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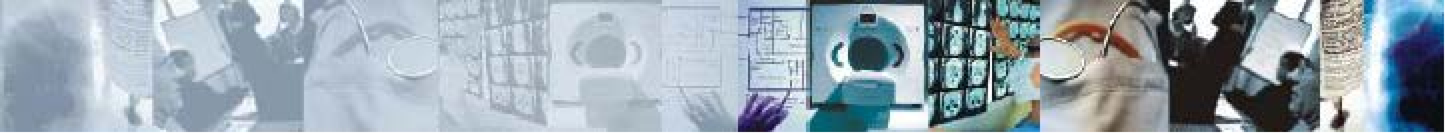

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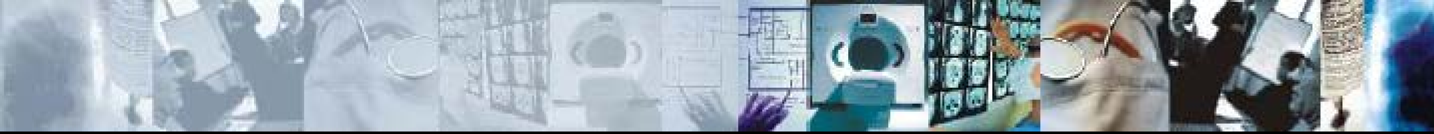
Welcome You To

An Introduction to Healthcare Facility Design

Architects Lecture Series 2004 – No. 4

Design Concepts:

Should Form Always Follow Function?



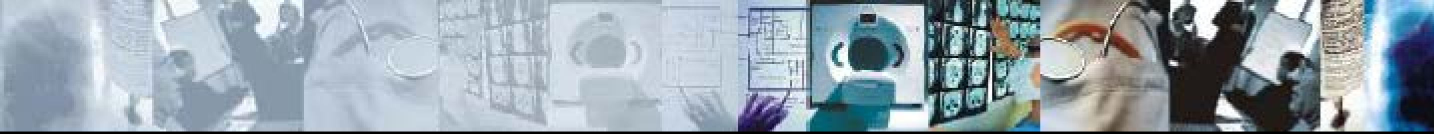
Horatio Greenberg first stated that “form follows function” in 1739.

His phrase became a battle cry for the architect Louis Sullivan in the late Nineteenth century.

Sullivan was one of the earliest proponents of the Modernist movement in architecture.

Le Corbusier, another famous Modernist architect, talked of a house as a “machine for living in”.

If Le Corbusier had been a healthcare architect, maybe he would have talked about designing hospitals as “machines for healing in”.



The international style let us down rather badly in terms of human value.

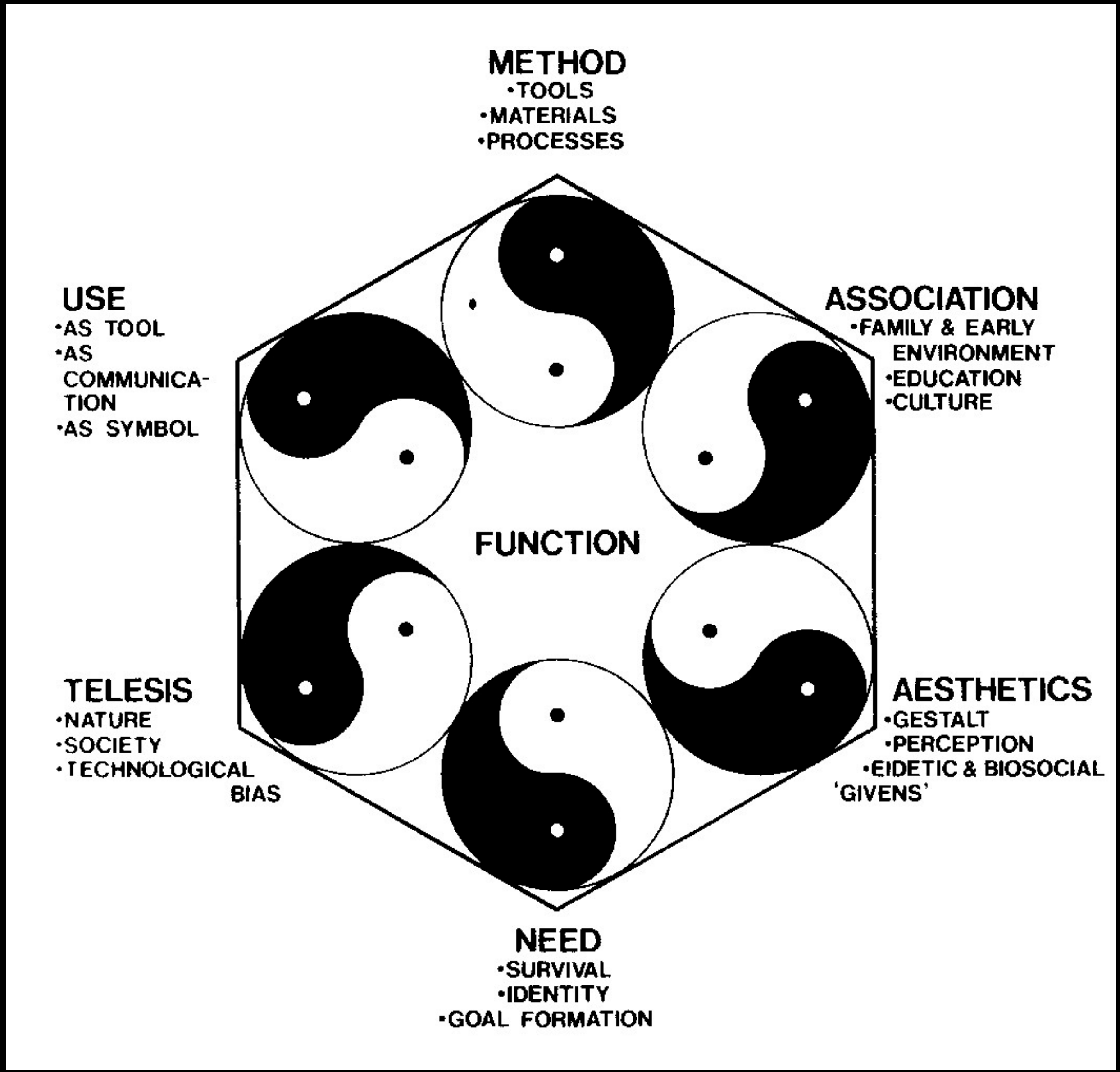
“Should I design it to be functional,” the students say, “or to be aesthetically pleasing?”

This is the most often heard, the most understandable, and yet the most mixed-up question in design today.

“Do you want it to look good or to work?”

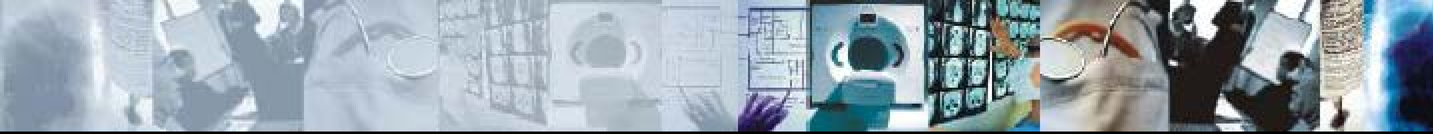
Barricades are erected between what are really just two of the many aspects of function.

The Function Complex



The Yin-Yang monad indicates the soft-hard, feeling-thinking,intuitive-intellectual mix that define each of these criteria

From "Design for the Real World" by Victor Papanek

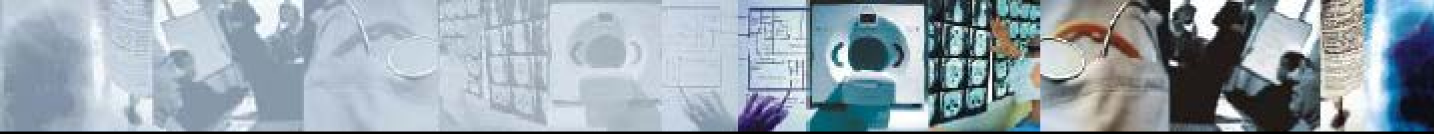


Method: **The interaction of tools, processes, and material.**

When early Finnish and Swedish settlers in what is now Delaware decided to build, they had at their disposal trees and axes.

The material was a round tree trunk, the tool an axe, and the process a simple “kerf cut” into the log.

The natural result of this combination of tools, materials, and processes was a log cabin.

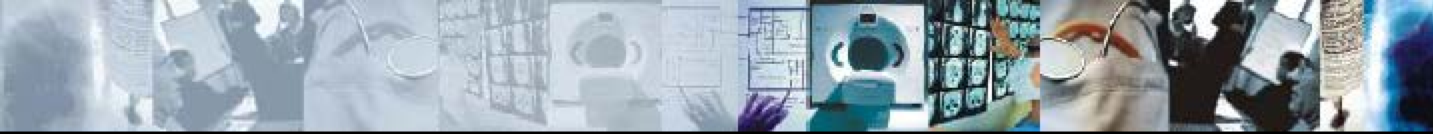


Use: "Does it work?"

A vitamin bottle should dispense pills singly.

An inkbottle should not tip over.

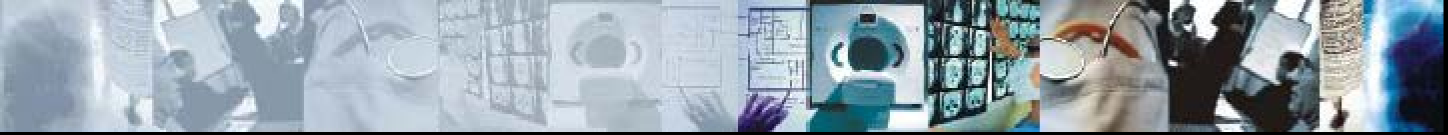
But a ballpoint pen shaped and colored like a pickle and made of a creepily yielding plastic is a tawdry perversion of design for use.



Need:

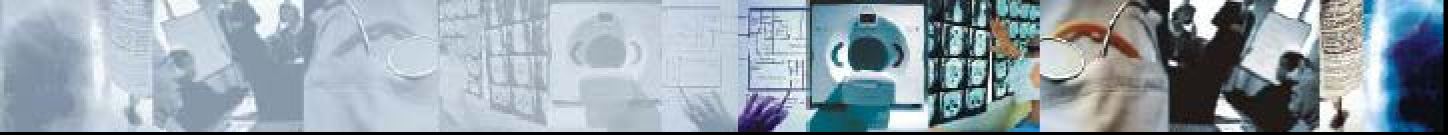
Much recent design has satisfied only evanescent wants and desires, while the genuine needs of man have often been neglected.

The economic, psychological, spiritual, social, technological, and intellectual needs of a human being are usually more difficult and less profitable to satisfy than the carefully engineered and manipulated “wants” inculcated by fad and fashion.



Telesis: **"The deliberate, purposeful utilization of the processes of nature and society to obtain particular goals".**

The telesic content of a design must reflect the times and conditions that have given rise to it and must fit in with the general human socio-economic order in which it is to operate.

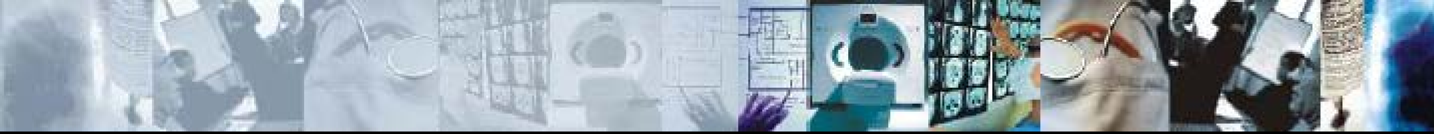


Association:

Our psychological conditioning, often going back to earliest childhood memories, comes into play and predisposes us to, or provides us with antipathy against, a given value.

Most associational values are universal within a culture and frequently are based on the traditions of that culture.

These values come from unconscious, deep-seated drives and compulsions.



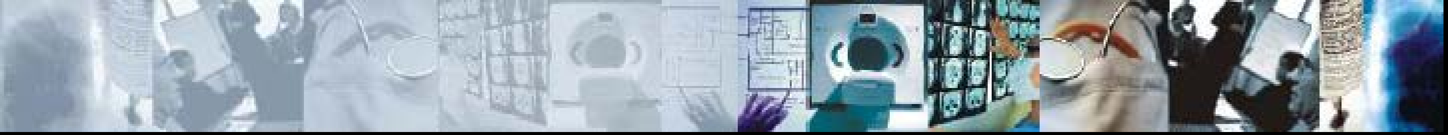
Aesthetics:

We know that aesthetics is a tool, one of the most important ones in the repertory of the designer, a tool that helps in shaping his forms and colors into entities that move us, please us, and are beautiful exciting, filled with delight, meaningful.

We know what we like or dislike and let it go at that.

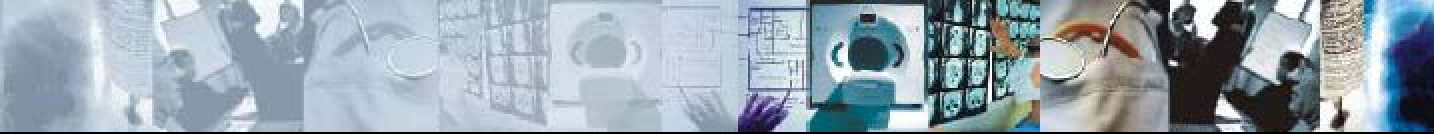
Artists (and architects) themselves begin to look at their productions as auto-therapeutic devices of self-expression, confuse license and liberty, and forsake all discipline.

They are often unable to agree on the various elements and attributes of design aesthetic.



Designers often attempt to go beyond the primary functional requirements of method, use, need, telesis, association and aesthetics; they strive for a more concise statement: precision, simplicity.

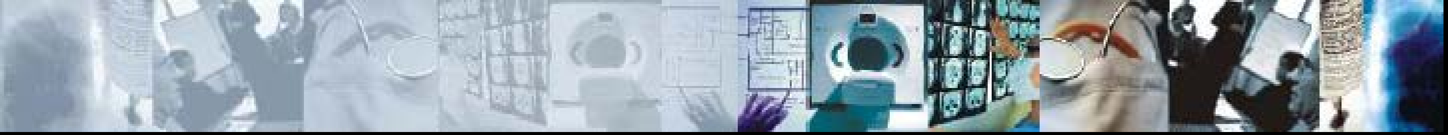
In a statement so conceived we find a degree of aesthetic satisfaction comparable to that found in the logarithmic spiral of the chambered nautilus, the ease of a seagull's flight, the strength of a gnarled tree trunk, the color of a sunset.



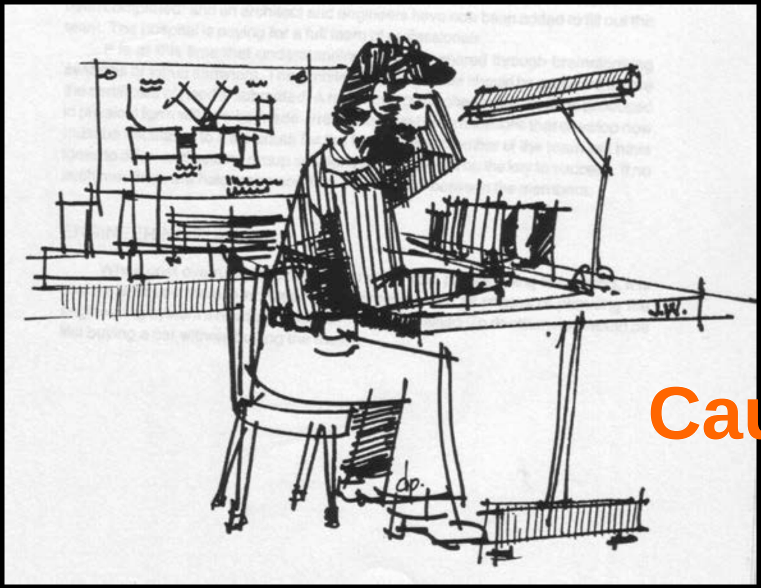
The particular satisfaction derived from the simplicity of thing can be called elegance.

When we speak of an elegant solution we refer to something that reduces the complex to the simple.

It is a demonstration of our enchantment with the near perfect.

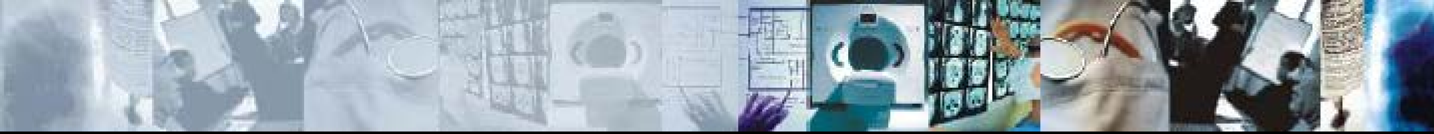


Back to healthcare architecture…



Caution! Architect at Work

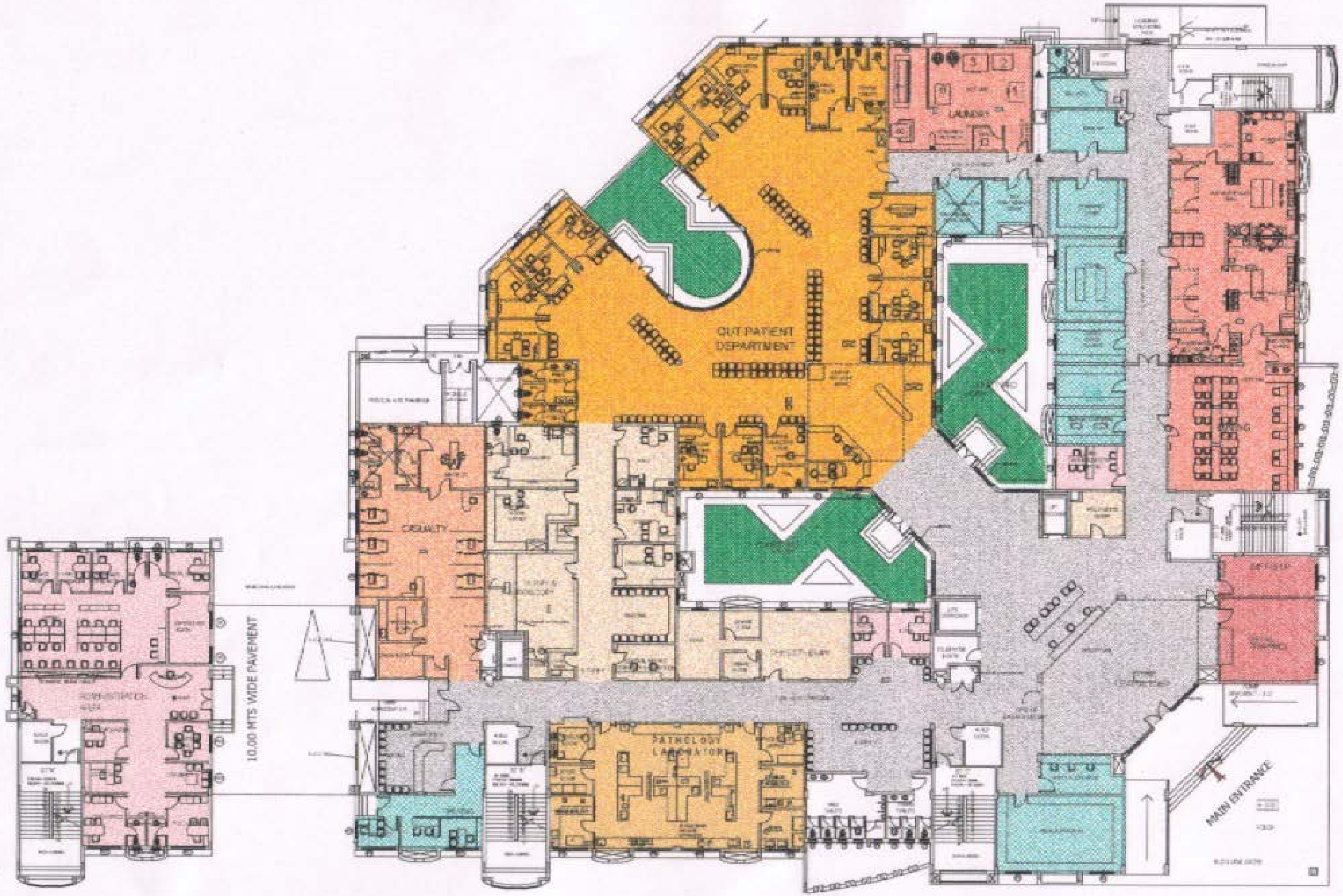
- **The focus moving away from treating "illness" to creating "wellness".**



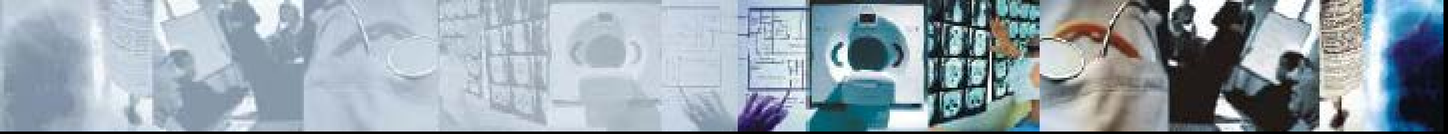
The qualities of a successful hospital could be said to be as follow:

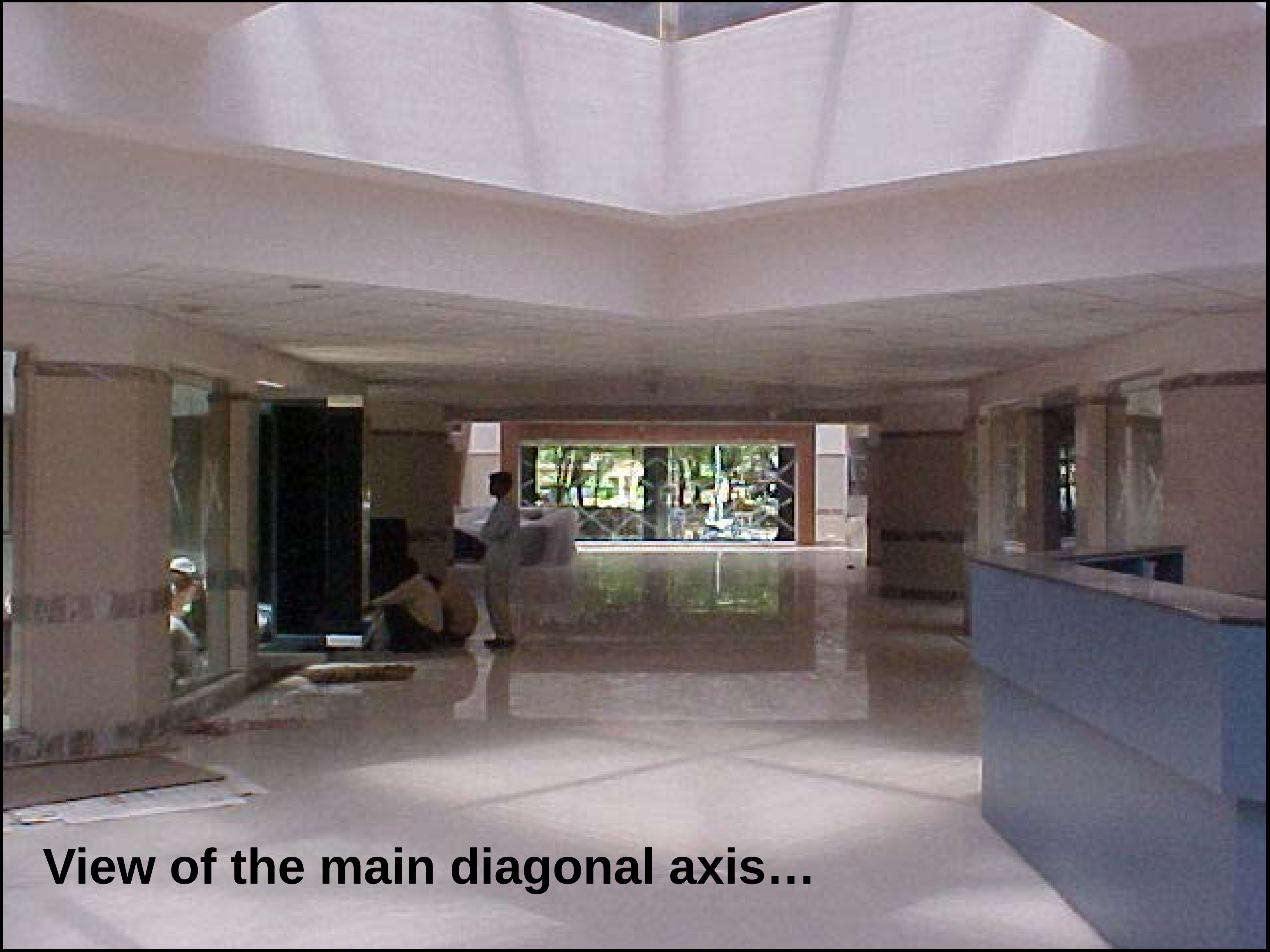
(beyond functional planning and technical issues…)

1. **Clear Orientation.**
2. **Connection with Nature.**
3. **Connection with People.**
4. **Appropriate Scale.**



Bringing light and nature deep into the building



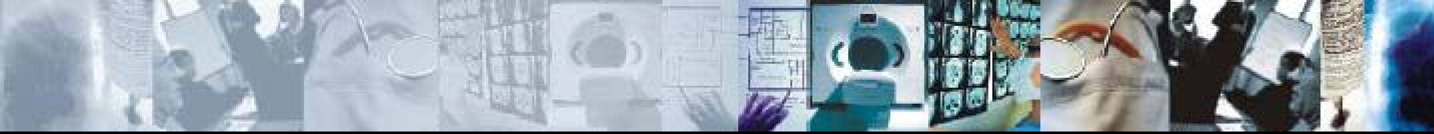


View of the main diagonal axis…

A view of one courtyard…

A view of the skylight…

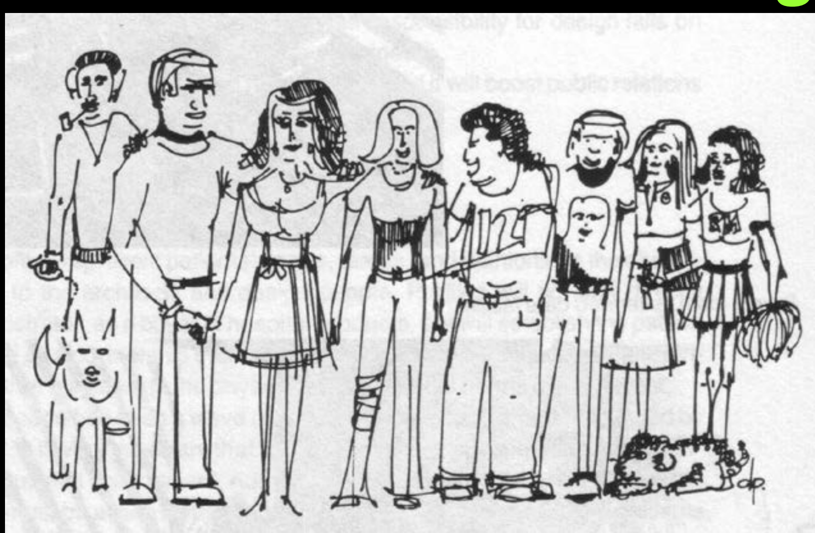
Light from the skylight…

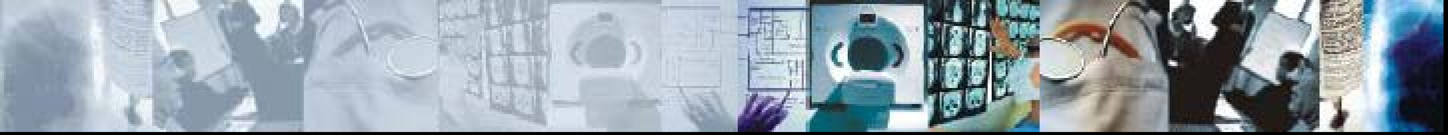


The **design "concept"** for any proposed building **is the central idea that is the driver for making architectural design decisions** related to the project.

