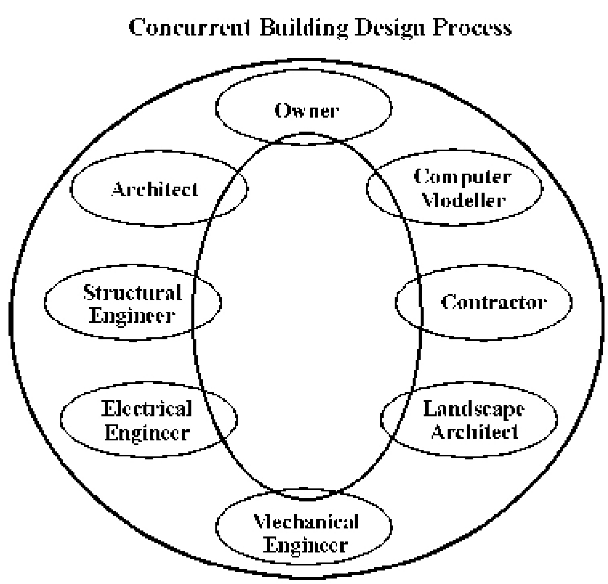

Figure 3. Integrated or Concurrent Design Process

Figure 3 is an idealized diagram. Someone has to co-ordinate the inputs from the various team members and ensure that the integrated design process is on track with real deliverables. Sometimes an external project facilitator is hired for the process, and sometimes one of the design team members can serve as the facilitator.

For most large buildings, the Contractor is not usually involved at the design stage, as it is not known who the contractor will be until after the building is tendered. The accumulated knowledge of contractors, however, should be tapped for the integrated design process, even if the contractor is not directly present at the table.

One might question, for instance, whether all of this communication and integration is necessary. For instance, what information would the electrical engineer and the landscape architect have to share? However, there are several items of interest. The electric lighting scheme for a building is often designed by the electrical engineer, and the exterior planting schedule (trees, vines, site grading, etc.) can affect the daylighting scheme, which will in turn affect the control system for the lighting.

A great advantage of the integrated design process is that capital cost savings in certain areas (heating and cooling, for example) can be achieved by improving the building orientation and the building envelope. Lower energy bills and life-cycle costs can result. The great American architect Frank Lloyd Wright once wrote that "You should never put anything in a building that serves only one function." For building elements to "multi-task," a high degree of integration is needed, and generally this cannot be achieved with "dis-integrated" designs resulting from poor communication among the design staff.

Getting the Integrated Design Process Started.

1. Define the Design Goals

Different owners will have different goals. It is very important, from the start of the IDP, to have the goals well defined. For some building projects, the goal may be very simple, such as providing the owner, who wishes to sell the building on completion, an acceptable rate of return in the marketplace. Another owner, such as a housing co-operative, may have a larger number of goals such as a very durable building with low energy costs, high local material content, high local labour content, a highly attractive building, excellent indoor air quality, etc. Having the goals for the building well articulated is a major first step in the IDP process. A written statement of the design goals is very useful.

2. Be quantitative with the goals where quantitative criteria are appropriate.

Some quantitative criteria might include the following:

Energy Related Goals:

i. The building will meet the Commercial Building Incentives Program energy target (25% less than the Model National Energy Code for Buildings)

- Lighting levels in the offices will not exceed 400 lux; lighting power densities will not exceed 7 watts/sq.metre
- All hallway lighting will be controlled during non-occupied hours using occupancy sensors
- All ventilation air must have heat recovery equipment installed with a minimum sensible heat recovery effectiveness of 0.6

- Heating and cooling energy should preferentially be distributed using liquid flows rather than air flows
- Indoor Air Quality Goals:
  - All interior carpeting must meet the Carpet and Rug Institute standard for offgassing of volatile organic compounds and formaldehyde
  - The separation distance between air intakes and air exhausts and chimneys for the building must meet the ASHRAE recommended values
  - All paints must be of a low offgassing type
  - All occupied spaces must have a ventilation rate of 8 L/s per person when occupied, or match the ventilation rates as specified in the ASHRAE Standard 62
- Water Conservation Goals
  - All clothes washing and dishwashing machines must meet the Energy Star rating standard where appropriate
  - All shower heads must have a flow rate not to exceed 10 litres/minute at a pressure difference of 551 kilopascals (80 psig)
  - All toilets must have a water consumption per flush not to exceed 6 litres
  - Exterior landscaping shall be designed to minimize water use. Native vegetation with low water requirement is to be used, and lawn areas should be minimized.
- Natural Lighting Goals
  - The building orientation and window placement should favour the use of natural lighting and not artificial lighting during the daylit hours. Exterior shading, light shelves and light coloured surfaces are recommended, as well as an interface with the room lighting to dim or turn off artificial lighting when daylight is available.