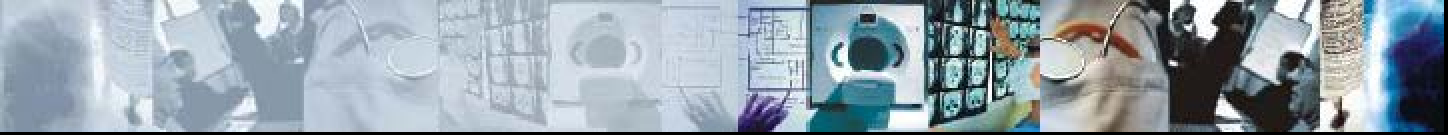
While there are many possible such concepts that could be used in the design of a healthcare facility, enumerated below are a few that come to mind:

Could 'a design for the family' be one?



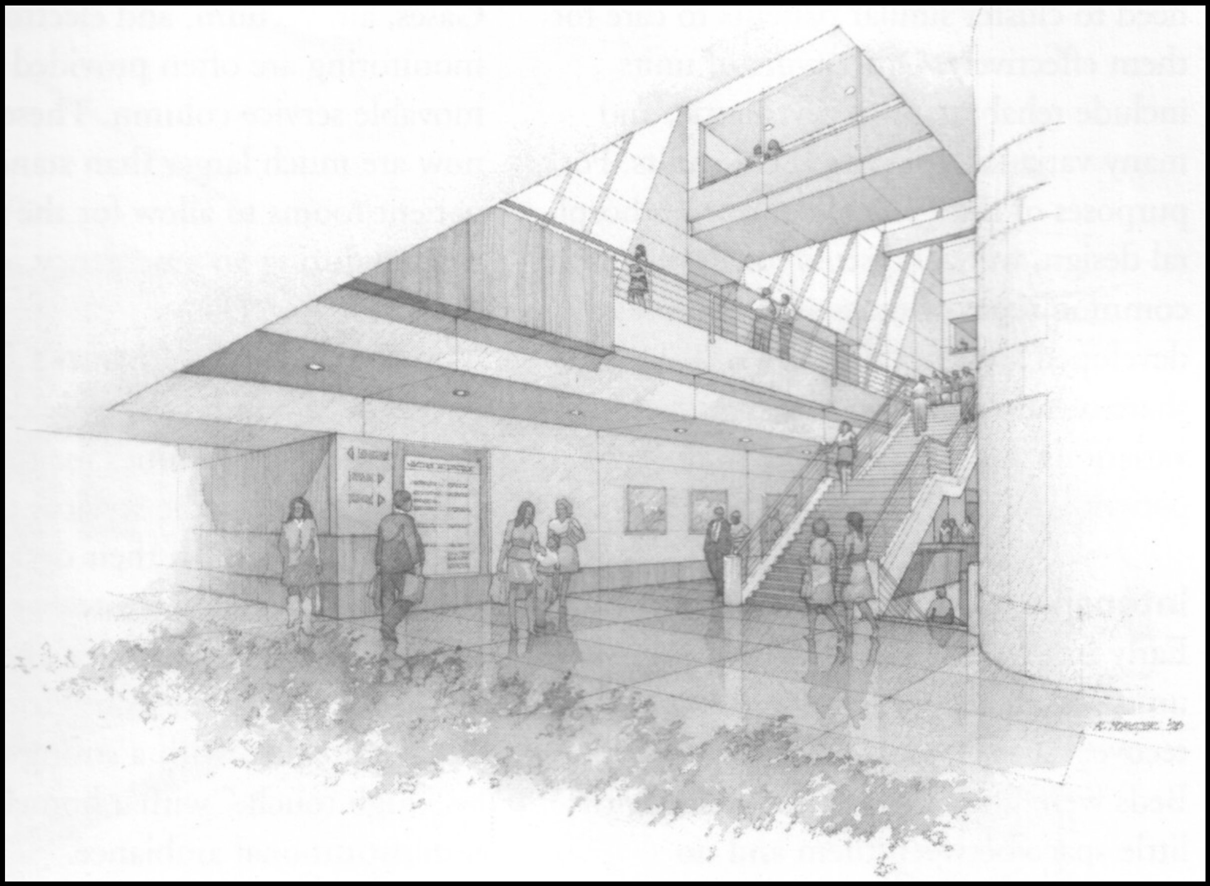


1. An **idea for building form** derived from (or dictated by!) the proposed site.
2. The need to build the hospital in a **phased manner** could impact the layout and form, many times in combination of the above-mentioned site constraints or features.
3. An idea about how to lay out the **major circulation paths** through the building / campus, for ease of way finding and efficiency of movement of staff, patients and materials.
4. The **functional relationships and area requirements** of the various departments taken possibly in consideration together with all the above factors.

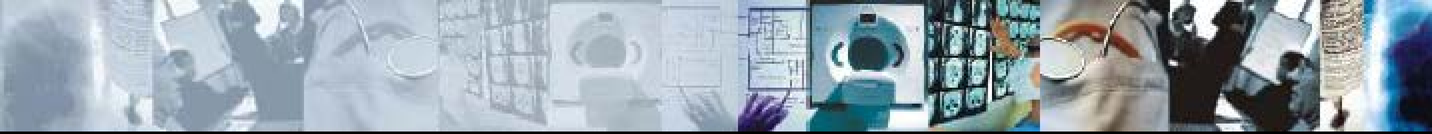


5. The climate of the location, or the way in which the building will be lit and ventilated, by artificial or natural means. If there are severe budget constraints, as in many developing countries, this factor could be a major determinant of building form.
6. Rarely, a strong idea of the form of the building as sculpture.
7. Mostly, a combination of all these factors, given varying degrees of importance.

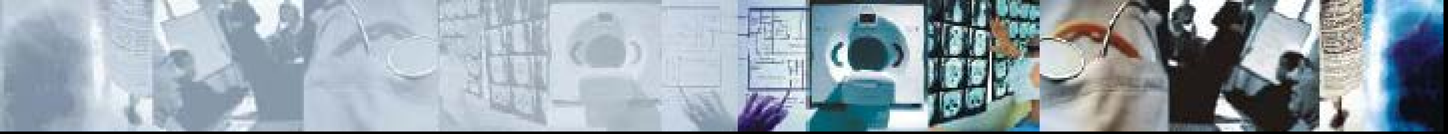
Form need not only follow function. Let it follow your dreams sometimes.



The Atrium Lobby at UCSF Stanford Health Care, Center for Cancer Treatment and Prevention / ambulatory care pavilion, shown here, is an example of form with the rough edges of a hospital's reality rounded off.

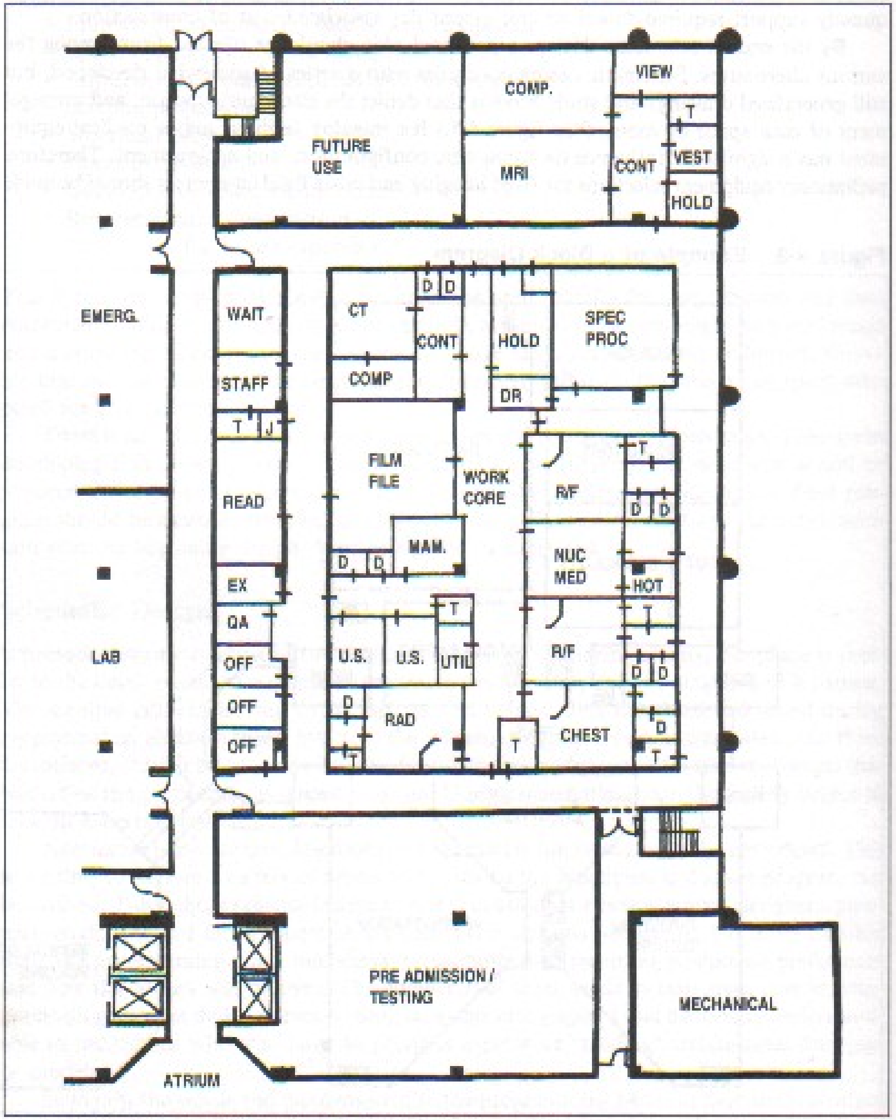


…a note for the non-architects among us…



Example of a Single-Line Schematic Departmental Layout

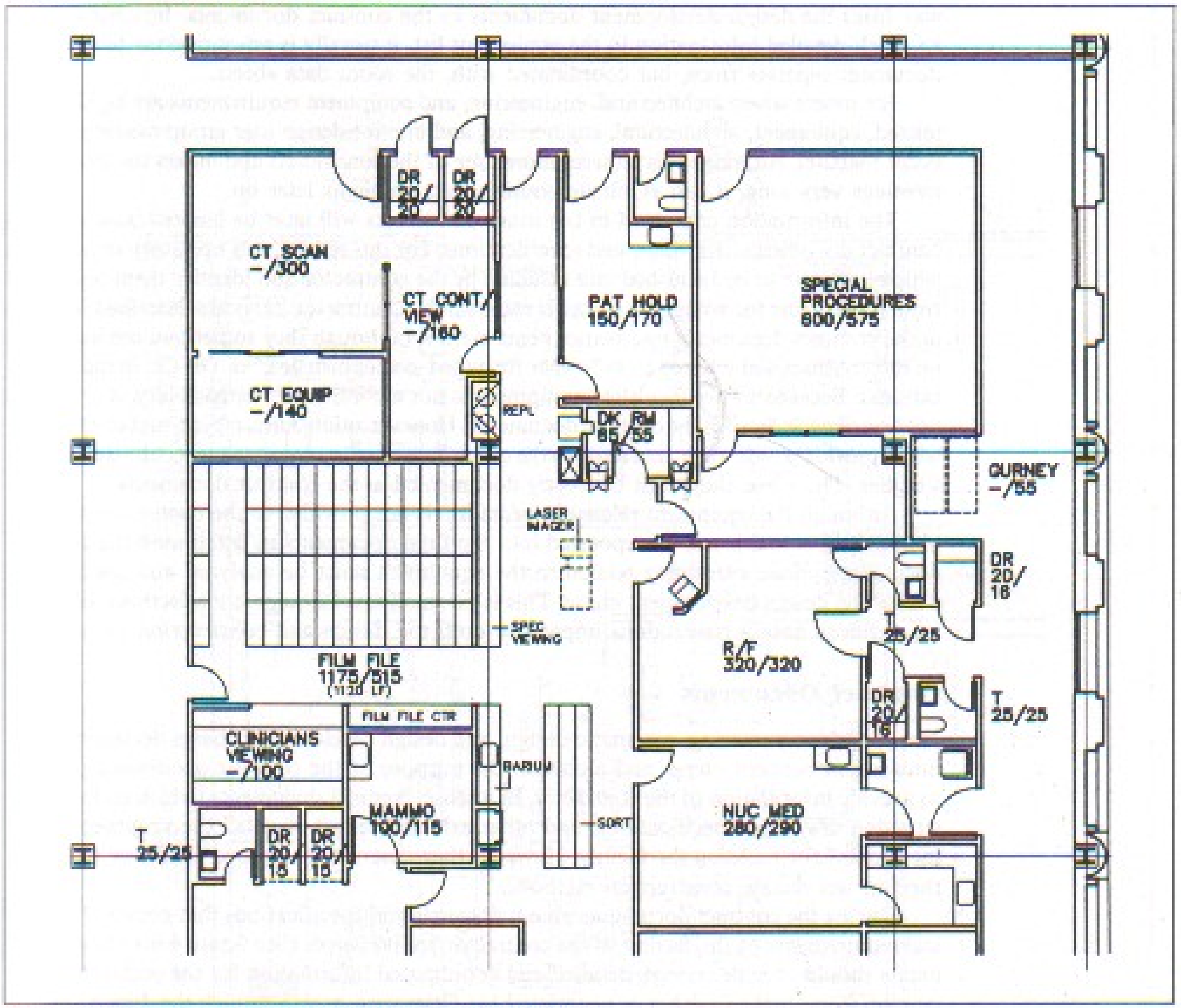
Figure 4-4. Example of a Single-Line Schematic Departmental Layout



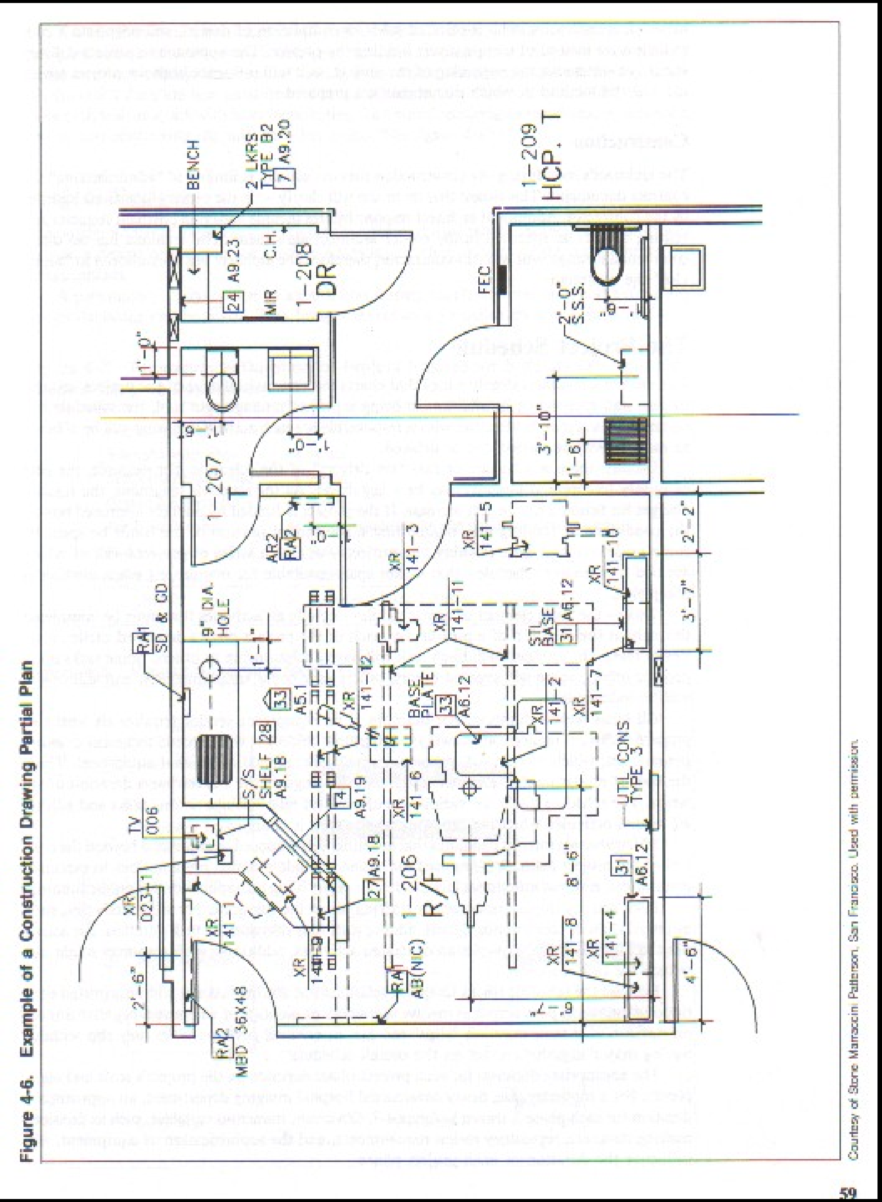
Courtesy of Stone Marraccini Patterson, San Francisco. Used with permission.

Example of a Schematic Design Partial Plan

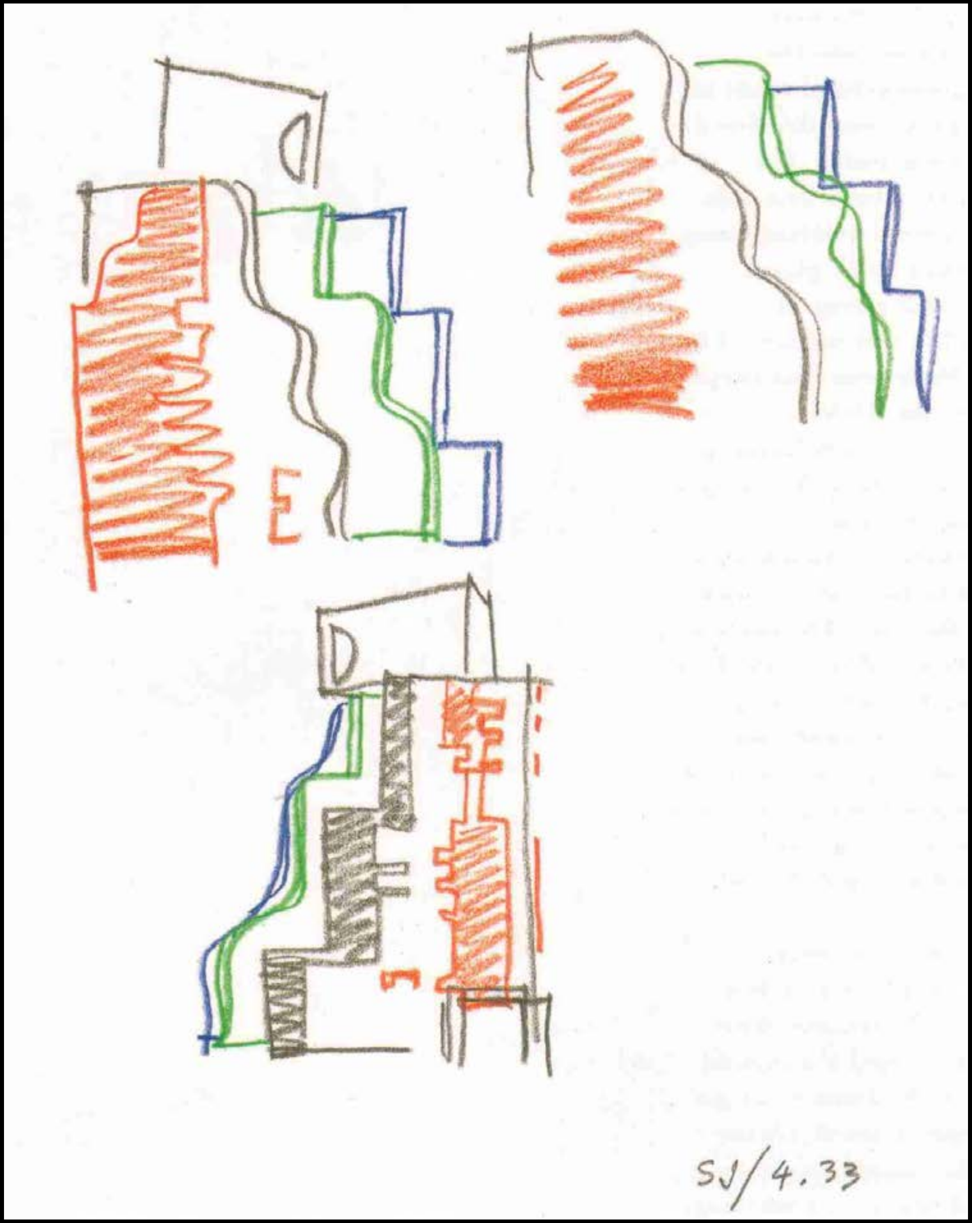
Figure 4-5. Example of a Schematic Design Partial Plan



Example of a Construction Drawing Partial Plan

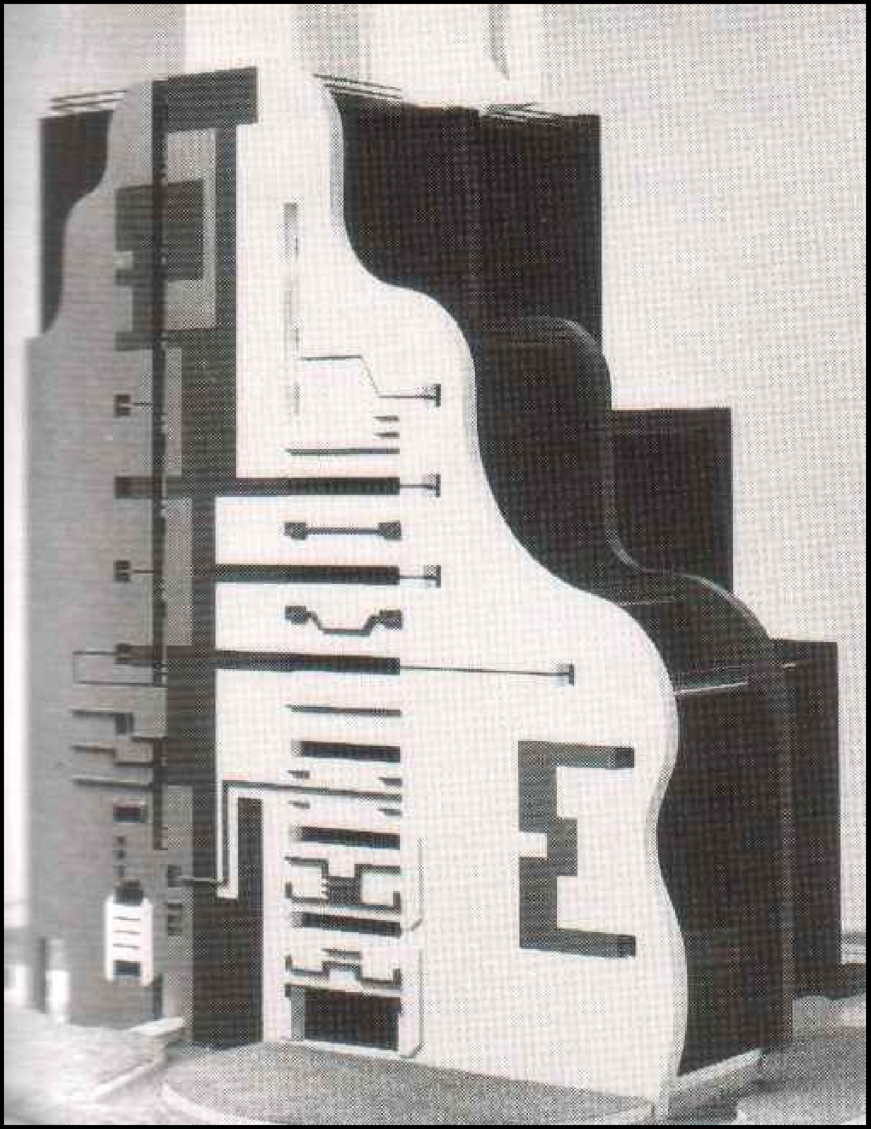


Conceptual sketches by **Sumet Jumsai**



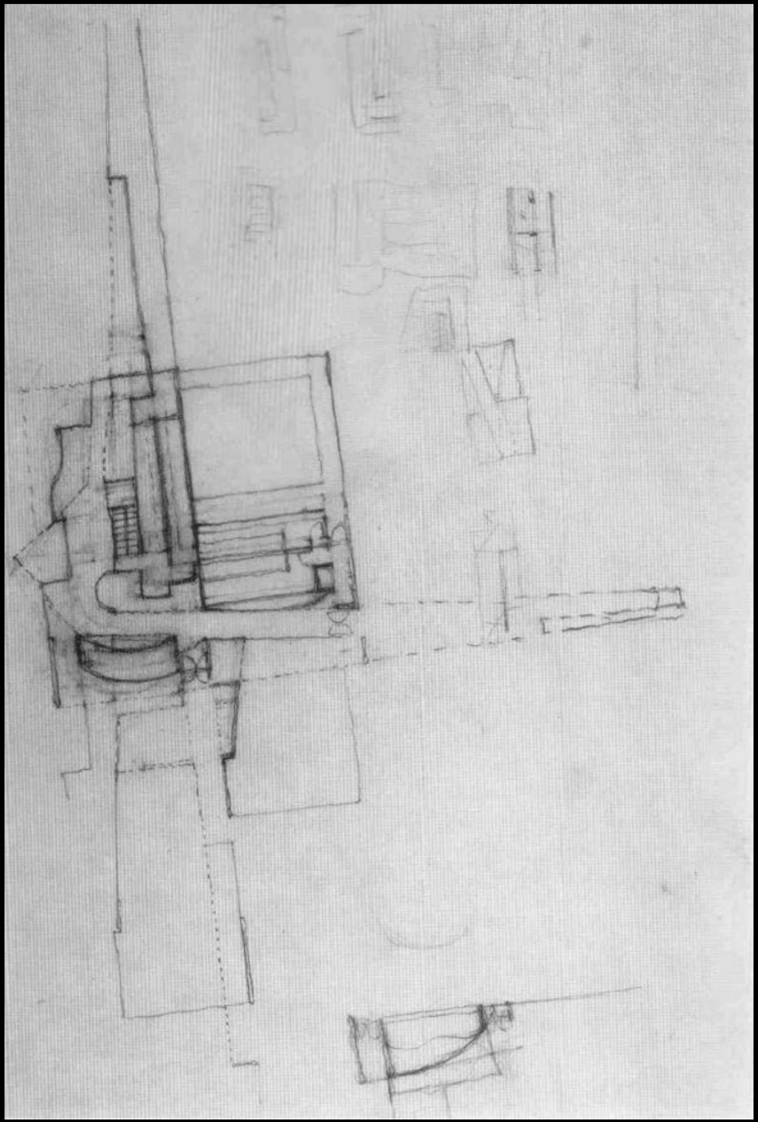
Model of finished design by

Sumet Jumsai

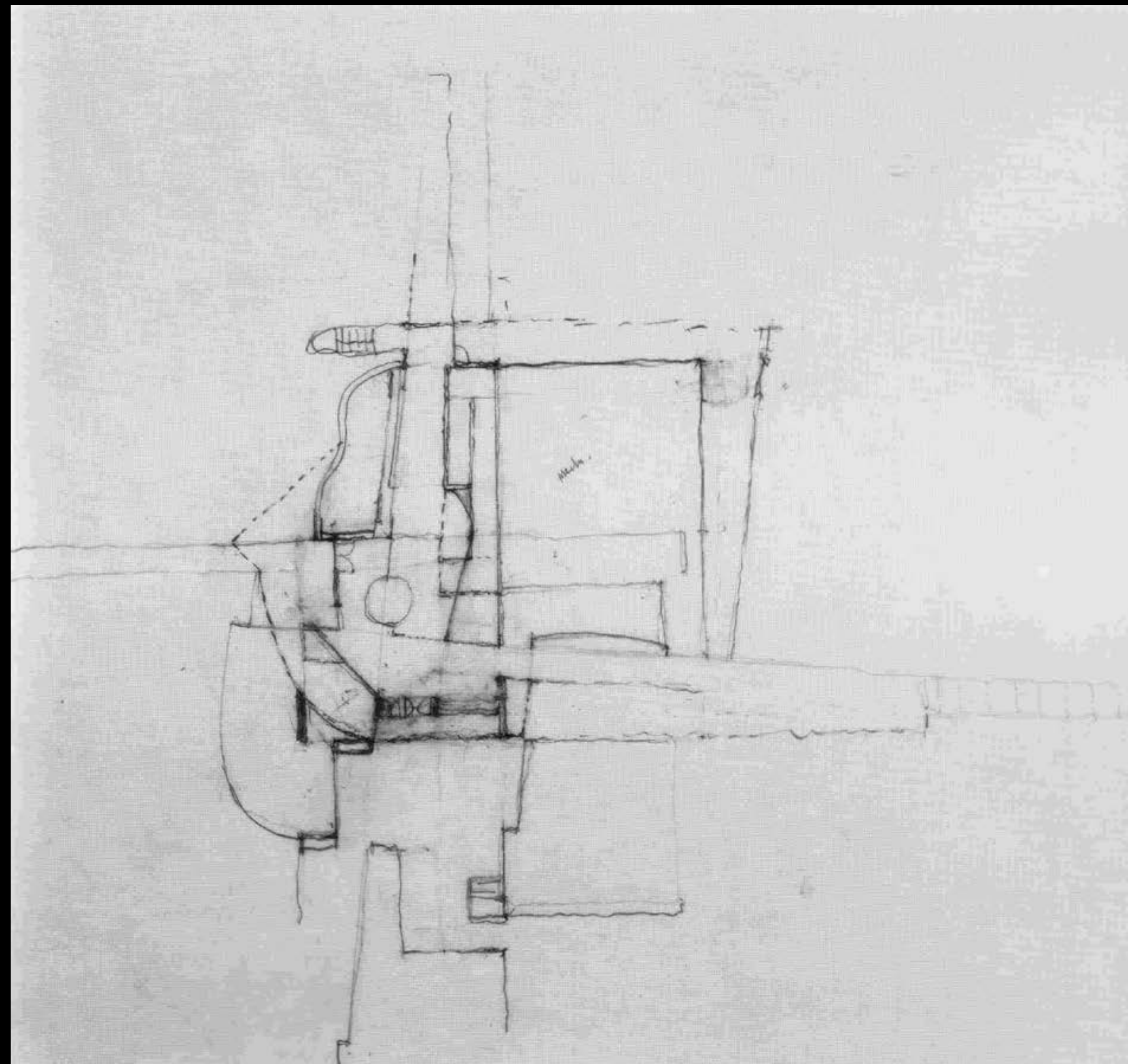


Conceptual sketch by

Richard Meier

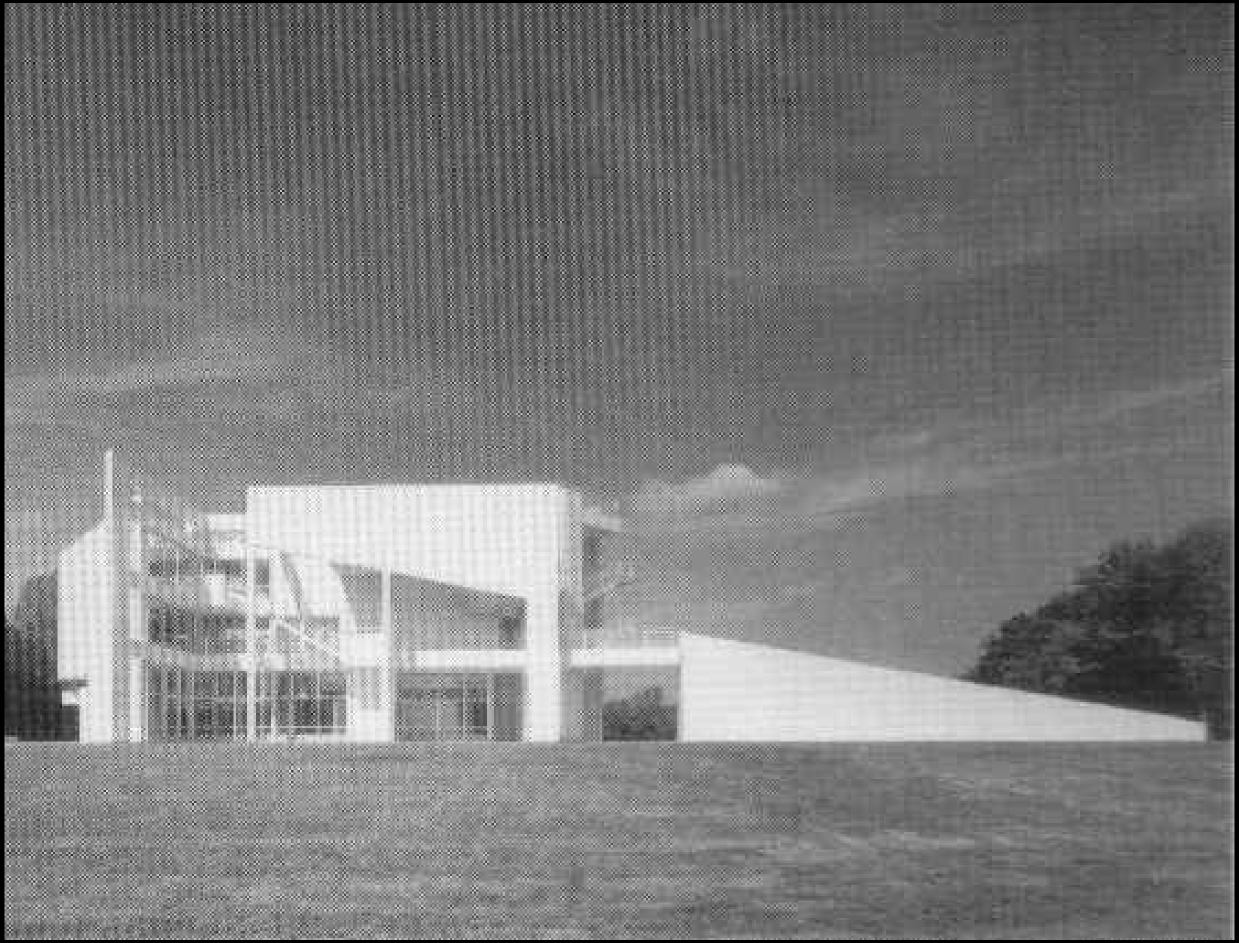


Conceptual sketch by Richard Meier

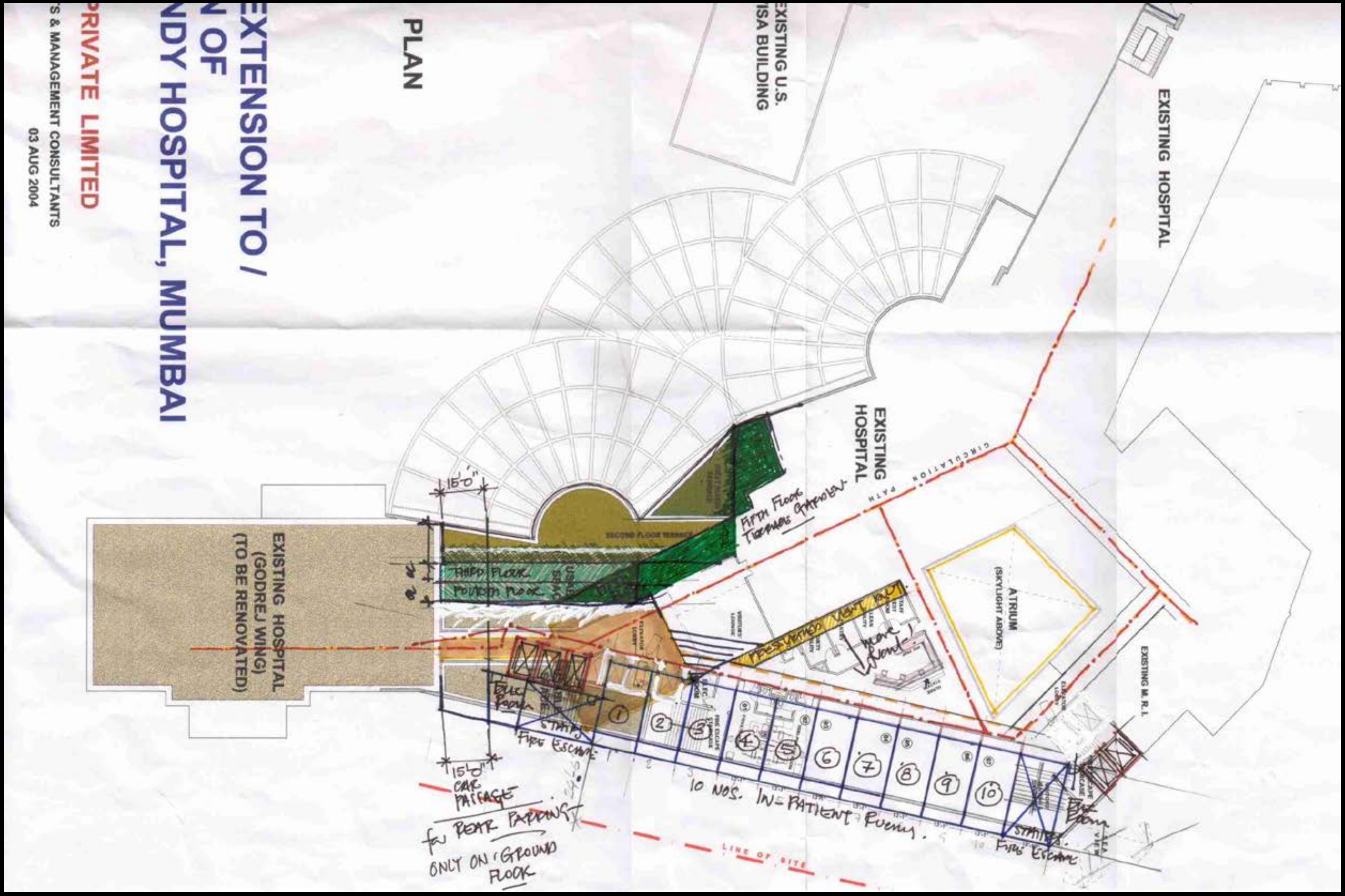


Finished design by

Richard Meier



Conceptual Design Sketch by Hussain Varawalla



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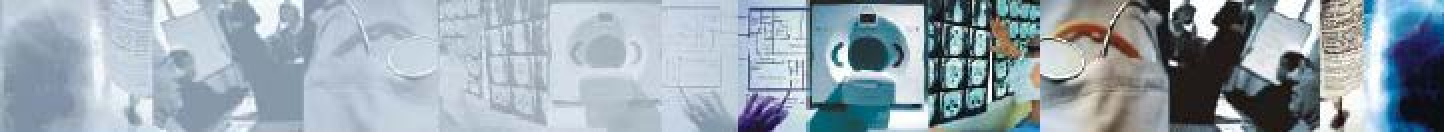
Welcome You To

An Introduction to Healthcare Facility Design

Architects Lecture Series 2004 – No. 5

Green Design:

Environmentally Effective Design Principles



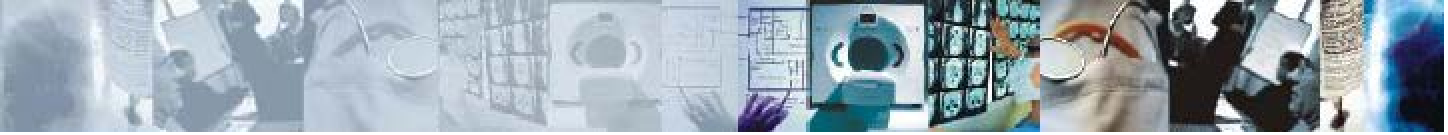
Note:

The following material has been taken verbatim from the sources as described in the text. While Hosmac (India) is committed to the views expressed here in principle, we are still a long way from being able to execute these design and project management techniques and imperatives in reality. We still need to fully understand the implications, and gain the necessary mastery over the technical aspects of the views expressed here.

I do not claim to be an expert on what is written in the text of this lecture, but I feel a strong need to share it with all of you nonetheless, as I believe we need to care, we need to create and we need to celebrate in reclaiming the earth for all of us.

Please excuse my presumptuousness in speaking on a topic I know not much of.

Hussain Varawalla

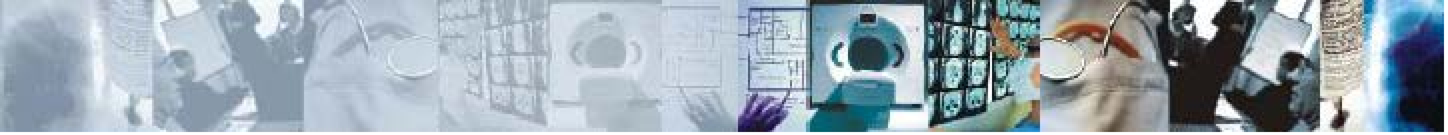


Tadao Ando makes the following points in his foreword to the book

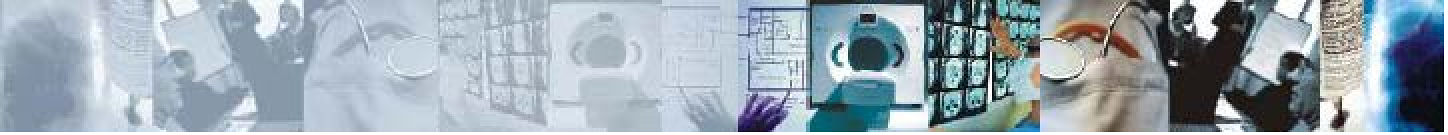
“Architecture and the Environment: Bioclimatic Building Design”

by

David Lloyd-Jones

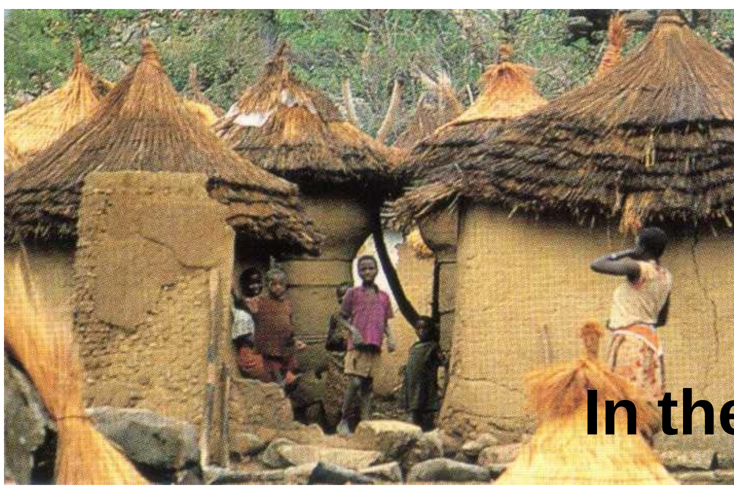


1. **The whole world today harbors misgivings over the crisis facing the global environment**
2. **The entire world has generally shared the common belief that an economy led society is the ultimate and desired direction**
3. **The result of our attempt to use resources that have been the products of billions of years of solar energy within what is relatively a mere instant has been, conversely, to spew more substances and energy into the environment than the planet is capable of digesting, and this has thrown the entire global ecosystem out of balance.**
4. **All over the world we are finally beginning to recognize the threat that abnormal weather and pollution in the air, water and ground are posing to civilization**



5. **Though it is troublesome to make biodegradable goods and to utilize natural energy in our present ways of life, it is not impossible.**

   We have already developed sufficient technologies to effectively utilize Mother Nature while sustaining her unspoiled beauty, and now is the time for the entire world to awaken to the limits of our materialistic ways and to change our society as a whole.

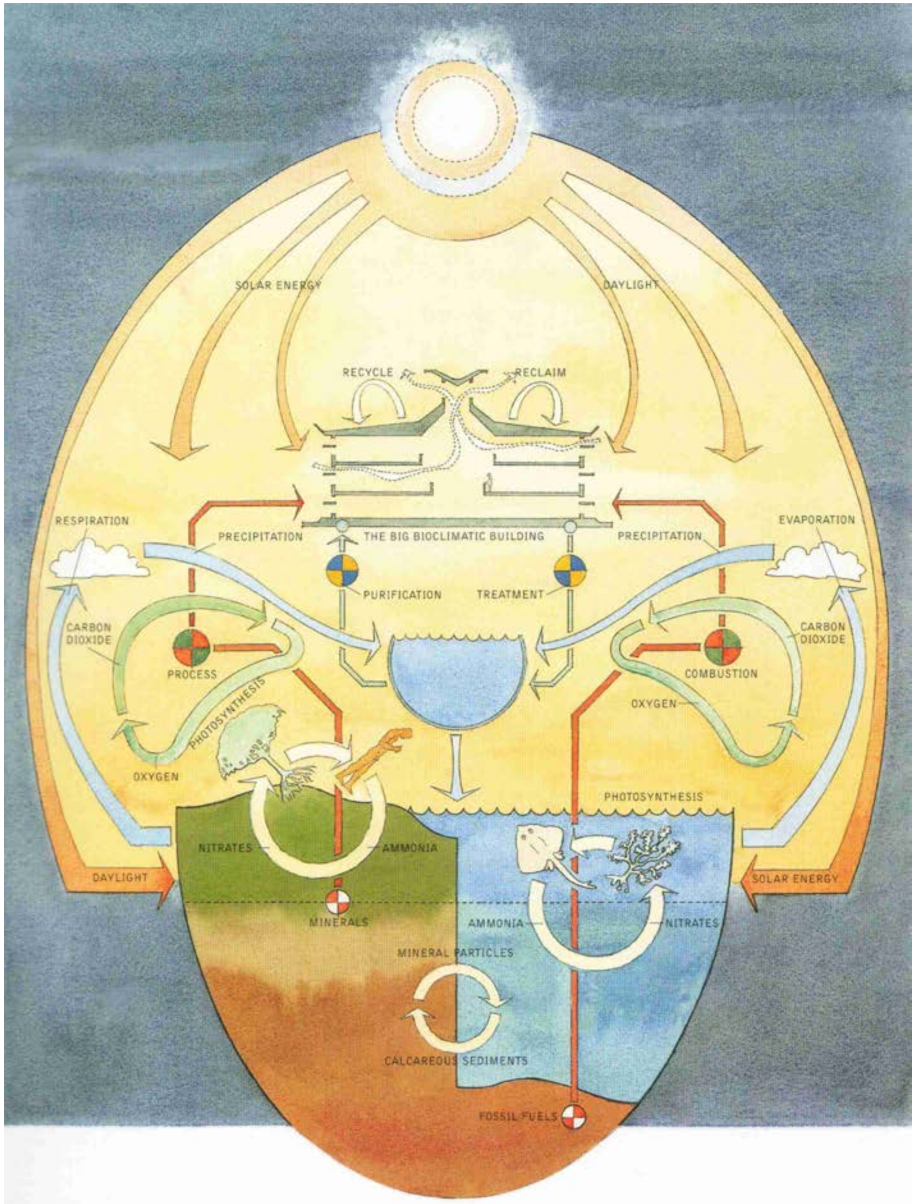


In the beginning there was shelter…

"That human beings stand separate from a nature that must be controlled, that the mind is somehow superior to the body, and that all sexuality entails a seduction – a danger and a problem – are all assumptions upon which much of Western thought and culture is based. And all of them in some way underlie our exploitation of the earth, our distrust of emotion, and our loneliness and reluctance to love."

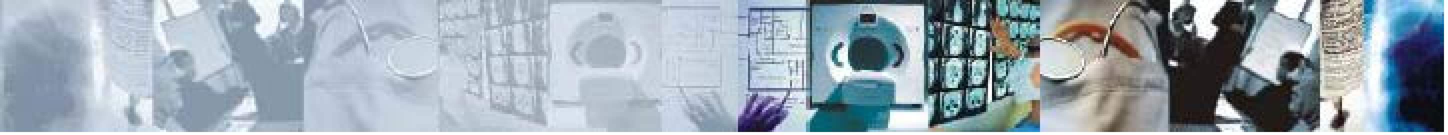
An excerpt from

'Nature, Man and Woman' by Alan Watts



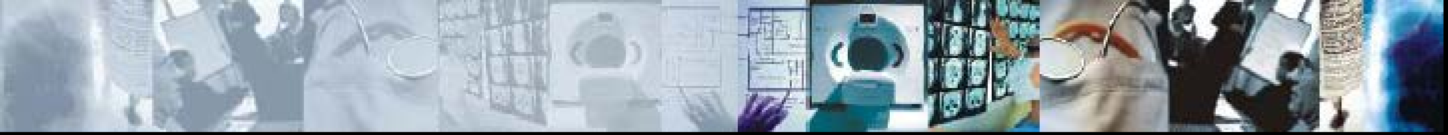
The earth is governed by interrelated 'bio-cycles' which at any one time should be broadly in balance, but over periods of time do evolve and change.