- Recycling and Solid Waste Management Goals
- Transportation Goals

All of the major design team members should be present as the goals for the building are formed (assuming the owner does not provide these in advance). In turn, the design team members should ensure that all of their associates involved with the design are also informed. It does little good if the owner wishes to have a high efficiency office lighting system (less than 0.75 watts/square foot) and the draftsperson selects a system that uses 2 watts/square foot because she was unaware of the overall goals of the project.

3. Proceed with the Integrated Design

The following elements in an integrated design should all be formally addressed with all members of the design team present:

1. Owner’s expectations, including minimum requirements regarding energy performance.
2. Building function, and massing of the building
3. Site development–use of natural attributes of the site (solar orientation [passive and active], views, access to daylight, levels of daylighting required, wind patterns, snow patterns, opportunities for use of site based resources, transportation, landscaping)
4. Regulatory constraints, code and zoning requirements

5. Building structure type – wood, steel, concrete, etc.
6. Building thermal and moisture protection
7. Interior finishes
8. Heating, ventilating, air conditioning, water supply and removal
9. Electricity supply and demand, equipment, artificial lighting, motor selection, controls, etc.
10. Landscaping
11. Quality Control

Each of these 11 categories will have either major or minor effects on each of the design team members. Time should be spent at the start of the project reviewing each of these categories with all design team members present, focussing in on design concepts that can be carried forward. Ideally, consensus on these issues can be reached by the design team members. In some cases, additional information will be needed to help make decisions. Each design team member should come to this meeting prepared with one or more design approaches in his or her specialty area. Visual presentations illustrating the concepts are much preferred to oral descriptions, particularly for technologies that may be new to the other design team members. Every design team member has to "sell" their ideas to other members to get consensus and to show how their idea "fits" with the design/performance goals.

This integrated approach should continue from the conceptual stage through the detailed design stage and on to the construction and commissioning stages. In the C-2000 process for advanced Canadian commercial buildings, a designated Integrated Design Facilitator has been used to assist with the integrated design approach.

What are some of the disadvantages of integrated design?

1. It is a change from past methods, and who ***really*** likes change?
2. Most professional people are trained in an environment where they are most comfortable working with their own kind: architects with architects, engineers with engineers, etc. Integrated designs must be interdisciplinary, but our universities, colleges and trade schools almost exclusively focus on single discipline learning.
2. More decisions have to be justified and defended.
3. Egos are more exposed, power struggles can occur.
4. Designs can take longer until people around the table are more familiar and comfortable with the process.
5. IDP does not work well (or at all) in a fee environment where one's compensation is rigidly based on a percentage of the capital cost of the building. In a percentage-based fee environment, for instance, the mechanical engineer's fee would be a certain percentage of the cost of the mechanical engineering contract for the building. There is no financial incentive for the mechanical engineer to reduce the cooling or heating plant size when his or her fee is based on the size of the mechanical contract. A leaky, poorly insulated envelope with poor windows demands larger heating and cooling equipment, which will generate a higher design fee for the mechanical consultant. It is best to negotiate fee sharing among all participants up front (perhaps using traditional percentages) and get that out of the way.
6. A relatively strong but fair leader or facilitator is needed to keep the process on track. Extra effort is needed to involve all design members in a meaningful way.
7. An environment must exist where <u>all</u> design team members feel free to offer creative suggestions

and challenge other members.

What are some advantages of integrated design?

1. Decisions are made in a group environment. There are fewer surprises and fewer guesses involved.
2. An opportunity exists at the start of the project to clearly communicate to the entire design team the expectations of the client and the energy performance goals of the project.
3. Equipment can be more appropriately sized, as the intended use of the building and its spaces are more widely known.
4. Synergies can results; components can serve more than one function and save costs.
5. All expertise is present at one table, and a stimulating environment for problem solving is possible.
6. Conflicts can be dealt with at the design table and not on the job site. Tender document quality and coordination between documents can be improved.
7. Smaller, more appropriately sized heating, cooling, and ventilating equipment can result, with substantial savings.
8. The owner can achieve a more cost-effective and satisfying building, with better comfort levels and lower energy costs.

Most large buildings are not designed using an Integrated Design Process. The Integrated Design Process approach, by breaking down the "Silos" of individual designers, can help make large building projects less dis-integrated, and more successful.

In the automotive and aircraft design field, integrated design is now relatively common. There even exists a **Society of Concurrent Product Development** (www.sce.org) whose mission is to "develop and promote the application of Concurrent Engineering and Integrated Product Development in companies and organizations worldwide."

Here in Canada, the C-2000 program developed by Natural Resources Canada has been a key catalyst in encouraging the Integrated Design Process for buildings. Nils Larsson of NRCan has been an eloquent and tireless advocate. More information on the C-2000 Integrated Design Process is available at http://www.buildingsgroup.nrcan.gc.ca:80/projects/idp_e.html