The bio-climatic building recognizes these cycles and is designed to support rather than undermine them over the course of it's life.



The environmental crisis that currently faces us has focused attention on the impact buildings have had on the environment.

1. Buildings in the Western world – their construction and use – are responsible for 50% of the deleterious emissions that are causing the planet to overheat.
2. Architecture, as much as any design activity, is dependent on a satisfactory reconciliation of the intuitive with the rational. Axiomatic to arriving at an inspirational balance between sense and sensibility are two relationships – that of building to site, and both of these to nature itself.
3. A sustainable architecture appropriate to the demands of the next millennium will not materialize solely through applying the remedies of giving new life to the building physics of the last decade.



4. **An enduring sustainable architecture will emerge and convey the multifarious concerns of our time. It will both reflect deeply intuitive impulses of our cybernetic age and express the rigor of operational analysis. It will also be informed and stimulated by the range of measures formulated by government bodies and others to give greater protection to our habitat.**

The challenge is to reach a point where

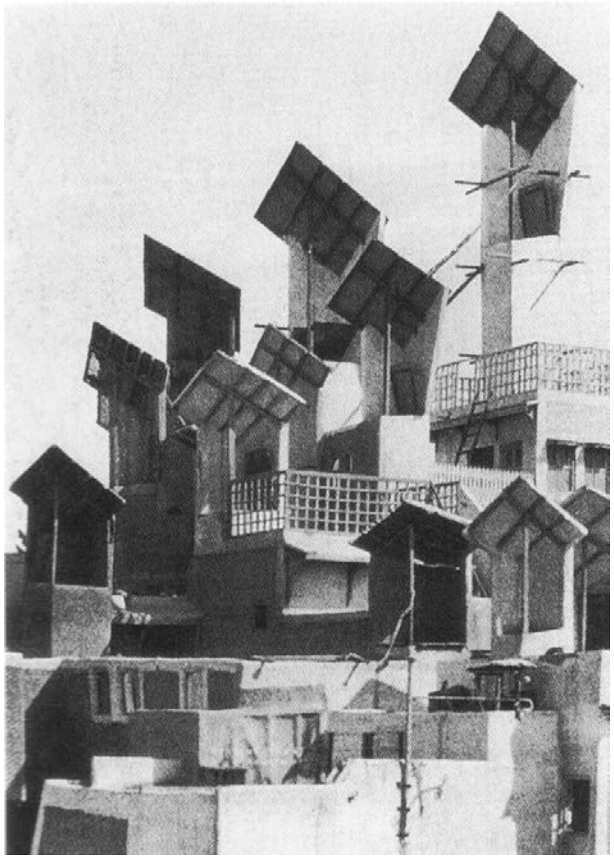
green architecture

is indistinguishable from

good architecture.

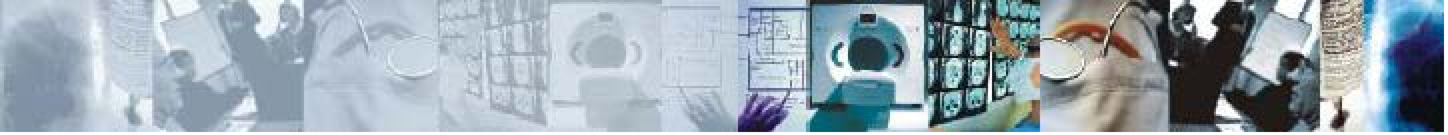
Green Healthcare Architecture:

An Introduction to Sustainable Building Practices



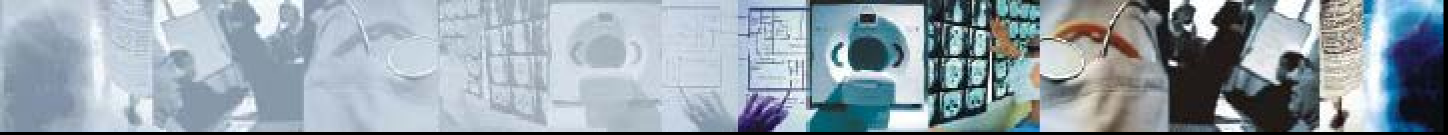
Wind towers in traditional homes in Baghdad.

The towers direct air into the heart of the building.



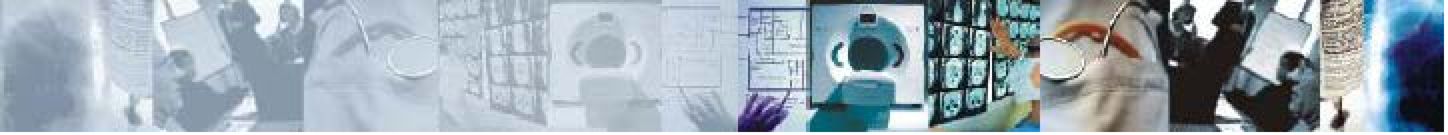
Health care institutions' core mission of protecting human health provides the basis for them to speak with their words and actions on the health implications of building construction and operation.

The healthcare industry has a leadership opportunity to move the larger building industry to a healthier approach by demonstrating the best in healthy, sustainable design, construction, operations and maintenance practices in it's own facilities.



Whole system look to maximize impact

The optimal approach to green design involves a whole system look at the facility, incorporating all aspects of design and all disciplines working together to find the best solutions to design challenges.

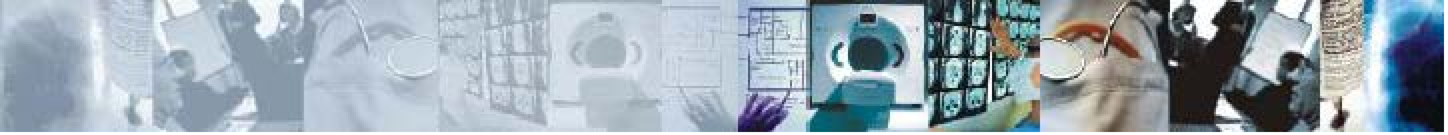


Prioritize for maximum immediate impact

Target green design issues that:

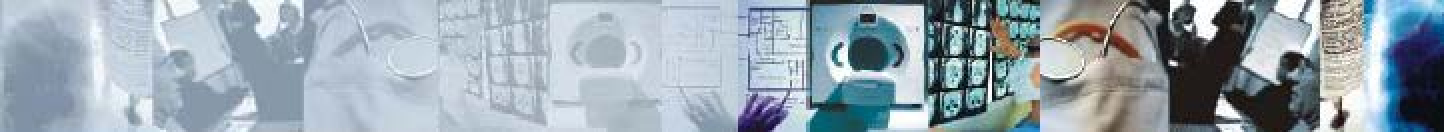
1. **Address an important environmental problem, ideally one that is directly health related and thus tied to the organization’s core mission, with credible scientific evidence on the level of the problem, although there may not necessarily be scientific unanimity on the problem.**

For example, persistent bio-accumulative toxins (PBT’s such as dioxin, lead and mercury) are recognized as a major problem by most environmental agencies.



2. **Have multiple benefits.** For example, eliminating PVC reduces environmental health impacts upstream and downstream while reducing indoor exposure to DEHP and heavy metals.

   Energy saving measures reduce air and water pollution, cut global warming while producing bill savings for the facility. Elimination of materials that outgas formaldehyde and other VOC's improves patient outcomes, and increases staff productivity while reducing potential for triggering multiple chemical sensitivity syndromes.



1. **Use materials that are readily available.** In the case of a geographically dispersed health system this means available throughout the system's region.

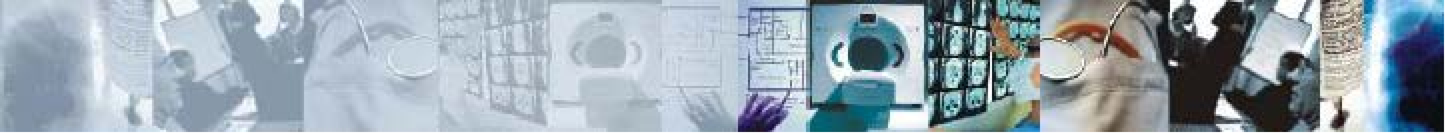
2. **Are cost effective**, being competitively priced or paying for additional investments through reduced operating and maintenance costs.

3. **Meet the service criteria** of the system.

4. **Have a track record** of experience and referrals and no approval barriers with state regulatory agencies.

5. **Have demonstrable results** in direct environmental impact.

6. **Move the industry forward** by providing a useful demonstration project or, better yet, by exercising market pull, such as on materials suppliers to provide more green offerings or to promote them more strongly or to provide better prices.



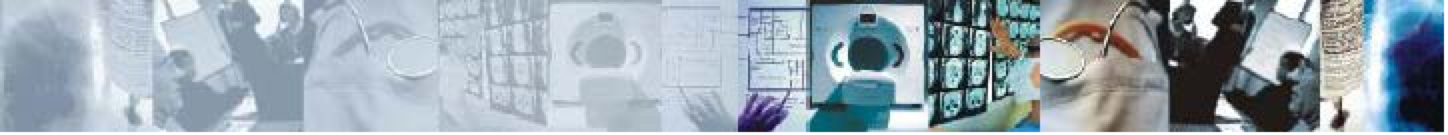
Reconciling Economics

and

Environmental Concerns

"Then I say the earth belongs to each…generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence."

Thomas Jefferson

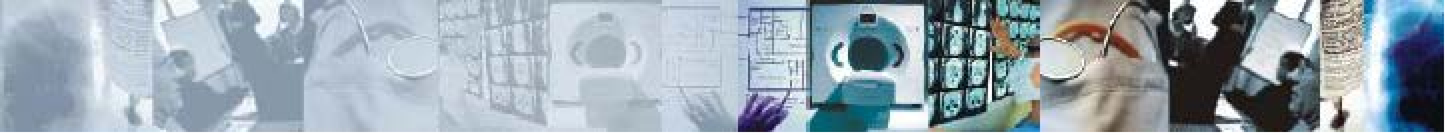


A healthcare facility building project brings a wealth of social benefits to our communities.

Yet in weighing these benefits, we should also be aware of how our hospitals directly and indirectly contribute to environmental and human health problems.

Few people in the building trades, let alone average citizens, fully realize the extent to which building construction and operation generates material waste and results in energy efficiencies and pollution.

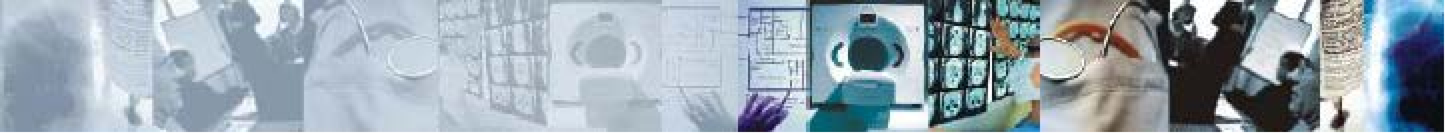
These so-called ‘externalized costs’ do not show up on any balance sheet, meaning that the environment – and ultimately society in general – will be forced to absorb them.



Every day, buildings squander valuable capital by wasting energy, water, natural resources and human labor.

Most of this waste happens inadvertently, as a result of following accustomed practices that often just meet, but fail to exceed, building codes.

Progressive promoters of healthcare facilities have begun to convert these liabilities into economic opportunities by adopting cost-effective new technologies, processes, and materials that dramatically reduce environmental impacts while increasing profitability.



Hidden costs of construction

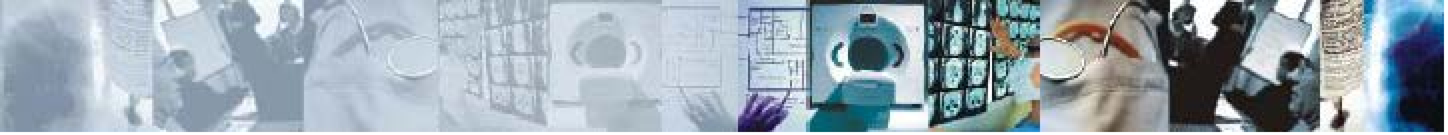
The hidden costs of construction include the adverse environmental impacts of construction-related activities.

Today's design decisions have local, regional, and global consequences.

According to the Worldwatch Institute, almost 40% of the 7.5 billion tons of raw materials annually extracted from the earth are transformed into the concrete, steel, sheetrock, glass, rubber and other elements of our built environment.

In the process, landscapes and forests are destroyed, and pollutants are released into the soil, water, and air.

Twenty-five percent of our annual wood harvest is used for construction, which contributes to flooding, deforestation, and loss of biodiversity.

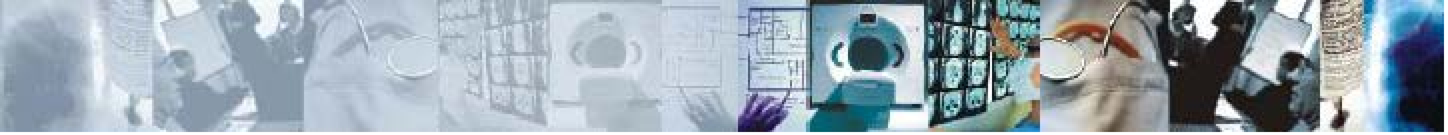


Operating a healthcare facility extracts an ongoing toll on the environment as well.

Globally, buildings use about 16% of our total water withdrawals; in the US that amounts to about 55 gallons per person per day. Buildings consume about 40% of the world's energy production.

As a consequence, buildings (among them healthcare facilities) are involved in producing about 40% of the sulfur dioxide and nitrogen oxides that cause acid rain and contribute to smog formation.

Building energy use also produces 33%, or roughly 2.5 billion tons, of all annual carbon dioxide emissions, significantly contributing to the climate changes wrought by the accumulation of this heat-trapping gas.



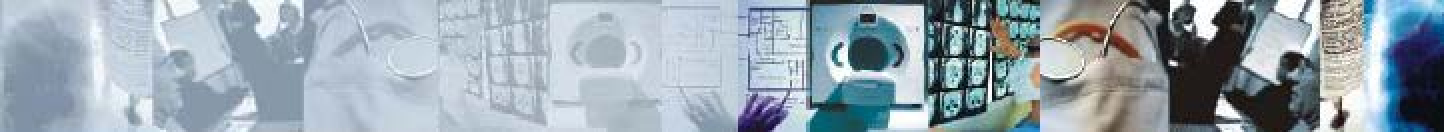
A ‘no-regrets’ action

Looking across the full spectrum of conventional building performance (including conventionally built healthcare facilities), it is clear that our design and construction practices are falling short of what could be achieved with even a small number of strategic, cost-effective corrections.

Many industries have a growing appreciation that sound economic and environmental choices are not mutually exclusive, but instead are compatible to the point of being interdependent.

This suggests that environmentally effective (or ‘high performance’) building practices will be increasingly market-driven as the economic advantages of environmentally sound design and construction continue to gain industry recognition and support.

Therefore, implementing these practices should be considered a ‘no-regrets’ policy initiative that results in economic gain while producing positive environmental results.



Well-Integrated

Design and Construction

A whole greater than the sum of its parts

An integrated or 'whole building' design approach requires thinking about the building and its site as a series of interlinked and interdependent systems, so that a single design refinement simultaneously improve several building systems' performance.

Like the domino effect, one refinement can trigger multiple savings or other benefits.

For example, careful decisions on building shape and window placement that take into account both prevailing wind and sun angles, may not only enhance a hospital's thermal performance, but can also result in improved daylighting.

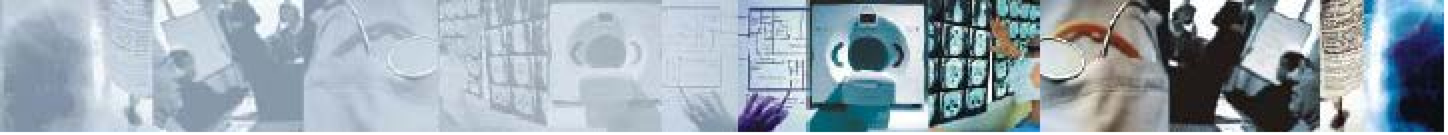
Using simple, time-honored techniques

Environmentally effective (high performance) designs draw on principles used in much older building practices.

As such, they rely on the manipulation of land features, building form and exterior materials to manage the climate and get the most out of the materials at hand *before* invoking electrical and mechanical assistance from energy-driven heating, cooling and lighting systems.

High performance design also favors 'state-of-the-shelf' technology over sophisticated 'state-of-the-art' equipment.

The preference for keeping equipment as simple and maintenance-free as possible is vital to the interest of the healthcare facility promoters, given the various demands made on limited resources.

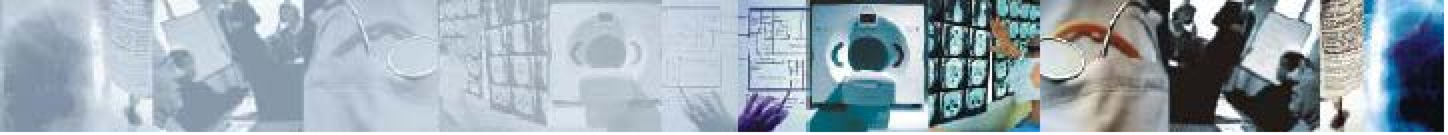


Team Design

Environmentally effective (high performance) outcomes also demand a much more integrated team approach to the design process and mark a departure from traditional practices, where emerging designs are handed sequentially from architect to engineer to sub-consultant.

A unified, more team-driven design and construction process brings together various experts early in the goal-setting process.

This helps high performance buildings achieve significantly higher targets for energy efficiency and environmental performance.



Innovative products and tools

An integrated building design process reexamines the use of traditional products or building assemblies, and identifies innovative technologies or green product and system alternatives that offer significantly improved environmental performance.

These progressive design approaches can be further refined through the use of computer energy modeling.

Energy modeling simulates the proposed design’s response to climate and season. Designers can preview and improve the performance of interdependent features such as orientation, daylighting, alternative building shell design, and various mechanical systems.

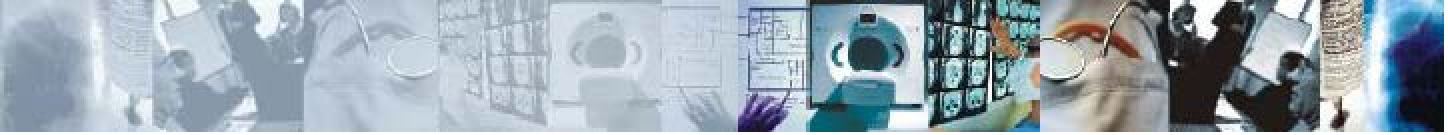
Energy modeling quickly evaluates cost-effective design options for the building envelope or mechanical systems by simulating the various alternatives in combination.

This process takes much of the guesswork out of green building (and green healthcare facility) design and specification, and enables a fairly accurate cost/benefit forecasting.

"Discovering the DOE-2 model was invaluable. I can't imagine doing this kind of project without it ever again…With this technique we can actually prove to our clients how much money they will be saving."

Robert Fox, Principal, Fox and Fowle, architect of Four Times Square.

Lessons Learned, Four Times Square.

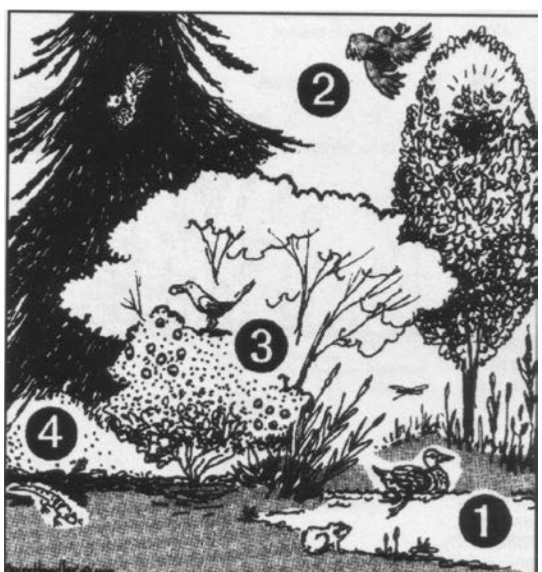


‘Green’ Design Strategies: Site Design and Planning

Sustainable site planning identifies ecological, infrastructural, and cultural characteristics of the site to assist designers in their efforts to integrate the building and the site. The intent is to encourage optimum use of natural / existing features in architectural and site design, such that building energy use is diminished and environmental degradation is minimized.

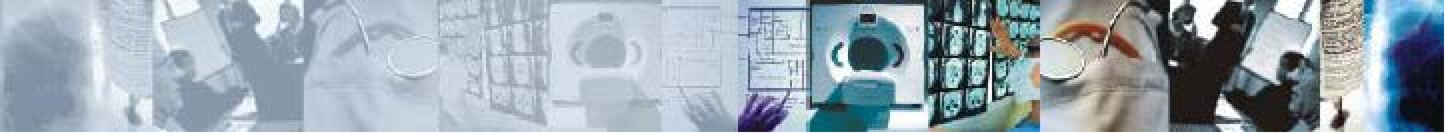
Understanding the Site

1. **Inventory and analyze the regional and local ecological context**
2. **Topographical features**
3. **Inventory and analyze urban/historical context**
4. **Identify and prioritize the site's natural and cultural attributes**

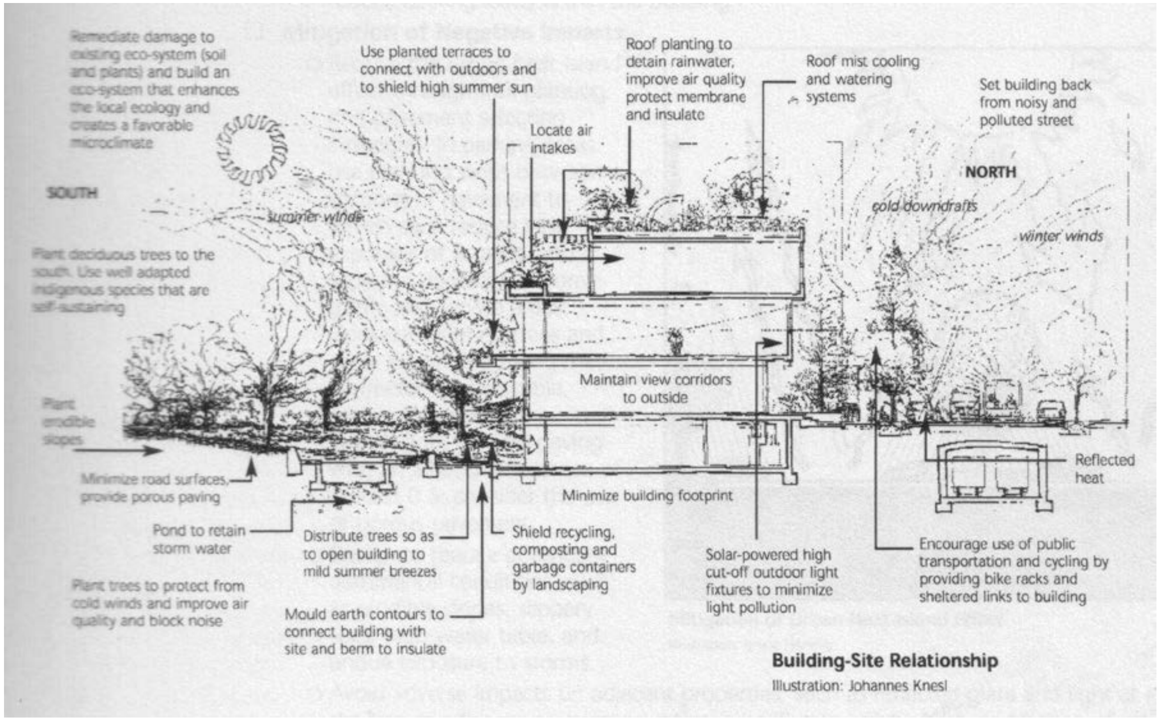


<u>Ecologically Sensitive Areas</u>

An inventory of a site's plant species – and an understanding of the ecological niche into which they fit – will reveal which areas are either sensitive or threatened, and which serve as wildlife habitat. The image above illustrates some of the relationships between vegetation and a site which either establish or enhance wildlife habitat: (1) surface water; (2) a variety of tree canopy heights (3) fruit bearing "native" plant species; and (4) natural leaf mulch



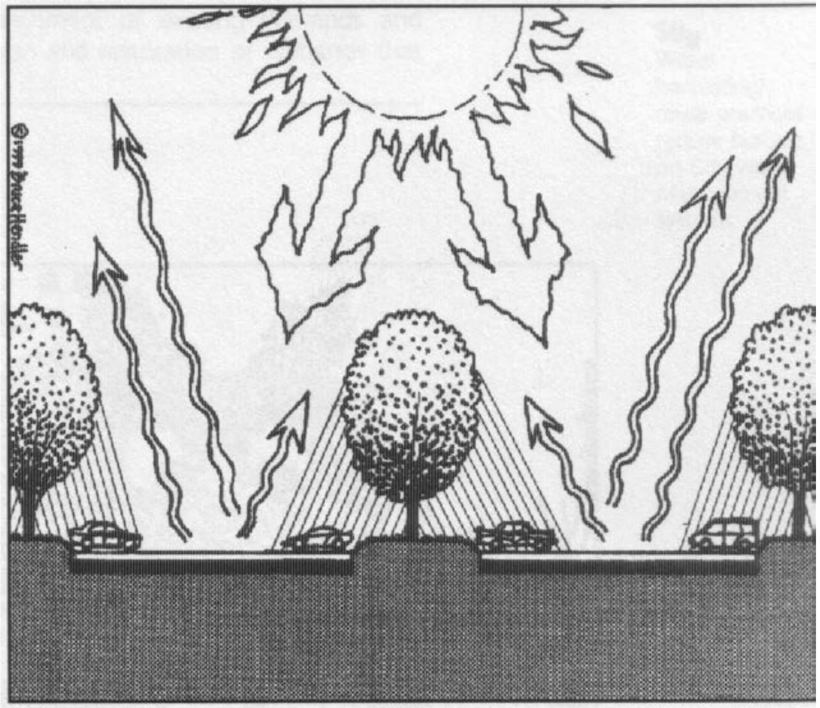
Building-Site Relationship



Taken together, the site design and building design should support the ecological and cultural functions of the entire development. The project as a whole should be designed to minimize negative environmental impacts on surrounding areas and to maximize opportunities to restore natural systems.

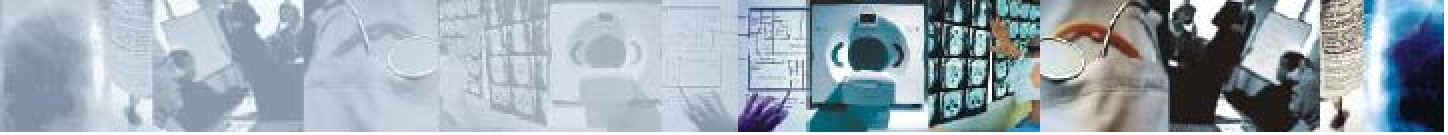
Building-Site Relationship

1. General site layout
2. Improved environmental quality
3. Mitigation of negative impacts
4. Site lighting



Mitigation of

Urban Heat Island Effect

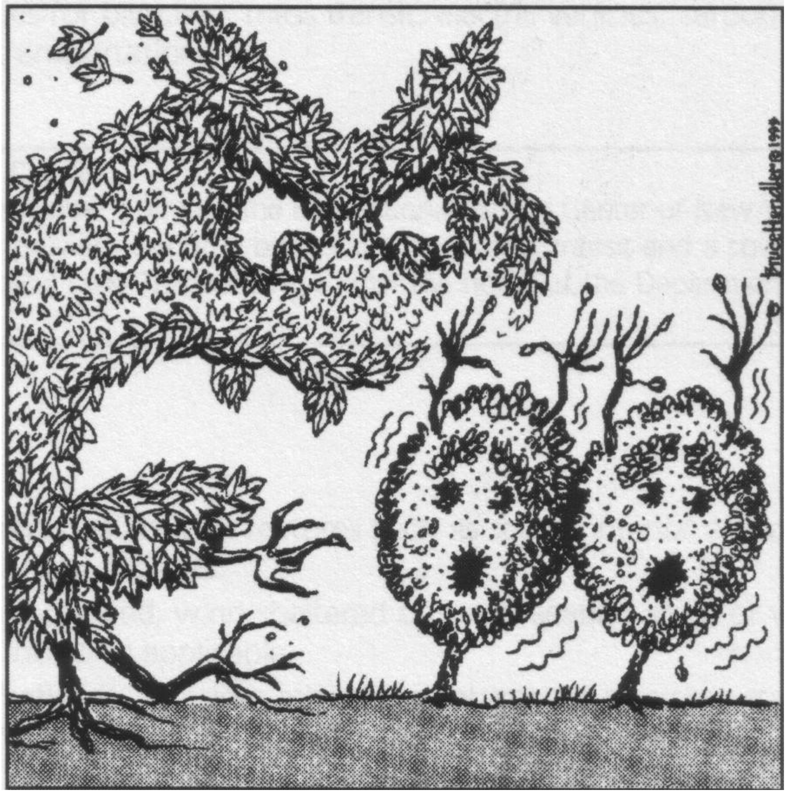


Sustainable Landscape Practice

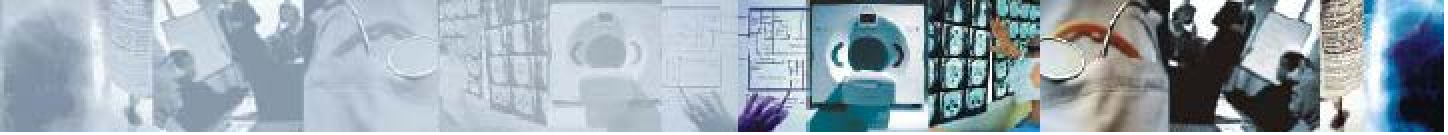
The landscape features must be selected and configured to suit site conditions and restore habitat using self-sustaining landscape design and site maintenance procedures. Practices should promote the conservation and restoration of existing biological and water resources, including species diversity, soil fertility, and aeration.

Sustainable Landscape Practice

1. Planting Practice
2. Water Use / Pollution Prevention
3. Soil Quality
4. Resource Use



Invasive Species



Encouraging Alternative Transportation

1. **Provide adequate bicycle amenities**
2. **Bus stop seating areas**
3. **Provide alternative fueling facilities**
4. **Carpool incentives**

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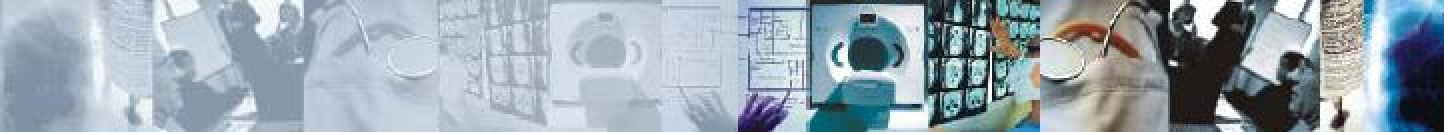

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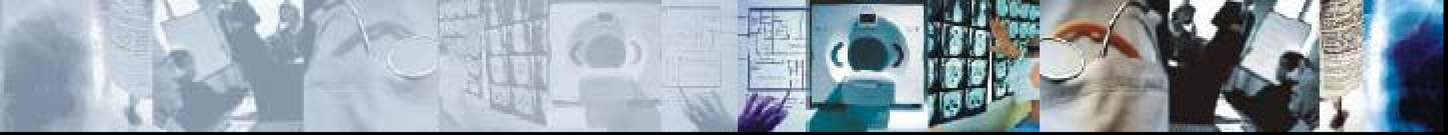
Welcome You To

An Introduction to Healthcare Facility Design

Architects Lecture Series 2004 – No. 6

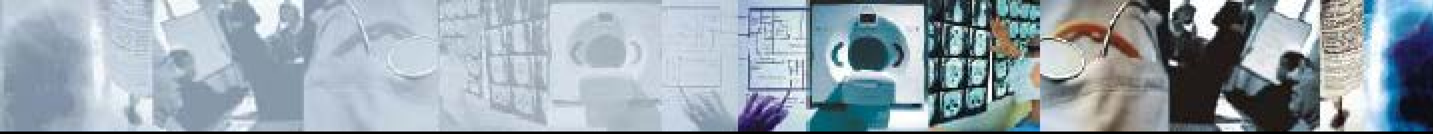
Alternative Building Forms:

Pro's & Con's – Horizontal or Vertical



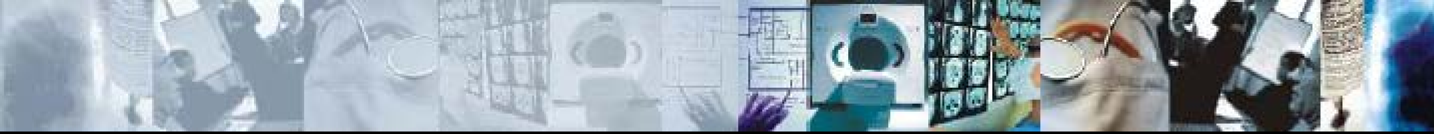
In the First World countries of the West, the trend in the recent past has been to steadily move away from hospitals organized primarily around vertical circulation systems.

This trend has been most marked in the UK, where the Nightingale-inspired horizontal pavilion hospital never died out, as it did in many other countries.

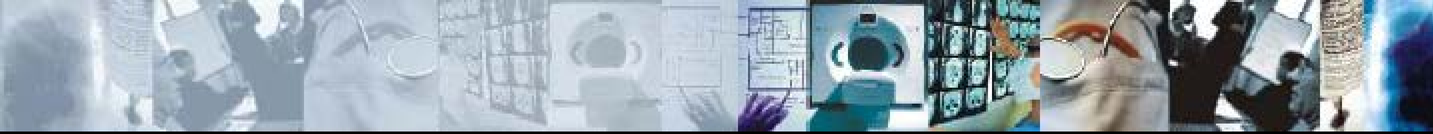


The inherent problems of vertical organization, and particularly of a tower block of wards, is that of a limited envelope with no means of lateral expansion.

The considerable portion of each floor taken up by lifts, stairs and service shafts, is not only inherently wasteful and expensive, it also makes the plan form more rigid, and inhibits subsequent alteration.



Growth of a vertically organized hospital tends to take the form of clusters of smaller blocks at its base, with increasingly difficult service and circulation routes.



Tall buildings are more likely to need expensive climate control, to consume more energy, and have greater problems of evacuation in cases of fire than have lower ones, in which horizontal evacuation is through successive protected zones further away from the source of the fire.

The advantage frequently claimed for tall hospitals is that they occupy less land.

This is only valid for inner urban hospitals, such as the (moderately) tall Chelsea and Westminster Hospital, London, where the floor area is similar at all levels.

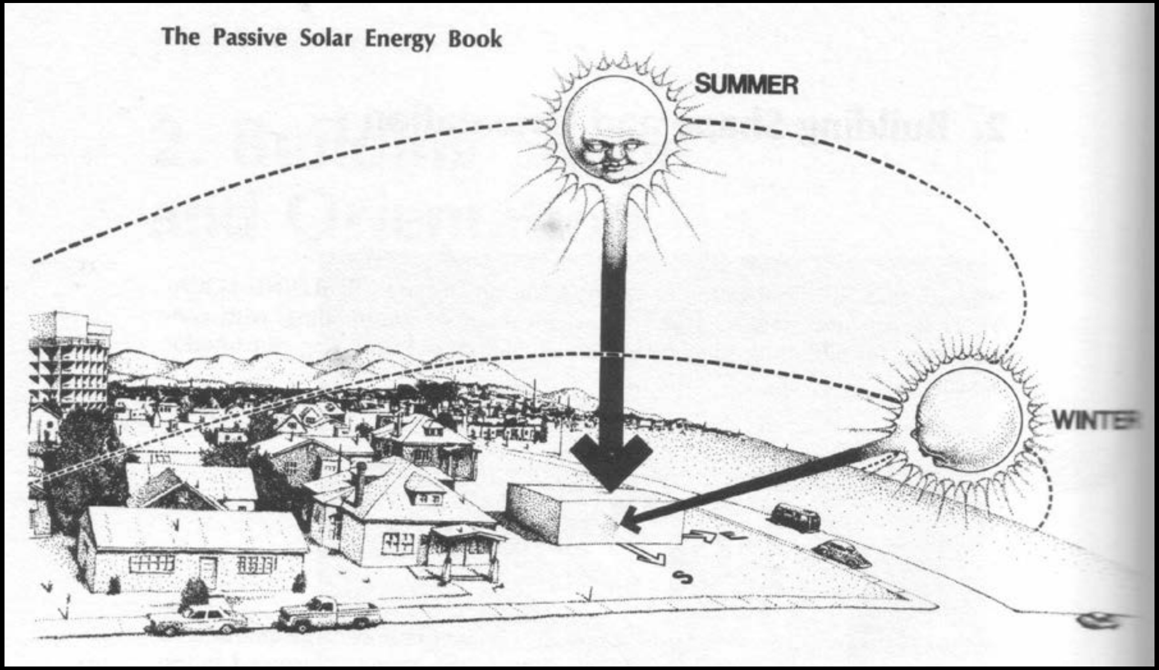
The commonest type of tall hospital, especially in the USA, is the "tower on podium" form, popularized by Gordon Friesen with his mineworkers hospitals, and based on a production engineering principle of supplies fed the wards from a basement service center.

The podium of these hospitals usually spreads to occupy a site similar to those of compact low-rise hospitals.

The flexibility limitations of such hospitals become more evident as the proportion of the total built volume comprising wards is tending to diminish.

Many times, the building form and massing could largely be determined by the climate of the location of the proposed hospital, that is, the designer's response to these characteristics of the site.

The amount of care taken in placing and orienting a building on the site with respect to open spaces and the sun is perhaps the single most important decision you will make regarding the building with respect to its response to the climate.

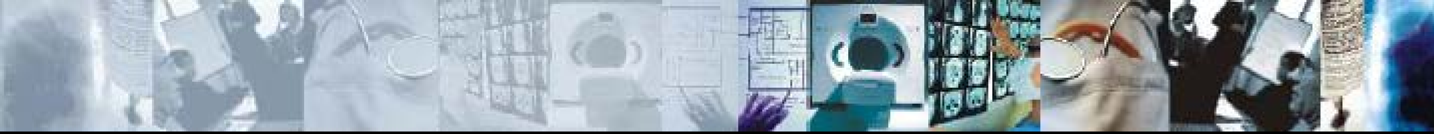


With an idea for the location of the building on the site, it is necessary to determine the rough shape of the building before laying out interior spaces.

Buildings shaped without regard for the sun's impact require large amounts of energy to heat and cool.

Large amounts of energy are used to heat and cool buildings all over the world.

In spite of worldwide dwindling energy resources, many buildings today are still shaped without regard for the sun's impact on, and potential contribution to, space heating and cooling.

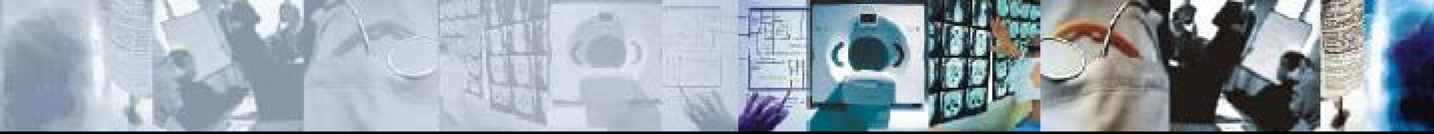


This is an approach to architecture made necessary and timely in an era of rapacious energy consumption.

We need more than ever before to follow a way of building that is strongly related to site, climate, local building materials and the sun.

It implies a special relationship to natural processes that offers the potential for an inexhaustible supply of vital energy.

Much vernacular architecture has always reflected a strong relationship to daily and seasonal climatic and solar variations.



Nowadays the architect's approach to problem solving has been characterized by an emphasis on technology to the exclusion of other values.

Especially in healthcare facility design, there is great dependence on the mechanical control of the indoor environment rather than the exploitation of climatic and other natural processes to satisfy our comfort requirements.

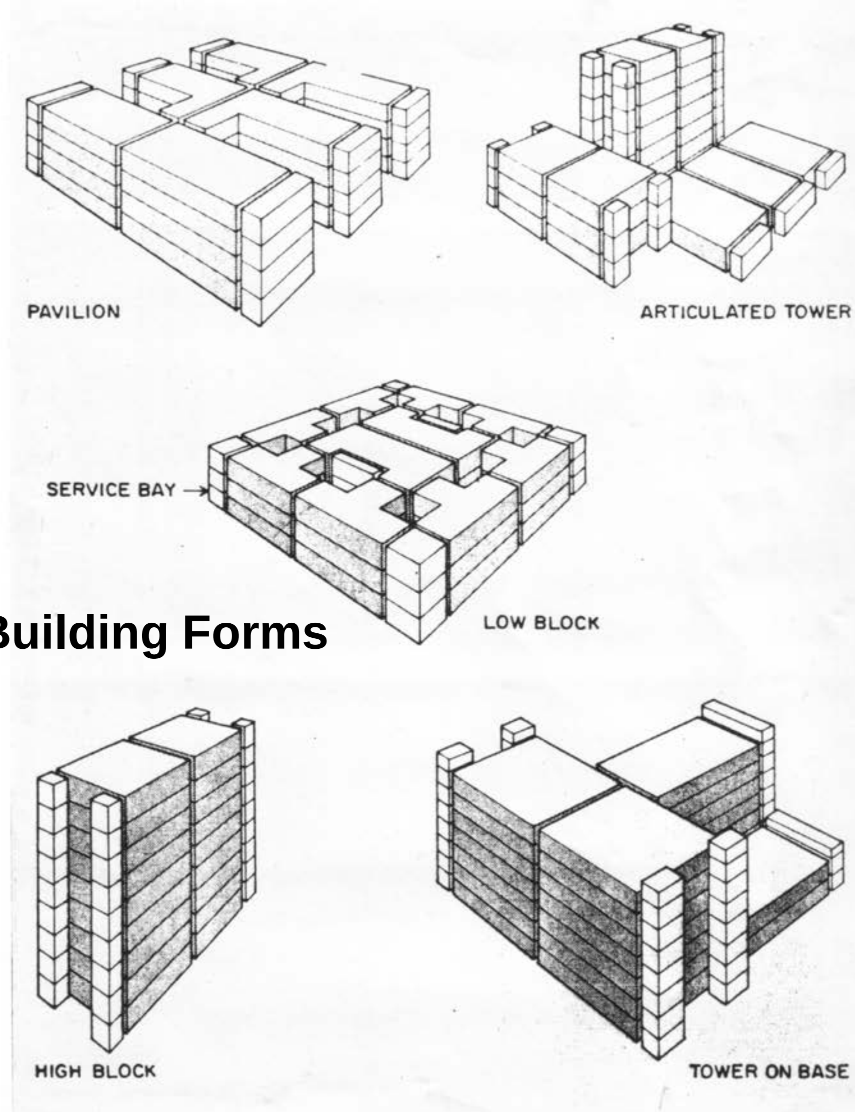
In a sense, we have become prisoners of complicated mechanical systems, since windows must be inoperable and sealed in order for these systems to work.

A minor power or equipment failure can make these buildings uninhabitable.

Little attention is paid to the unique character and variation of local climate and building materials.

One can now see essentially the same type of building coast to coast.

Alternative Building Forms



Various types of hospital configurations.
Source : Hospitals and Health Care Facilities by Redstone.

Design Concepts: Should Form Always Follow Function?

Lecture Series 2004

The American sculptor Horatio Greenberg first stated that "form follows function" in 1739. His phrase became a battle cry for the architect Louis Sullivan in the late Nineteenth century. Sullivan was one of the earliest proponents of the Modernist movement in architecture.

A little simplistically put, he means that a building should be designed taking as the starting point for it's design the activities that that building is meant to house. Hence the final shape (or 'form') of the building would be directly derived from its intended use (or 'function').

This dictum was restated as "form and function are one" by Frank Lloyd Wright. Both statements have contributed to a seeming divorce between that which works well and that which is beautiful. The implication in "form follows function" is that as long as the functional requirements are satisfied form will follow and seem pleasing.

Le Corbusier, another famous Modernist architect, talked of a house as a "machine for living in".

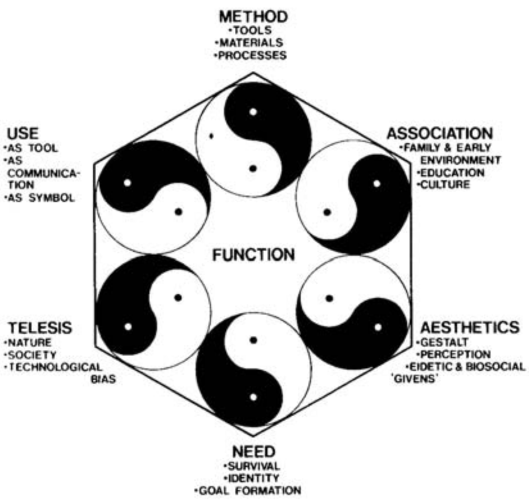
If Le Corbusier had been a healthcare architect, maybe he would have talked about designing hospitals as "machines for healing in".

We have earlier discussed the complexity of the functional needs of a modern hospital, and the specialized knowledge needed by its designer with respect to its engineering services and the needs of the medical equipment it houses. So we can see how a hospital, especially one being built in the new millennium, could well be considered to be "a machine for healing in".

In fact, many (if not most) of the hospitals built in India during the latter part of the last century seem to have been designed to provide a roof over the increasingly complex medical procedures being performed within, with their architects being little more than "doctor's draftsmen", translators of medical and technological requirements into built form. Grim and cheerless buildings that cannot be dignified with the word "architecture".

The concept that what works well will of necessity look well has been the lame excuse for all the sterile architecture, furniture and implements of the twenties and thirties. The international style let us down rather badly in terms of human value. "Should I design it to be functional," the students say, "or to be aesthetically pleasing?" This is the most often heard, the most understandable, and yet the most mixed-up question in design today. "Do you want it to look good or to work?" Barricades are erected between what are really just two of the many aspects of function.

Below are the six parts of the function complex:



The function complex. The Yin-Yang monad appears at each of the six aspects, indicating the soft-hard, feeling-thinking, intuitive-intellectual mix, which determines each of these six evaluative criteria.

Method: The interaction of tools, processes, and material.
When early Finnish and Swedish settlers in what is now Delaware decided to build, they had at their disposal trees and axes. The material was a round tree trunk, the tool an axe, and the process a simple "kerf cut" into the log. The natural result of this combination of tools, materials, and processes was a log cabin.

Use: "Does it work?"
A vitamin bottle should dispense pills singly. An inkbottle should not tip over. A plastic-film package covering sliced pastrami should withstand boiling water, yet open easily. But a ballpoint pen shaped and colored like a pickle and made of a creepily yielding plastic is a tawdry perversion of design for use.

Need: Much recent design has satisfied only evanescent wants and desires, while the genuine needs of man have often been neglected. The economic, psychological, spiritual, social, technological, and intellectual needs of a human being are usually more difficult and less profitable to satisfy than the carefully engineered and manipulated "wants" inculcated by fad and fashion.

Telesis: "The deliberate, purposeful utilization of the processes of nature and society to obtain particular goals". The telesic content of a design must reflect the times and conditions that have given rise to it and must fit in with the general human socio-economic order in which it is to operate.

Association: Our psychological conditioning, often going back to earliest childhood memories, comes into play and predisposes us to, or provides us with antipathy against, a given value. Most associational values are universal within a culture and frequently are based on the traditions of that culture. These values come from unconscious, deep-seated drives and compulsions.

Aesthetics: Here dwells the traditional bohemian artist. A mythological figure, equipped with sandals, lover, garret and easel, pursuing dream-shrouded designs. The cloud of mystery surrounding aesthetics can (and should) be dispelled. The dictionary definition, "a theory of the beautiful, in taste and art," leaves us not much better of than before. Nonetheless we know that aesthetics is a tool, one of the most important ones in the repertory of the designer, a tool that helps in shaping his forms and colors into entities that move us, please us, and are beautiful exciting, filled with delight, meaningful. We know what we like or dislike and let it go at that. Artists (and architects) themselves begin to look at their productions as auto-therapeutic devices of self-expression, confuse license and liberty, and forsake all discipline. They are often unable to agree on the various elements and attributes of design aesthetic.

If we contrast the "Last Supper" by Leonardo da Vinci with an ordinary piece of wallboard, we will understand how both operate aesthetically. As "pure art" the painting was a source of inspiration, delight, beauty, catharsis…in short, a communication device for the Holy Church at a time when a largely preliterate population was exposed to few pictorial or graphic stimuli. But the "Last Supper" also had to fill the other requirements of function; aside from the spiritual, its use was to cover a wall. In terms of method it had to reflect the material (pigment and vehicle), tools, (brushes and painting knives), and processes (individualistic brushwork) employed by Leonardo. It had to fulfill the human need for spiritual satisfaction. And it had to work on the associational and telesic planes, providing reference points from the Bible. Finally, it had identification through association easier for the beholder through such traditional symbols as the racial type, garb and posture of the Savior.

No one argues that in a great work of art such as the "Last Supper" prime functional emphasis is aesthetic, with use (to cover a wall) subsidiary. The main job of wallboard is it's use in covering a wall, and the aesthetic assumes a highly subsidiary position. But both examples must operate in all six areas of the function complex.

The six parts of the function complex are informed by the past: experience and tradition. But Januslike the function complex also faces the future. The ongoing dimensions of what we design, make and use lie in the consequences. All of our tools, objects, artifacts, transportation devices or buildings have consequences that reach out into such diverse areas as politics, health, income and the biosphere.

Designers often attempt to go beyond the primary functional requirements of method, use, need, telesis, association and aesthetics; they strive for a more concise statement: precision, simplicity. In a statement so conceived we find a degree of aesthetic satisfaction comparable to that found in the logarithmic spiral of the chambered nautilus, the ease of a seagull's flight, the strength of a gnarled tree trunk, the color of a sunset. The particular satisfaction derived from the simplicity of thing can be called elegance. When we speak of an elegant solution we refer to something that reduces the complex to the simple. It is a demonstration of our enchantment with the near perfect.

How did we wander into this discussion on design theory? Let us get back to our main thesis, namely, healthcare facility design concepts:

What has changed in recent times is the very definition of the word "healing", moving away from medical interventions to embrace a more holistic meaning, the focus moving away from treating "illness" to creating "wellness".

When healthcare designers now conceptualize hospitals, they need to think of them as buildings designed to promote the "wellness" of not only the "patient" (replace with: "healthcare consumer"), but also of his / her family and friends who visit and the staff who provide the care.

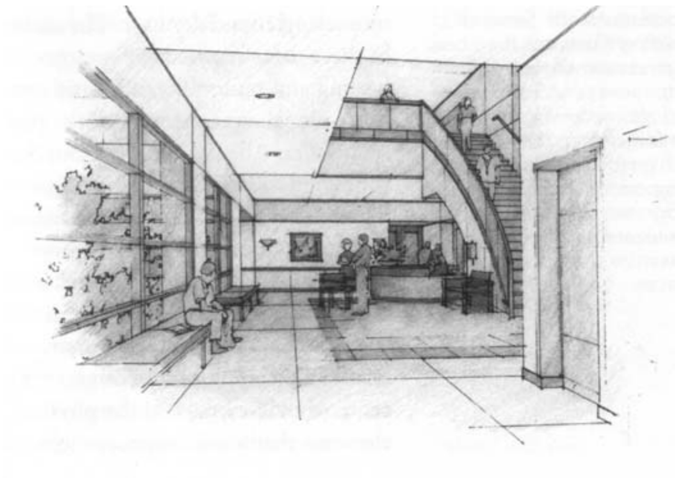
In conceptualizing hospitals today, we need to take our cue from the hospitality industry, the patient needs to be treated as a guest, someone who is to be informed about what he / she will undergo during his / her stay in the hospital, and should be enabled to take active and meaningful part in taking decisions about his / her treatment.

'Form' could still follow 'function', providing we redefine the function of a hospital as an institution built to create a more holistic 'wellness', to consider the dignity, emotional needs and mental state of our 'patient / guest' to be every bit as important as his / her physical health.

In the Women's Health Services Building, West Allis, Wisconsin, USA, the living room area (shown below), immediately adjacent to the main entry, serves as the heart of the building. Careful attention was given to the space to create a residential character. Here patients and visitors can congregate, sit by the fireplace, or read in the library.

We do not need more echoing green painted hallways with harsh, unforgiving fluorescent lights. Controlling noise, using pleasant colors, sufficient and comfortable waiting spaces, clarity in way finding, using natural light and greenery judiciously are just some of the imperatives in “patient-friendly design”. Polite and helpful staff, the ready availability of information about the status of the patient to their family and friends and concern about the patients mental state are just some of the imperatives in “patient-focused care”.

At West Allis, for example, there was a definite desire for the postpartum patient area to have a strong literal connection with the birthing floor, and this was provided with an open mezzanine and connecting stair (shown below). The architects thus used design as a tool to provide reassurance.



The design “concept” for any proposed building is the central idea that is the driver for making architectural design decisions related to the project. As such, it is the architect who will formulate what he / she thinks is the most important design factor(s) for that particular project. While there are many possible such concepts that could be used in the design of a healthcare facility, enumerated below are a few that come to mind.

1. An idea for building form derived from (or dictated by!) the proposed site.
2. The need to build the hospital in a phased manner could impact the layout and form, many times in combination of the above-mentioned site constraints or features.
3. An idea about how to lay out the major circulation paths through the building / campus, for ease of way finding and efficiency of movement of staff, patients and materials.
4. The functional relationships and area requirements of the various departments taken possibly in consideration together with all the above factors.
5. The climate of the location, or the way in which the building will be lit and ventilated, by artificial or natural means. If there are severe budget constraints, as in many developing countries, this factor could be a major determinant of building form.
6. Rarely, a strong idea of the form of the building as sculpture.
7. Mostly, a combination of all these factors, given varying degrees of importance.

This notion of using a “concept”, a central driving idea to determine the final shape of a hospital’s built form is necessary because it makes, more than for any other building type, the process manageable. Without the help of this yardstick along which any idea relating to the design can be measured, the designer would get lost in the complexity of the issues involved, more so a neophyte healthcare designer. A design concept serves the purpose of speeding up the decision process, enabling the design of the project to be completed within the specified time frame, which is usually ASAP. This only serves to underline the importance of the choice of concept, which is a unique decision which needs to be made separately for each project, based on it’s particular features. We suggest that a little more time spent at project inception thinking about this would be time well spent. If you are not an architect, we suggest you ask the architect you employ for your project regarding his concept for your hospital, and do a reality check on it.

The better an architect is, the more the possibility that now and then he / she may levitate an inch off the ground. This may be difficult to spot, and if he's designing your vacation home, to be ignored (encouraged?). If he / she is designing your hospital, we suggest you gently nudge him half an inch closer to the ground. Half an inch of disconnect from reality is all any healthcare architect is allowed and that too very occasionally.

Inside a hospital's built form, reality rules. But its rough edges need to be rounded off by your designer's dreams. So allow him his half-inch, a little more rather than a little less occasionally.

Form need not only follow function. Let it follow your dreams sometimes.

The Atrium Lobby at UCSF Stanford Health Care, Center for Cancer Treatment and Prevention / ambulatory care pavilion, shown here, is an example of form with the rough edges of a hospital's reality rounded off.

Green Design: Environmentally Effective Design Principles

Lecture Series 2004

Following is the foreword to the book "**Architecture and the Environment**: Bioclimatic Building Design" by David Lloyd Jones, written by **Tadao Ando:**

The whole world today harbors feelings of misgiving over the crisis facing the global environment and the general loss of our spiritual culture. Now, more than ever, it is time to return to our point of origin, to deepen our understanding of the environment and to correct our ways of mishandling the earth's forests and woodlands which play such an important role in shaping and developing the human spirit.

The cities of the twentieth century were built on a basis of function and rationality. Technological innovation and changes in social structure have caused an excess of people and things to become concentrated in urban areas. The entire world has generally shared the common belief that an economy-led society is the ultimate and desired direction. Driven by consumption, mankind has generated tremendous amounts of dynamic power, never before seen in our history, by converting the planet's irreplaceable fossil fuels and, in doing so, we have also released massive volumes of by-products into the air and the seas. We have also produced many non-biodegradable chemicals not found in Mother Nature.

The result of our attempt to use resources that have been the products of billions of years of solar energy within what is relatively a mere instant has been, conversely, to spew more substances and energy into the environment than the planet is capable of digesting, and this has thrown the entire global ecosystem out of balance.

All over the world we are finally beginning to recognize the threat that abnormal weather and pollution in the air, water and ground are posing to civilization. Economic development that wastes limited resources and destroys the environment brings only momentary prosperity; it lacks sustainability and threatens the very existence of future generations. Now is the time to change our consciousness in this regard and, focusing on solar energy, to come up with the appropriate means of utilizing our resources such as wind, water, and so on.

In the process of changing our ways, we should focus on the natural cleansing effects and the power of self-regeneration found within thick, foliated woodlands and learn to use these limited resources carefully under the guidance of the earth's ecosystems.

Though it is troublesome to make biodegradable goods and to utilize natural energy in our present ways of life, it is not impossible. We have already developed sufficient technologies to effectively utilize Mother Nature while sustaining her unspoiled beauty, and now is the time for the entire world to awaken to the limits of our materialistic ways and to change our society as a whole.

Note:

The above and the following material have been taken verbatim from the sources as described in the text. While Hosmac (India) is committed to the views expressed here in principle, we are still a long way from being able to execute these design and project management techniques and imperatives in reality. We still need to fully understand the implications, and gain the necessary mastery over the technical aspects of the views expressed here.

I do not claim to be an expert on what is written in the text of this lecture, but I feel a strong need to share it with all of you nonetheless, as I believe we need to care, we need to create and we need to celebrate in reclaiming the earth for all of us.

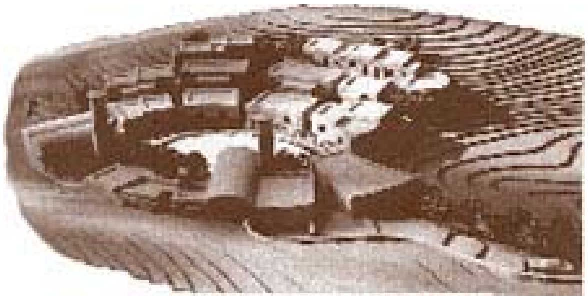
Please excuse my presumptuousness in speaking on a topic I know not much of.

Hussain Varawalla

Five Principles of Ecological Design

1. Solutions grow from Place

Ecological design begins with the intimate knowledge
Of a place.
It is small scale and direct, responsive to
Local conditions and people.
If we are sensitive to the nuances of place,
We can inhabit without destroying.



2. Make Nature Visible

Making natural cycles and processes visible brings the
Designed environment back to life.
Effective design helps inform us of our place within nature.

3. Design with Nature

By working with living processes, we respect the needs of all species.
Engaging processes that regenerate rather then deplete, we become more alive.
Making natural cycles and processes visible brings the designed environment
Back to life.
Effective design helps inform us of our place within nature.

4. Ecological Accounting Informs Design

Trace the environmental impacts of design and use this information
To determine the ecologically sound design possibilities.

5. Everyone is a Designer

Listen to every voice in the design process.
As people work together to heal their places, they also heal themselves.

The following essay has been created using material from the Preface to the book "**Architecture and the Environment**: Bioclimatic Building Design by David Lloyd Jones.

'The formation of the first earth being a piece of divine architecture' Thomas Burnett: *The Theory of the Earth,* (2 vols, 1684 – 90)

Some have said that architecture is the Mother of the Arts, thereby claiming for it both maternal and aesthetic ascendancy. If this is so, the matriarch in architecture holds in balance the well-being of another mother figure: Mother Earth, while the art in architecture, uniquely, has to meet the complex demands of use as well as transporting the senses. It is on the relationship of these two roles – architecture as an art of function and architecture as an environmental custodian – that this essay is focused.

The environmental crisis that currently faces us has focused attention on the impact buildings have had on the environment. People who have taken an interest in the subject now know that buildings in the Western world – their construction and use – are responsible for 50% of the deleterious emissions that are causing the planet to overheat. They also know that the goal of radically reducing energy use (and thereby carbon dioxide and other 'greenhouse' gases) has been broadened to include the goal of sustainable equilibrium in the use of resources, a state whereby that which one generation uses is replaced in kind or value for the benefit of the next. However, it is also true that the dialogue between architecture and nature is as old as architecture itself. It is only in recent history – say since the Second World War – that this happy interaction has been extinguished. Until then, both aesthetic and functional attributes of architecture were inextricably linked to nature. Seen in this light, Green architecture represents an overdue return to, and a broadening of, this innate and continuing exchange.

Architecture, as much as any design activity, is dependent on a satisfactory reconciliation of the intuitive with the rational. A building has to be both poem and machine. Few buildings achieve this felicitous equipoise. Those that are sensually stimulating often lack sound construction technique, or fail to fully meet operational requirements; and those that successfully answer practical needs often fail to generate an emotional charge. Many fall short on both counts. Axiomatic to arriving at an inspirational balance between sense and sensibility are two relationships – that of building to site, and both of these to nature itself.

The relationship of building and site to the wider natural environment is subject to the intuitive and the rational. Market towns and native villages expand organically following successive subjective and pragmatic decisions. Conversely, the peoples of ancient civilizations, such as the Pharonic in Egypt and the Mayan in the Yucatan, selected sites by divination and disposed buildings on them in accordance with the rights and rituals of their 'deities' earthly representatives. The art of architecture, therefore, has to embrace both the inspirational and the analytical, and architectural response to our environmental predicament will also reflect this dichotomy.

Commentators on Green architecture have generally reacted to global depredation in terms of remedial mechanistic measures; technological innovation, rational planning, appropriate specification of materials and effective building systems management. However, an examination of buildings that have a feeling for nature, as distinct from the more specific concern with assaults on global bio-systems, shows that an intuitive response can be as profound and elevating as one based on careful analysis and measured application.

A sustainable architecture appropriate to the demands of the next millennium will not materialize solely through applying the remedies of giving new life to the building physics to the last decade. The relationship of buildings to environment is after all not just a recent concern; it has been a vital force throughout history, and the precise nature of the relationship has varied widely to reflect the preoccupations of each era. The distinction of this period is that the traditional discourse between building and nature could turn into an act of bidding farewell. An enduring sustainable architecture will emerge and convey the multifarious concerns of our time. It will both reflect deeply intuitive impulses of our cybernetic age and express the rigor of operational analysis. It will also be informed and stimulated by the range of measures formulated by government bodies and others to give greater protection to our habitat. The challenge is to reach a point where green architecture is indistinguishable from good architecture.

The author, David Lloyd Jones' view is:

Green architecture is a comprehensive province of the discipline, broad in its sympathies and, at best, transcends any environmentally based ethic to become, not just good, but great architecture. Gustav Metzger, the veteran architectural critic, stated at the 1996 symposium on sustainability at the Architectural Association:

First we had nature. And then came the Environment. Environment is the smoke humanity has put on nature: the people who used Latin had no word for environment – they knew only natura.

The author, David Lloyd Jones, goes on to say:

I have tried to avoid the use of the word 'Green' in describing a type of architecture as it has become such a portmanteau (all-embracing) concept; I use the more building specific term 'bioclimatic', by which I mean an approach to design which is inspired by nature and which applies sustained logic to every aspect of the project, focused on optimizing and using the environment. The logic covers conditions of setting, economy, construction, building management and individual health and well being, in addition to building physics.

(He is referring to the examples given in the book)

Jones, David Lloyd: **Architecture and the Environment: Bioclimatic Building Design:** 1998, Lawrence King Publishing. ISBN 1 85669 103 9

New achievers

Many successful new healthcare projects are taking shape throughout the developed Western countries today, calling into question the performance levels of more typical healthcare construction endeavors, both in the West and in India. This prompts us to ask just how far our conventional healthcare buildings are falling short of the mark, judged by the standards of 'green' architecture, the popular name given to environmentally responsive and ecologically sustainable building.

Health care institutions' core mission of protecting human health provides the basis for them to speak with their words and actions on the health implications of building construction and operation. The healthcare industry has a leadership opportunity to move the larger building industry to a healthier approach by demonstrating the best in healthy, sustainable design, construction, operations and maintenance practices in it's own facilities.

This approach to design is known as 'green' architecture. This design approach addresses concerns such as energy efficiency, the use of clean energy resources, an improved indoor environment through usage of green building materials and maximizing the use of controlled daylighting, encouraging recycling and waste prevention / management strategies and designing in ways that promote good building operations practices.

Whole system look to maximize impact

The optimal approach to green design involves a whole system look at the facility, incorporating all aspects of design and all disciplines working together to find the best solutions to design challenges. Careful priority setting can assure that an organization's initial efforts have maximum impact and provide room to grow and develop the organization's ability to steadily improve its environmental impact over time.

Prioritize for maximum immediate impact

Target green design issues that:

1. **Address an important environmental problem**, ideally one that is directly health related and thus tied to the organization's core mission, with credible scientific evidence on the level of the problem, although there may not necessarily be scientific unanimity on the problem. For example, persistent bioaccumalative toxins (PBT's such as dioxin, lead and mercury) are recognized as a major problem by most environmental agencies.
2. **Have multiple benefits.** For example, eliminating PVC reduces environmental health impacts upstream and downstream while reducing indoor exposure to DEHP and heavy metals. Energy saving measures reduce air and water pollution, cut global warming while producing bill savings for the facility. Elimination of materials that outgas formaldehyde and other VOC's improves patient outcomes, and increases staff productivity while reducing potential for triggering multiple chemical sensitivity syndromes.
3. **Use materials that are readily available.** In the case of a geographically dispersed health system this means available throughout the system's region.
4. **Are cost effective,** being competitively priced or paying for additional investments through reduced operating and maintenance costs.
5. **Meet the service criteria** of the system.
6. **Have a track record** of experience and referrals and no approval barriers with state regulatory agencies.
7. **Have demonstrable results** in direct environmental impact.
8. **Move the industry forward** by providing a useful demonstration project or, better yet, by exercising market pull, such as on materials suppliers to provide more green offerings or to promote them more strongly or to provide better prices.

Support longer-term strategies:

Parallel to the efforts that pass these screens for immediate results, an institution can also establish a strategy of putting its weight behind longer term efforts to make possible those design changes that require regulatory approval or further manufacturer development to be ready for application.

Start with the finishes:

One excellent place to start for immediate impact is in the specifying of environmentally sound interior finish materials, with an emphasis on indoor air quality and lifecycle toxin reduction. Many of the materials currently widely used in interiors, such as vinyl flooring, have multiple negative health impacts throughout their lifecycle as well as raising health hazards within the facility, making them a clear priority for a healthcare facility. Benefits to the institution can include:

1. **Reduced operating costs:** Alternative materials are commercially available that, while sometimes costing more to install, can, in many cases, pay for themselves rapidly through operations and maintenance savings.
2. **Improved patient outcomes:** Improving indoor air quality can reduce stress on healing patients.
3. **Improved productivity:** Many studies have found higher productivity and retention results from green building designs.
4. **Reduced exposure to future liability** as awareness of the hazards of the materials grows (as happened with lead and asbestos).
5. **Opportunities to attract and keep members** who are concerned about chemical sensitivities and environmental health.

Key health criteria for material selection

Selecting environmentally sound interior finish materials should start with certain health related mandates:

1. **PVC free materials** for flooring, wall covering, carpet backing, ceiling tile and furniture.
2. **No added formaldehyde** particularly in wood products such as in casework, furnishing and flooring.
3. **Low or no VOC** paints, adhesives, stains, finishes, floor coverings and furniture. Watch for important new work on testing and setting standards for emissions from materials.

Further sustainability attributes of materials

In addition to direct health impacts, selecting materials should also involve evaluating the following environmental attributes:

1. **Recycled** (preferably with high post consumer content), **reused / salvaged,** remanufactured or from rapidly renewing sustainable sources.
2. **Sustainably harvested.** Specify certification (FSC wood, etc.)
3. **Regional sources** to reduce energy required to transport the material.
4. **Low embodied energy**
5. **Durable**
6. **Low maintenance** and not requiring toxic materials to maintain.
7. **Easily reusable, recyclable, compostable** or otherwise biodegradable on disposal. Ideally the manufacturer should help facilitate this.

Moving beyond materials

Building upon a basis of progress in the interior materials realm, a healthcare organization can then expand out to other areas of importance to a sustainable healthcare facility design: energy and water usage, site design, structural materials, waste management and construction process and design for green operations and maintenance.

A complete integrated approach to sustainable design will complement the healthcare organization's fulfillment of its commitment to the health of its patients and the world with economic multiple payoffs from improved productivity, reducing operating costs, reduced liability, and, most importantly, better patient outcomes.

This Green Buildings priority statement produced by the Building Green Health Care work group of the Healthy Building Network and Health Care Without Harm.

For more information, visit www.healthybuilding.net and www.noharm.org

Reconciling Economics and Environmental Concerns

"Then I say the earth belongs to each…generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence."

Thomas Jefferson

A healthcare facility building project brings a wealth of social benefits to our communities. Yet in weighing these benefits, we should also be aware of how our hospitals directly and indirectly contribute to environmental and human health problems. Few people in the building trades, let alone average citizens, fully realize the extent to which building construction and operation generates material waste and results in energy efficiencies and pollution. These so-called 'externalized costs' do not show up on any balance sheet, meaning that the environment – and ultimately society in general – will be forced to absorb them. Every day, buildings squander valuable capital by wasting energy, water, natural resources and human labor. Most of this waste happens inadvertently, as a result of following accustomed practices that often just meet, but fail to exceed, building codes. Progressive promoters of healthcare facilities have begun to convert these liabilities into economic opportunities by adopting cost-effective new technologies, processes, and materials that dramatically reduce environmental impacts while increasing profitability.

Hidden costs of construction

The hidden costs of construction include the adverse environmental impacts of construction-related activities. Today's design decisions have local, regional, and global consequences. According to the Worldwatch Institute, almost 40% of the 7.5 billion tons of raw materials annually extracted from the earth are transformed into the concrete, steel, sheetrock, glass, rubber and other elements of our built environment. In the process, landscapes and forests are destroyed, and pollutants are released into the soil, water, and air. Twenty-five percent of our annual wood harvest is used for construction, which contributes to flooding, deforestation, and loss of biodiversity.

Operating a healthcare facility extracts an ongoing toll on the environment as well. Globally, buildings use about 16% of our total water withdrawals; in the US that amounts to about 55 gallons per person per day. Buildings consume about 40% of the world's energy production. As a consequence, buildings (among them healthcare facilities) are involved in producing about 40% of the sulfur dioxide and nitrogen oxides that cause acid rain and contribute to smog formation. Building energy use also produces 33%, or roughly 2.5 billion tons, of all annual carbon dioxide emissions, significantly contributing to the climate changes wrought by the accumulation of this heat-trapping gas.

Today, we are just beginning to understand the high cost of inefficient practices in yet another critical realm: our buildings' interior environments. The U.S. Environmental Protection agency has ranked poor air quality as among the top five environmental to public health, and claims that unhealthy indoor air (which may be two to eight times more contaminated than outside air) can be found in up to 30% of new and renovated buildings. As a nation, the price the United States of America pays for this sub-par performance ranges from $ 10-60 billion in combined health premiums, absenteeism, and annual productivity losses due to sick building syndrome and building-related illnesses.

The healthcare industry also pays indirect premiums for less efficient, traditionally built facilities. These hospitals can impose unnecessary additional burdens on municipal services such as water supply and treatment and solid waste management, indirectly affecting local taxation and municipal budgets. Healthcare facilities should help, not hinder, in the provision of public health services.

A 'no-regrets' action

Looking across the full spectrum of conventional building performance (including conventionally built healthcare facilities), it is clear that our design and construction practices are falling short of what could be achieved with even a small number of strategic, cost-effective corrections. Many industries have a growing appreciation that sound economic and environmental choices are not mutually exclusive, but instead are compatible to the point of being interdependent. This suggests that environmentally effective (or ‘high performance’) building practices will be increasingly market-driven as the economic advantages of environmentally sound design and construction continue to gain industry recognition and support. Therefore, implementing these practices should be considered a ‘no-regrets’ policy initiative that results in economic gain while producing positive environmental results.

Well-integrated design and construction

A whole greater than the sum of its parts

An integrated or ‘whole building’ design approach requires thinking about the building and its site as a series of interlinked and interdependent systems, so that a single design refinement simultaneously improve several building systems’ performance. Like the domino effect, one refinement can trigger multiple savings or other benefits. For example, careful decisions on building shape and window placement that take into account both prevailing wind and sun angles, may not only enhance a hospital’s thermal performance, but can also result in improved daylighting. These measures will reduce both heating and cooling loads, and in turn, could generate first cost savings achieved through downsizing HVAC equipment and reducing mechanical space requirements.

Using simple, time-honored techniques

Environmentally effective (high performance) designs draw on principles used in much older building practices. As such, they rely on the manipulation of land features, building form and exterior materials to manage the climate and get the most out of the materials at hand *before* invoking electrical and mechanical assistance from energy-driven heating, cooling and lighting systems. High performance design also favors ‘state-of-the-shelf’ technology over sophisticated ‘state-of-the-art’ equipment. The preference for keeping equipment as simple and maintenance-free as possible is vital to the interest of the healthcare facility promoters, given the various demands made on limited resources.

Team Design

Environmentally effective (high performance) outcomes also demand a much more integrated team approach to the design process and mark a departure from traditional practices, where emerging designs are handed sequentially from architect to engineer to sub-consultant. A unified, more team-driven design and construction process brings together various experts early in the goal-setting process. This helps high performance buildings achieve significantly higher targets for energy efficiency and environmental performance.

A team-driven approach is, in effect, ‘front-loading’ of expertise. One or more facilitated workshops might involve the owner, design professionals, operators and contractors (where possible) in a brainstorming session or ‘partnering’ approach that encourages cooperation in achieving high performance goals while breaking down traditional adversarial roles. During design development, frequent input from users and operators can accelerate progress, eliminate redundant efforts, engender commitment to decisions, reduce errors, and identify synergistic opportunities.

Innovative products and tools

An integrated building design process reexamines the use of traditional products or building assemblies, and identifies innovative technologies or green product and system alternatives that offer significantly improved environmental performance. These progressive design approaches can be further refined through the use of computer energy modeling. Energy modeling simulates the proposed design’s response to climate and season. Designers can preview and improve the performance of interdependent features such as orientation, daylighting, alternative building shell design, and various mechanical systems. Energy modeling quickly evaluates cost-effective design options for the building envelope or mechanical systems by simulating the various alternatives in combination. This process takes much of the guesswork out of green building (and green healthcare facility) design and specification, and enables a fairly accurate cost/benefit forecasting.

"Discovering the DOE-2 model was invaluable. I can't imagine doing this kind of project without it ever again…With this technique we can actually prove to our clients how much money they will be saving."

Robert Fox, Principal, Fox and Fowle, architect of Four Times Square.
Lessons Learned, Four Times Square.

Current barriers to environmentally effective buildings

Following are some of the difficulties that may be encountered in mainstreaming environmentally effective (high performance) design and construction:

⇨ **Steep Industry Learning Curve**

There is a general lack of knowledge about the economic and environmental benefits of high performance buildings, as well as a dearth of familiarity with green building concepts and practices.

⇨ **Fiscal Considerations**

Current fiscal policies mandate relatively rapid paybacks for energy efficient improvements. To finance 'deeper' retrofits (system upgrades and improvements to building envelopes), which may yield some initial economic advantages, but much greater operating savings over time, investments with lower rates of return and longer payback cycles should be considered.

⇨ **Barriers to Implementation**

Funding entities are less likely to sponsor energy- and infrastructure-related improvements to the project may be more enamored of higher-visibility improvements with greater ability to project the image of the sponsor. If they additionally do not share in the savings, they will have even less motivation to fund efficiency-oriented capital improvements.

⇨ **Regulatory Disincentives**

Local building codes may define code compliance in terms of meeting a minimal standard for system performance. In practice, this discourages industry performance beyond the bare bones of code minimum.

This Green Healthcare Facility Design initiative is jointly presented by:

Hosmac India Private Limited, Hospital Architects, Planners & Management Consultants, Mumbai
HOPES, Help Organization for People, Environment and Society.

HOPES is networked with a global movement called Healthcare Without Harm, involving more than 300 NGO's and professional organizations spread over 50 countries, working towards establishing environmentally sound healthcare practices and healthcare facility design and construction.

For more information, visit www.healthybuilding.net and www.noharm.org

These notes on "Reconciling economics and environmental concerns", "Well-integrated design and construction" and "Current barriers to environmentally effective buildings" have been adapted from the High Performance Building Guidelines, City of New York, Department of Design and Construction, April 1999.

Measurable Costs and Benefits from Environmentally Effective Buildings

This article describes some of the measurable benefits that can be achieved by integrating environmentally effective (high performance) measures in buildings (including healthcare facilities.):

(All examples of cost savings and other benefits are taken from data available for municipal buildings in New York City, USA and the New York City Municipality.)

1) Facility Specific Benefits

a) Reduced Operational Energy Expenditures
Environmentally effective (high performance) buildings with improved envelopes and efficient lighting, equipment, and HVAC systems use less energy than conventional buildings. Potential savings may be measured by determining an annual energy cost budget for a building designed in accordance with these green design principles and comparing it with a building designed to meet minimum applicable local codes or traditional building practices. The annual operating budget savings will equal the difference between the respective energy cost budgets.

For a typical 100,000 square foot municipal building, a 35% savings in energy use would result in a reduction of up to USD 70,000 in energy costs each year.

b) Operations and Maintenance Savings

i) Reduced Water Consumption
Installing water meters in residential buildings and billing for service based on consumption has caused building occupants in New York City to diminish their water use by an average of 20%, primarily through conscious efforts to reduce waste (such as repairing leaks.) Healthcare facilities, for example, can reduce water consumption by installing efficient plumbing fixtures.

If all municipal buildings in New York City used commercially available water-saving technologies to reduce water consumption by 20% (compared to fixtures meeting code minimums), the City could save over USD 625,000 a year. Extrapolating from this you can imagine savings possible in all healthcare facilities in New York or any other large metropolis, which use considerably more water per capita.

Actual savings are likely to be even greater, because retrofitting existing facilities will result in replacement of many old plumbing fixtures, which use significantly more water than the later ones.

ii) Reduced Municipal Solid Waste

By reducing the amount of solid waste healthcare facilities generate, they will accrue savings in the payments they make for collection, transport and disposal (for example, potentially infectious waste) of that waste. They will also save by implementing waste recycling measures prescribed by green operations and maintenance procedures and practices, to the extent that they will need to purchase less new materials.

In any major metropolis, healthcare facilities can reduce landfill costs borne by that city's municipality by pursuing recycling and waste reduction measures, and also help the city achieve its recycling goals. They have, as discussed earlier, a moral responsibility to be leaders in any such socially desirable effort.

iii) Improved maintenance of Buildings

Many times the healthcare facility's Operations & Maintenance budget tends to be set independently of any assessed O & M need. This can result in a large backlog of maintenance and reduce the savings potential of high efficiency systems. Conversely, implementing high performance housekeeping practices and designing the facility for more efficient maintenance can eliminate deferred maintenance and improve the performance and durability of building systems. While not resulting in direct savings to the personnel budget, these practices may have a positive impact on the quality of life for building occupants and maintenance staff, and result in increased productivity. Where no maintenance backlog exists, real operational savings are more.

c) Construction Cost Trade-Offs

Usage of environmentally effective design principles is likely to result in some discrete first cost savings on certain items. For example, specifying double glazed windows with high performance selective coatings, in conjunction with an energy efficient lighting design, may reduce heat loss and gain to such an extent that it will be possible to downsize the entire HVAC system (chillers, boilers, fans, pumps, ducts, pipes, etc.). Although savings on specific items may be significant, the reduction to the capital budget is likely to be offset by other expenditures, such as the increased cost of high performance windows or measures to assure good indoor air quality. In many cases, the use of these design principles will result in a marginal increase to the capital budget as a whole. Following integrated design and development strategies recommended in following articles in this series is the best way to maximize the opportunities for cost trade-offs and minimize or eliminate any capital cost premiums.

d) Reduced Disposal Costs for Construction and Demolition Waste

Measures to reduce construction and demolition (C & D) waste include reusing existing structures and materials, avoiding the purchase of excess materials and reducing materials packaging. Reducing waste reduces the cost to contractors who must pay for C & D waste collection and disposal. While savings opportunities exist, there is currently not enough consensus on C & D waste data to provide a range of savings.

e) Increased Employee Performance

i) Increased Productivity

A growing body of case study evidence supports the theory that high performance buildings – those with better lighting, improved ventilation, and fewer air contaminants – are beneficial to employee health and productivity. Although precise methods of measuring these costs and benefits are still in development, the potential for savings is significant.

In New York city Municipal Agencies, annual agency personnel costs vary from USD 200-300 per square foot for administrative agencies, to over USD 500 per square foot for uniform agencies. A 1% increase in productivity could be worth USD 2.00 to USD 5.00 per square foot, or up to USD 500,000 a year for a 100,000 square foot building.

ii) Reduced Absenteeism and Employee Turnover

Investing in high performance buildings can also help insure against predictable losses in productivity.

The New York City personnel services budget is about USD 18.4 billion a year. Total equivalent sick leave taken is about 9 days a year. If a healthier work environment reduced the average number of employee sick days taken each year to 8 or 7, the City could realize benefits of USD 55 million to USD 110 million each year.

Loss of productivity and additional personnel costs occasioned by employee turnover can also be significant, though environmental conditions are only some of the many factors that contribute to the turnover problem.

If investing in a better work environment helped the City increase retention by only 1%, the avoided cost of employee turnover could exceed USD 120 million per year.

f) Reduced Exposure to Risk of Litigation

Improving the quality of life for building occupants can reduce the organization's (including healthcare providers) risk of exposure to litigation related to the work environment, including sick building syndrome, exposure to chemicals and hazardous materials, and accidents resulting from improper maintenance. The growing awareness of – and willingness to take legal action over – illnesses potentially associated with the building environment may increase the organizations vulnerability to litigation arising therefrom.

Irrespective of any judgments rendered in these types of cases, the organization concerned would need to expend considerable resources to investigate and defend against such actions. Following green design principles would help reduce exposure to litigation by minimizing the likelihood that poor indoor air quality and other environmental problems will occur.

2) Economic Development

An investment in environmentally effective (high performance) healthcare facilities is an investment in the future of the community and in a larger sense, society. It is likely to produce indirect economic benefits through development of the nascent clean and efficient technologies industry.

To the extent that a society can obtain the same energy services using less energy (through increased efficiency) or through reduced reliance on imported fuel (based on integration of clean technologies such as wind and solar energy), that society will derive social and economic benefits. The first benefit is obvious – improving efficiency reduces energy bills and provides a direct savings to the members of that society. Also, the entire society will benefit from the improved air quality that results from reduced burning of fossil fuels.

Energy and resource efficient buildings also reduce the amount of money that utilities need to invest in fuel, operations and maintenance, and related costs at power plants. Over time, the need to build and upgrade facilities and to expand the transmission and distribution system is reduced, and the resulting savings can be passed on to consumers. Although efficiency services cost money, these investments pay for themselves in energy savings. Achieving efficiency is a relatively labor intensive process, which provides direct benefits to the society by resulting in more jobs, while any equipment imported from elsewhere to produce energy is a loss to that society. Money that is retained in the local economy contributes to the tax base.

3) External Environmental Benefits

Reducing energy use lowers the emission of oxides of nitrogen, sulfur dioxide, and carbon dioxide produced by power generation at power plants. These air pollutants contribute to ground level ozone (the primary component of smog), acid rain, and climate change, as well as their related health effects. For example, ground level ozone can cause respiratory problems, especially among the very young, the elderly, and those with respiratory illnesses. Oxides of nitrogen contribute to the formation of particulate matter that is linked to heart and lung disease. Acid rain causes damage to lakes and rivers, as well as to crops and buildings. The appropriate siting of buildings, together with environmentally preferable building materials and products, reduces the impact of real estate development and building use on land and water. By investing in environmentally effective buildings today, the society will be contributing to solving these problems – a much more cost-effective and well-reasoned approach than paying for remediation efforts later on. It owes this foresight to the coming generations, and healthcare facilties as a building type committed to the maintenance of that society's health, owe it to themselves to take the lead.

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For more information, visit www.healthybuilding.net and www.noharm.org

This note on "Measurable Costs and Benefits from Environmentally Effective Buildings" has been adapted from the High Performance Building Guidelines, City of New York, Department of Design and Construction, April 1999.

‘Green’ Design Strategies: Site Design and Planning

Preservation of site resources and conservation of energy and materials – both during construction and in on-going building operations – are important and often overlooked benefits of good site design. Sustainable site planning identifies ecological, infrastructural, and cultural characteristics of the site to assist designers in their efforts to integrate the building and the site. The intent is to encourage optimum use of natural / existing features in architectural and site design, such that building energy use is diminished and environmental degradation is minimized.

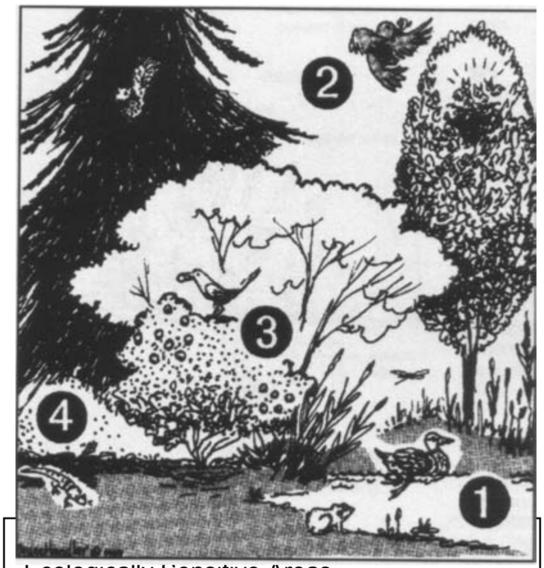
Understanding the Site

This ‘green’ design strategy consists of making an inventory and analyzing site resources, relationships, and constraints to better enable the designers to maximize energy efficiency while conserving and restoring ecological and cultural resources.

Technical Strategies

1) **Inventory and analyze the regional and local ecological context.** This will allow the design team to better understand and respond to site conditions, opportunities and constraints. This inventory and analysis includes, but is not limited to:

   a) Relevant climate-specific characteristics.
   b) Existing air quality and ground level wind patterns.
   c) Soil and ground water testing to determine pollution levels, water table, bearing capacity, and what types of fertilizer or soil amendments may be necessary for planting. Determine the need for retaining/stockpiling existing topsoil.
   d) Inventory of existing vegetation and identification of any threatened species or significant habitats.
   e) Mapping of natural hazard zones, such as exposure to high winds and storms, floods, unstable soils, steep slopes, fault lines, former (buried) water features, etc.



Ecologically Sensitive Areas

An inventory of a site’s plant species – and an understanding of the ecological niche into which they fit – will reveal which areas are either sensitive or threatened, and which serve as wildlife habitat. The image above illustrates some of the relationships between vegetation and a site which either establish or enhance wildlife habitat: (1) surface water; (2) a variety of tree canopy heights (3) fruit bearing “native” plant species; and (4) natural leaf mulch

1) **Topographical features.** Survey topography, existing plants, and water features to better understand grading and drainage issues.

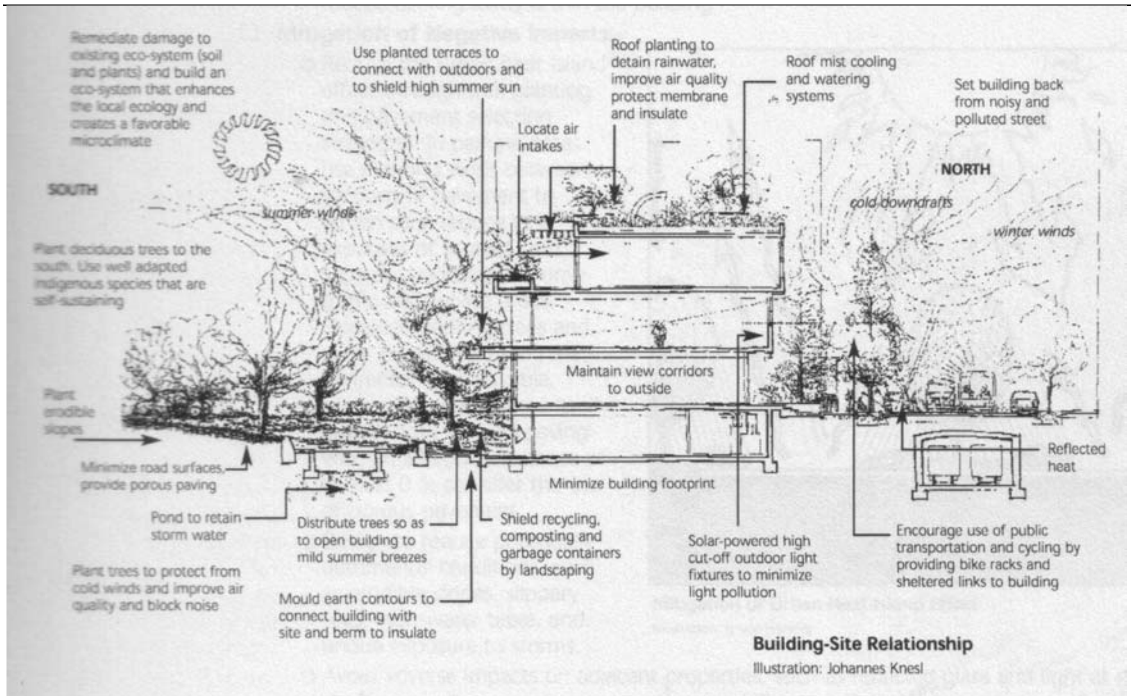
2) **Inventory and analyze urban / historical context** and community resources in order to effectively respond to cultural issues.

   a) Inventory infrastructure and utilities.
   b) Analyze transportation system and existing/potential linkages to the site.
   c) Identify construction constraints.
   d) Review land use patterns in the immediate area.
   e) Review the site’s cultural resources for possible restoration or incorporation.

f) Examine the architectural style(s) present in the neighborhood and consider the use of historical styles or traditional materials as a means of integrating the new or renovated building with the surrounding area.
g) Analyze cultural features and activities in the neighborhood and identify possible connections to the project.

2) **Identify and prioritize the site's natural and cultural attributes** that are to be protected, conserved, or restored.

Building-Site Relationship



Taken together, the site design and building design should support the ecological and cultural functions of the entire development. Well-designed open space creates a sustainable microclimate that in turn reduces building energy use and supports a high-quality interior environment. The project as a whole should be designed to minimize negative environmental impacts on surrounding areas and to maximize opportunities to restore natural systems.

Technical Strategies

1) General Site Layout

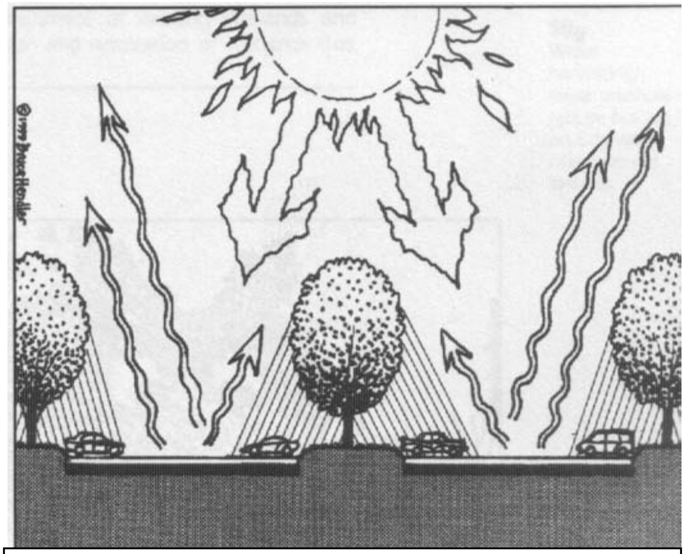
a) Organize building mass, orientation and outdoor spaces to provide efficient access to services; incorporate recreational areas that have multiple functions in addition to visual value. For example, rooftops can be used as gardens and for water collection; a water feature in a playground can provide both cooling and recreation for children.
b) Use earthforms, plantings, drainage and water detention systems, and soils to support the functions of the building and site (e.g., screening, windbreaks, etc.).
c) Employ passive solar principles in architectural design, orientation, and siting; use heat-retaining courtyard pavements (with proper shading).
d) Map sun and shade patterns associated with new construction. Design landscaping that optimizes selection and positioning of plants for sun and shade.

e) Incorporate adequate space for operational recycling and maintenance, including space for collection, storage, and access for collection vehicles.

2) Improved Environmental Quality

a) Coordinate landscape design with building energy design. Orient building, windows, and outdoor spaces to work together, taking advantage of light, air flows, and interesting views. For example, use plant material to screen parking and service areas, or orient a conference room window towards a pleasant view. Design landscaping to be seen from and complement interior spaces. Capitalize on views into and out of the site and adjacent areas.
b) Use deciduous shade trees and exterior structures such as louvers, arbors, and trellises to reduce cooling loads within the building.

3) Mitigation of Negative Impacts



Mitigation of Urban Heat Island Effect

a) Reduce the urban heat island effect through tree planting and pavement selection strategies. In parking areas, use planting strips between sections of pavement to screen cars, reduce vast expanses of asphalt, and separate pedestrians from traffic and service areas. Consider planting trees and other vegetation along the perimeter or, if possible, within the parking area itself. Specify light colored paving with an albedo reflectance of at least 0.5; consider the use of porous pavement.
b) Design to reduce potentially detrimental conditions, such as erodible slopes, slippery soils, high water table, and undue exposure to storms.
c) Avoid adverse impacts on adjacent properties, such as reflected glare and light at night, shading of adjacent greenspace, noise, air pollution, waste heat, or creation of gusty winds at grade.
d) Select light fixtures that reduce or eliminate the effects of light pollution on neighboring sites and the sky.

4) Site Lighting

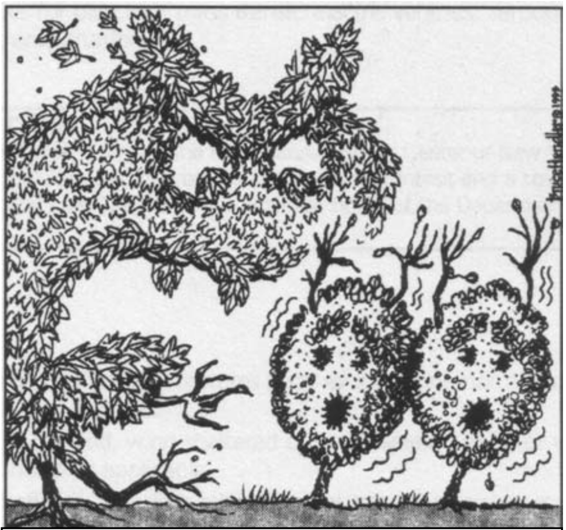
a) Use light colored or reflective edges along driveways or walks to reduce dependence on high-wattage electrical lighting at night. Use high-efficiency lights in exterior contexts such as uplighting fountains or sculptures, parking lights, and pedestrian lights.
b) Use solar power for exterior lights, telephones, and fountain pumps whenever site conditions allow.

Sustainable Landscape Practice

The landscape features must be selected and configured to suit site conditions and restore habitat using self-sustaining landscape design and site maintenance procedures. Practices should promote the conservation and restoration of existing biological and water resources, including species diversity, soil fertility, and aeration.

Technical Strategies

1) Planting Practices


Invasive Species

a) Reduce reliance on plant species that require frequent irrigation and maintenance. If irrigation is necessary, consider drip irrigation and other water-efficient irrigation systems. Emphasize plant diversity, plants that are native to the region and microclimate, and those which naturally grow together and are self-sustaining (i.e. reseed and without much maintenance).
b) Where planting adjacent to building openings such as air intakes, entries, or operable windows, avoid allergy-causing plantings and those requiring chemical treatment.
c) Avoid invasive species (those which threaten local native ecosystems).
d) Reduce dependence on fertilizer by using plants that contribute nitrogen to the soil (clover, honey locusts, black locusts and other legumes).
e) Provide good growing conditions, including adequate root space for plants, and especially for street trees. Tree pits should be 3-5 times the size of root ball dimensions. Whenever possible, locate trees so that the rooting zones of more than one tree can be combined.

2) Water Use / Pollution Prevention

a) Prevent non-point source pollution by planting watershed buffers, allowing infiltration via porous surfaces and minimizing parking. Porous surfaces include materials such as gravel, sand, ‘grasscrete’, and ‘geoblock’.
b) Remediate water quality by filtering stormwater through plantings and soil, preventing erosion, and buffering bodies of water from pollution sources.
c) Harvest rainwater and stormwater for irrigation and other uses on site, and to recharge the aquifer.
d) Reduce water pollution from pesticides, herbicides, and fertilizers by using plant combinations and maintenance methods that do not require chemicals.

3) Soil Quality

a) Analyze planting soil and implement on-site soil remediation measures such as introducing earthworms if they are sparse, adding organic matter and microorganisms to break down pollutants, and removing toxic materials.
b) Use mulch to conserve soil moisture, restore soil fertility, and reduce the need for fertilizers. Leave grass clippings, small plant debris, and fallen leaves to decompose on the ground. Use compost for soil amendment in lieu of peat moss (a non-renewable resource).
c) Provide space and bins for composting of landscape materials.

4) Resource Use

a) Use recycled, renewable, and locally available materials when constructing landscape features (e.g., recycled timber, plastic, rubber tyres).

Encouraging Alternative Transportation

The site should offer support facilities for bicycling, mass transit, electric vehicles, carpooling, and other less-polluting means of transportation.

Technical Strategies

1) **Provide adequate bicycle amenities.** Include features such as secure interior and / or exterior storage, lockers, and shower facilities.

2) **Bus stop seating areas.** Provide covered, wind-sheltered bus stop seating areas.

3) **Provide alternative fueling facilities.** Consider ethanol, a natural gas pumping station, and an electric car battery-charging site.

4) **Carpool incentives.** Provide a preferred carpool parking area.

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'Green' Design Strategies: Building Energy Use

Today's worldview of energy efficiency is very different from the energy conservation mentality of the 1970's, which is recalled by those of us who were around then as a time of long lines at the gas pumps and diminished comfort in our homes and places of work. The energy efficiency model of today involves benefits, not sacrifices. In environmentally effective (high performance) buildings, energy efficient design begins with a methodical reduction of the building's heating and cooling loads – those imposed by climate and those generated by people and equipment. With all loads minimized, mechanical systems are then selected based on highest output for lowest fuel consumption. The new efficiency means optimizing the performance of each of the buildings components and systems both individually and in interaction with other energy-consuming systems – air-conditioning, lighting, domestic hot water, etc. This is known as the practice of 'design integration.' In tandem with other energy efficient practices, building systems integration can provide excellent returns on the initial investment. Current practice also embraces the use of renewable energy technologies that reduce our reliance on fossil fuels and help alleviate carbon dioxide and other greenhouse gas emissions.

Computer software with proven reliability is now available that will predict energy costs for a proposed building design. This energy software, which is essential in the analysis of energy efficiency measures, facilitates informed decision making through the course of the design process. More specialized software, which describes specific environmental features such as daylight distribution and air flow patterns, is also useful for the successful integration of design quality with energy reduction.

Site and Massing Considerations

Taking advantage of the physical features of the building site and microclimate will reduce heating and cooling loads, thereby lowering overall energy consumption.

Technical Strategies

1) **Solar access.** Orient the building to maximize solar opportunities.

2) **Prevailing winds.** Orient the building to minimize thermal loss due to infiltration from prevailing winds while taking advantage of natural ventilation.

3) **Tree location.** Carefully consider the placement of existing and proposed deciduous and evergreen trees on site.

4) **Topographic modifications.** Utilize or modify existing topography to optimize thermal mass and / or insulation. Consider earth forms, berming, and other manipulations of the site section.

Interior Layout / Spatial Design

An appropriate layout of program spaces will help reduce energy consumption and will promote the use of passive solar heating and cooling.

Technical Strategies

1) **Program zoning.** Group similar programs functions in order to concentrate similar heating / cooling demands and simplify HVAC zoning loads. Determine optimum locations within the building so as to take advantage of microclimate conditions and building orientation.

2) **Non-windowed spaces as buffers.** When using passive solar design for heating, non-windowed spaces should be located on the north side against the exterior wall to create a thermal buffer for the main functions on the south side.

3) **Circulation zones as buffers.** Design public areas and circulation zones to serve as thermal collectors and buffers. These spaces can accept a wider range of temperature swings, based on limited duration of occupancy.

4) **Layout for natural systems.** Whenever possible, configure occupied spaces to optimize natural ventilation and daylighting. In general, locate open occupied spaces adjacent to exterior windows and use borrowed light for interior offices. Specify low partitions in office areas adjacent to window walls to enhance penetration of daylight to interior.

5) **Existing natural systems.** In an existing building, reuse and enhance existing built-in passive solar and energy efficiency strategies (EES's) such as natural convection, air circulation, building mass as a thermal flywheel, natural daylighting techniques, and other means.

6) **Stairs.** Provide inviting, pleasant staircases to encourage the use of stairs rather than elevators in low-rise buildings.

Building Envelope

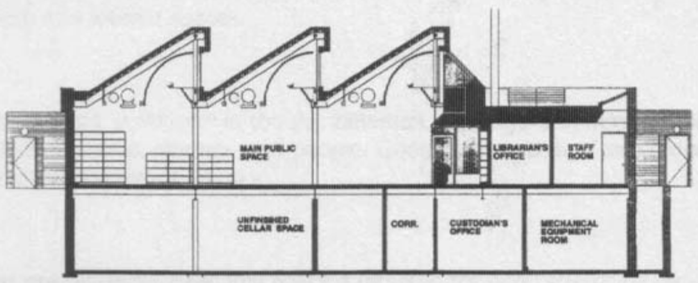
Appropriate assembly of wall, roof, foundation, and window materials will provide good thermal and moisture control, while supporting reductions in building energy use. A good envelope harnesses natural energy through effective use of passive solar and daylighting techniques.

The New Children's Center
The foster care intake/training facility for the Administration for Children's Services is being retrofitted into a historically significant structure that was built in 1912. For comfort as well as energy savings, the envelope is being upgraded with additional insulation (cellulose) and detailed to prevent thermal bridging. It also utilizes new higher performance windows.
Richard Dattner Architect, P.C.

Technical Strategies

1) **Passive solar (whole building) design strategies.** Use passive solar, 'whole building' design techniques and simple, effective technologies to achieve low- or no- cost heating, cooling and daylighting. Strategies and techniques may include:

a) Regulation of solar impact through appropriate fenestration and shading devices. A common and highly effective approach is to specify glazing with low emissivity (low-e) coatings and high R-values to reduce solar heat gain / loss. Shading strategies, such as vertical fins on east and west fenestrations, overhangs on the south side, arcades, trees, brise-soleils, and deep window insets, are also effective components of passive solar design.



New South Jamaica Branch Library

Given the siting constraints of this new branch library, the roof is the primary envelope element available as an interface with the natural environment. The south-facing monitors introduce sunlight for direct heat gain during the winter and lighting year-round. During the cooling seasons, automated shades limit the light to just the levels needed for library functions. The peaks in the roof collect the hotter air, which during the winter is circulated through the building by the HVAC system. During the cooling seasons, this hot air is exhausted. Curved diffusing baffles and reflective light shelves prevent direct sunlight from reaching the occupied areas of the building. The light fixtures are controlled by photo-sensors, filling in whatever portion of the required levels are unmet by daylight.
Stein White Architects, LLC

b) Moderation of interior temperature extremes through the use of thermal mass where appropriate. A buildings thermal mass resides in materials such as masonry and concrete that have the capacity to store and release heat as interior and exterior temperatures fluctuate. Building mass can function as a kind of thermal flywheel, in that it moderates the extremes of thermal loading within a building.
c) Enhanced insulation in the building shell to reduce energy loads.
d) ‘Air-lock’ entrances to reduce heat loss or gain.
e) Light-colored, reflective roof surfaces to reduce cooling loads and diminish the urban heat island effect.

2) **Natural ventilation.** Consider integrating natural ventilation strategies in the design of HVAC and exterior wall openings to reduce reliance on mechanical ventilation during swing seasons.

3) **Envelope detailing.** To prevent moisture build-up within the walls, detail the material assembly of the envelope in accordance with best vapor barrier practices. Use monolithic building systems and assemblies as opposed to smaller assembly parts. This will minimize the need for caulking and weather-stripping and will significantly reduce infiltration. Avoid thermal bridging through the exterior walls, roof, and floor details and components.

4) **Reduction of convective heat losses from unplanned air flows.** To reduce stack effect, seal between floors, stairwells, corridors, and elevator shafts. Be sure to seal distribution plenums and ductwork. Plan air pressure relationships between rooms as necessary.

5) **Radiant cooling.** Radiant cooling techniques may be worth investigating for internally load-dominated buildings. This technique utilizes the building envelope as a heat sink for the interior.

Daylighting / Sun Control

Whenever possible, controlled daylighting should be incorporated into the building as the preferred mode of interior illumination and to reduce lighting load and operating costs. This saves the most expensive form of energy we use: electricity, and the charges associated with peak demand.

Technical Strategies

1) **Glazing.** Specify glazing with high visible transmittance and integrate placement in building envelope to control glare. Consider the use of glass with higher daylight transmittance and lower shading coefficients on north walls where glare is much less of a problem. Consider fritted, translucent, and spectrally selective glazing tuned to end use and orientation.

2) **Monitors and clerestories.** Consider the use of roof monitors and high clerestory windows in addition to or in place of skylights. If using skylights, consider models that respond to differences in seasonal sun altitudes.

3) **Dimmers.** Specify and coordinate placement of photocell-dimming sensors that adjust electric lighting in response to the amount of available natural light.

4) **Light shelves.** Consider the use of interior and / or exterior light shelves to reflect natural light deeper into interior spaces. Provide shading devices, such as overhangs or vertical fins, to let in quality natural light but exclude undesired glare while controlling contrast ratios.

5) **Courtyards and atriums.** Incorporate courtyard, atrium, or other daylight-enhancing techniques to bring light into the interior.

6) **Fiber-optics.** For special applications, consider fiber-optic technologies or light pipes that transmit natural light deep into interior spaces.

Light Pollution

Sensitive site lighting will reduce light pollution in the sky, between buildings, and in open spaces, thus avoiding negative impacts on plants, animals and people. Good lighting design also reduces energy waste while improving night views of the sky.

Technical Strategies

1) **Reduced night lighting needs.** Reduce security lighting required for open spaces by securing off-limits areas and / or installing motion sensors. Limit lighting to zones where it is necessary for safe passage to entry and exit areas; control by timers. In other areas, provide security lighting controlled by motion sensors.

2) **Proper cut-off angles.** Use outdoor lighting fixtures with cut-off angles that prevent light from going upward or too far beyond the intended area of illumination.

3) **Lighting fixture height.** Reduce the height of luminaires relative to property boundaries. This will prevent light from straying onto adjoining properties.

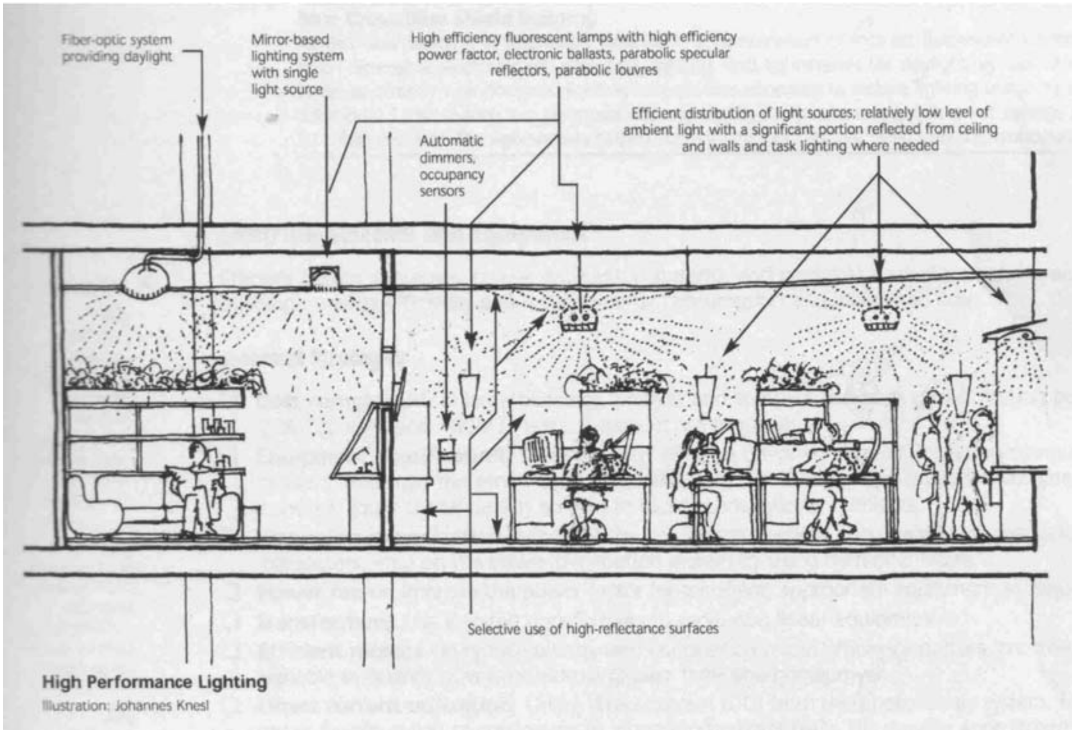
High Performance Lighting

A highly efficient light level distribution that improves visual quality while reducing electrical use may be achieved through efficient lighting layout, lamps, luminaires, and other components, together with localized lighting controls. Use fixtures that minimize the use of hazardous lamp materials.

Technical Strategies

1) **Lighting power density.** Minimize lighting power density to meet project requirements by designing a lighting system with characteristics such as:

a) Efficient light source distribution. Make the most of illumination source output by designing for appropriate room geometry, room surfaces (high surface reflectance), mounting heights, and use of parabolic specular reflectors and deep parabolic louvers.



High Performance Lighting
Illustration: Johannes Knesl

b) Low ambient lighting levels with task lighting, where appropriate. Consider lighting fixtures that provide significant illumination of ceiling and walls. These include pendant fluorescent lighting fixtures that direct light up and down.
c) High efficiency lamps and luminaires with electronic ballasts. These have a low propensity to attract dirt deposits, incorporate a minimum of hazardous substances, and are well cooled for optimum performance.
d) Efficiency-based controls, such as dimmers, occupancy sensors, photo cells, and time clocks.
e) Lumen maintenance controls. Since lamp efficiency degrades over time, the designer often compensates by ‘overdesigning’ the lighting system to account for reduced lumen output later on. Where appropriate, install lumen maintenance controls to ensure that no more than the required footcandle levels are delivered to the space. This will save energy in the early stages of the lamps life.

2) **Fixture uniformity.** Achieve and maintain uniform lumen levels through group relamping. This also allows for designing to a lower installed wattage.

High Performance Lighting
A typical high performance office environment may offer an ambient light level of 30 footcandles, supplemented by task lighting. High efficiency fluorescent lamps with parabolic reflectors and deep louvers could be used to achieve this level of illumination, providing a distribution of approximately 80% down and 20% up to the ceiling. High efficiency tri-phospher lamps would be selected for their capacity to provide as near a full daylight spectrum as possible; dimmer switches and occupancy sensors would then be used with automatic controls to adjust lighting levels as needed.

Electrical Systems and Equipment

Efficient design strategies, power distribution systems, and electrical equipment can increase the building's energy efficiency and reduce energy consumption and associated costs.

Technical Strategies

1) **Cost comparison.** In large buildings, analyze and compare the costs of distributing power at different voltages, if services are available.

2) **Equipment specification.** Specify energy efficient office equipment, including computers, printers, and copy machines. Select equipment with the Energy Star label. For computers, consider liquid crystal display screens in lieu of conventional monitors.

3) **Distortion minimization.** Minimize the distortion effects of non-linear loads (personal computers, etc.) on the power distribution system by using harmonic filters.

4) **Power factor.** Improve the power factor by specifying appropriate equipment as required.

5) **Transformers.** Use K-Rated transformers to serve non-linear equipment.

6) **Efficient motors.** To reduce energy use, consider premium efficiency motors, controls, and variable frequency drives for motors greater than one horsepower.

7) **Direct current utilization.** Utilize direct current (DC) from the photovoltaic system, fuel cell, or other source in lieu of conversion to alternating current (AC). DC may be appropriate for certain applications such as discrete lighting circuits or computer equipment.

8) **Avoid electromagnetic pollution / exposure.** Locate high concentrations of electricity (such as panel boards, transformers, or motors) away from building occupants personnel. If necessary, install electromagnetic field (EMF) shielding.

9) **Videoconferencing.** Consider application of videoconferencing between agencies to eliminate energy / emission costs and productivity losses caused by transportation to and from meetings.

Energy Sources

Various energy sources are available today. Designers should first capitalize on conservation techniques, then work to achieve an appropriate, integrated balance of solar heating, daylighting, energy entrained within the earth 9geothermal energy), air movement, and other renewable resources. Only then should they resort to fossil fuel technologies, seeking efficiencies in this realm as well. This integrated approach to whole building design reduces the production of greenhouse gases, smog, and acid rain; preserves natural resources; and slows the depletion of fossil fuel reserves. Energy sources are listed in the preferred order of deployment, based on their capacity to reduce environmental impact from emissions.

Technical Strategies

1) **Renewable Energy Resources**

    a) Photovoltaic (PV) panels in place of exterior wall and roof panels (building-integrated PV) to generate electric power for the building.
    b) Daylighting techniques that supplement or replace electric lighting.
    c) Solar energy technologies for heating. Passive solar heating can work in portions of buildings such as lobbies, corridors, and atriums of large institutional buildings.

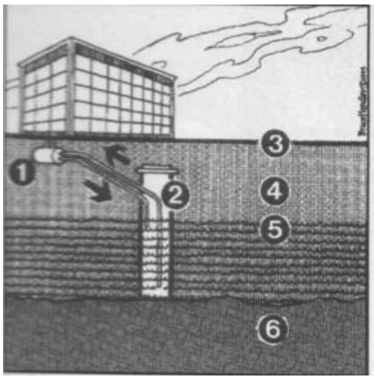
d) Solar hot water technologies can supplement domestic hot water heater reservoirs, especially in circumstances where large amounts of hot water are required (such as laundry facilities).

2) Super-Efficient and Hybrid Technologies

a) Geothermal heat pump technologies should be considered when subsurface conditions allow. Of available geothermal technologies, a vertical standing column well is generally most applicable to the urban context.
b) Fuel cells to provide electricity for off-the –grid sites and to support continuous base loads.
c) Heat recovery from mechanical systems and electric generation, including process heat, steam condensate, fuel cell waste heat, and exhaust air.

3) Conventional Fuel source Options

a) When available , electric utility company steam (generally a by-product of electric power generation), should be used for heating, cooling, hot water heating, steam driven pumps, and other applications as warranted.



Geothermal Heat Exchange Technology
The standing column well illustrated here is a geothermal heat exchange technology that is well-suited for use in developed urban areas since it draws heat from the earth in the winter months and deposits excess heat into the earth in the summer through vertical wells that can be located directly under or adjacent to a building.
1 Heat pump
2 6" diameter "standing column"
3 Ground level (surface)
4 Soil (depth varies)
5 Water table (depth and extent vary)
6 Bedrock (depth varies).
Illustration: Bruce Hendler

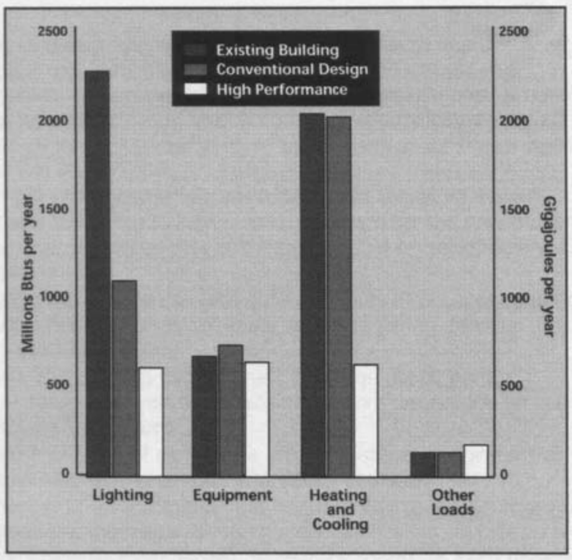
b) Dual fuel boilers can primarily be operated on natural gas to reduce air pollution, and can be switched to oil only when required.
c) During periods of high demand for electric power, gas powered equipment will provide an economical alternative to electric equipment. In specifying and locating these systems, designer should be aware of equipment noise levels.
d) Lighter grades of oil for oil burning equipment burn cleaner and produce less oil pollution.

4) Demand Reduction Strategies

a) Thermal storage systems work well in conjunction with conventional chiller systems to shift electric power consumption from periods where power is very expensive to periods where cost is lower.
b) Peak-shaving strategies rely on energy management systems, such as those that control ventilation fans by using carbon dioxide sensors. These sensors help ensure adequate ventilation and good indoor air quality while reducing peak loads.

5) Developing Technologies

a) Developing technologies include alternate energy sources such as methane from biological processes, micro-generators for on-site tri-generation, hydrogen and so on. These should be investigated based on building location and the



The Ridgehaven Building, San Diego
Breakdown of calculated energy loads for the Ridgehaven Building, showing 1) existing building, 2) conventional design, and 3) as built with high performance features, such as solar control films on glazing, energy efficient lighting, and high efficiency water-source heat pumps.
Source: City of San Diego

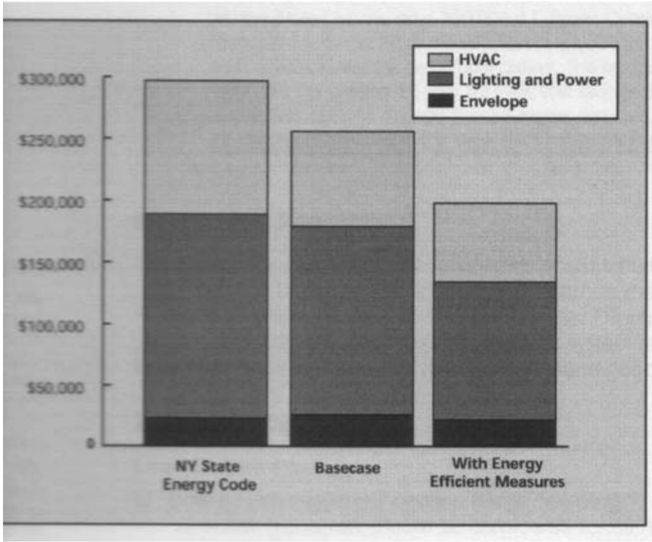
availability of the fuel source and technology.

Mechanical Systems

Mechanical systems must work in concert with the building layout, orientation, envelope, lighting strategies, electrical equipment, and site characteristics to reduce reliance on energy derived from fossil fuels, and to increase the use of renewable energy.

Technical Strategies

1) **Performance improvement.** In all design and construction efforts, strive to improve energy performance well beyond the basic requirements of the NYS Energy Code, applicable regulations, and consensus standards. Determine the overall environmental impact of building energy consumption. Energy performance analysis shall account for energy losses incurred during delivery from the point of generation to the point of use, as well as for the emissions generated by energy production (on and off-site).



New Children's Center, NYC Administration for Children's Services, Annual Energy Cost by End Use
At this new foster care/training facility, energy efficiency measures incorporated during design are estimated to achieve roughly 30% reduction in energy usage above NYS Code and 20% savings above a base case of good current professional practice.
Source: Steven Winter Associates

2) **Systems integration.** Consider the architectural features (orientation, exposure, height, neighboring structures, present and future landscaping, various options for the new building envelope, future interior lighting, and the occupancy of the building) when selecting HVAC alternatives and sizing the systems.

3) **Zoning.** Use separate HVAC systems to serve areas with different hours of occupancy, perimeter versus interior spaces, special occupancies such as computer rooms requiring 24-hour operation, spaces with different exposures, etc.

4) **Natural ventilation.** Determine if the building might benefit from the use of natural ventilation. For buildings in quiet zones and with clean outside air, consider natural (in lieu of mechanical) ventilation during swing seasons.

5) **Distribution systems.** Analyze the benefits of variable air volume systems vs. constant air systems; seek reductions in system load during periods of reduced demand.

6) **Gas heater / chiller.** Consider the use of a combination gas heater / chiller to reduce energy costs (and possibly) to reduce the equipment room size.

7) **Distributed mechanical rooms.** Consider independent mechanical rooms on each floor to reduce ductwork and enhance the balance of delivered air.

8) **Heat recovery systems.** Evaluate opportunities for heat recovery systems (sensible and latent).

9) **Partial load conditions.** Select high efficiency equipment that operates at high efficiencies under both full and partial load conditions.

10) **Modular boilers.** Consider installation of multiple modular boilers that allow more efficient partial-load system operation.

11) **Do not use CFC / HCFC refrigerants.**

12) **Condensing boilers.** Consider the use of high efficiency condensing boilers.

13) **Chiller sizing.** Evaluate various sizes and models of chillers to identify unit(s) that will most efficiently meet demand requirements.

14) **Ice storage.** Consider the application of an ice or water storage system as a means of avoiding peak loads for cooling.

15) **Emission controls.** Emission controls must comply with the latest federal regulations.

16) **Dessicant dehumidification.** Consider dessicant dehumidification as an alternative to the conventional practice of overcooling outside air to remove latent heat (moisture) prior to removal of sensible heat.

Energy Load Management

The management, continuous calibration, and maintenance of energy-related systems is often neglected, yet these are the only ways to optimize the life and performance of the systems and minimize the damage caused by fossil fuel use. Effective energy load management is a two-step process, consisting of load measurement and system response. Continuous calibration of sensors and instrumentation will yield top mechanical system performance in terms of energy use and comfort.

Technical Strategies

Load calibration

1) **Energy management system (large buildings).** An energy management system encompassing all building controls should be considered for all new buildings exceeding 40,000 sq. ft. For existing buildings of this size, an energy management system encompassing all building controls shall be provided when undertaking a complete renovation of the mechanical systems.

2) **Energy management system (small buildings).** An independent advanced control system or energy management system (as determined by economic analysis) should be considered for smaller buildings.

3) **Monitoring and controls.** Energy monitoring and control systems should provide:

   a) Energy consumption monitoring using hourly graphs to illustrate the effects of small operational changes and monthly graphs that depict historical trends and operating information over time.
   b) Controls (including load tracking and load anticipation capability) that optimize system response to building pick-up and download.
   c) Load shedding and peak electric demand reduction through scheduled equipment cycling or through use of non-electric powered equipment (for example, use of gas chillers).

d) Local controllers capable of independently managing equipment operation and gathering data for reporting. Carefully select the components of the mechanical / electrical systems being controlled for software compatibility. Ensure that all software required to operate the system is provided; ensure that software upgrades are received and loaded in a timely manner. Provide training materials and manufacturer maintenance contracts for all installed systems to operating personnel.

4) **Selection of control method components.** The control methods used to improve the efficiency of HVAC systems should include a building automation system, as appropriate. These systems are usually compatible with Windows – based workstations. Subsystem integration should be accomplished using a BACnet open protocol to ensure compatibility with different components and subsystems.

5) **Systems integration.** Assess the interactions between the HVAC equipment and other related systems, such as lighting, office equipment, fire protection, security, etc. Determine optimum operating modes for each system.

6) **Computerized control system.** Use a computerized control system to establish, maintain, and document building climate conditions. Accept only control systems with the capability to adjust set points, without the need for complete reprogramming. Control systems should be designed or specified to a level of complexity that's appropriate for the staff who will be supporting it's use.

7) **Control back-up systems.** Provide simple back-up controls so that equipment can function if the energy management system goes down. Depending on the complexity of the building and the equipment to be controlled, include the following control strategies in the energy management system as a means of ensuring efficient operation:

System Response

1) **Heating equipment.** When reviewing options for boilers, consider the following:

a) For larger boilers, oxygen trim controls to improve combustion efficiency.
b) Draft control inducers that reduce off-cycle losses.
c) Demand control for larger boilers, based on variations in heating demand.
d) Water reset control keyed to outside air temperature.
e) Burner flame control.
f) For small renovation projects, provide a time clock for night and weekend setbacks.

2) **Air conditioners, chillers and ventilation controls.** The following strategies will help get the most out of these key systems:

a) Generate energy consumption profiles that identify occurrences of peak loads and develop responsive management strategies for reducing utility bills.
b) Set up the HVAC building control system to operate based on need. If multiple sources are available, minimize simultaneous heating and cooling, and supply thermal conditioning from the most appropriate / efficient sources.
c) Limit electrical demand during peak hours by turning off non-essential equipment.
d) Establish temperature and humidity setpoints based on occupancy patterns, scheduling, and outside climate and seasonal conditions.
e) Consider carbon dioxide / volatile organic compound sensors to reduce outside air ventilation in large spaces with variable occupancy. Verify that specified settings are consistent with local and national code requirements.
f) Provide sensors that are capable of adjusting the ventilation rate based on the number of people present in a room. Locate sensors accordingly.
g) Provide adaptive, programmable thermostats capable of automatically adjusting settings based on recorded demand patterns. This prevents 'overshooting' or 'undershooting', and can result in energy savings of 10-20%.

h) Set supply air-temperature reset controls for variable air volume (VAV) systems based on space occupancy.
i) Control strategies for chilled water plant operation include:
   i) Chiller speed control through variable speed drive controllers, selection of modular chillers or chillers with multiple compressors, and chilled water reset.
   ii) Condenser water reset.
   iii) Chiller sequencing.
   iv) Soft-starting of chiller motor.
   v) Demand control.
   vi) Use of two-speed motors or multiple units for pumps / fans.
   vii) Use of variable speed controllers for fans and pump motors.
j) For small buildings, use time clocks with night and weekend set-backs for HVAC equipment.

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HOPES, Help Organization for People, Environment and Society.

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For more information, visit www.healthybuilding.net and www.noharm.org

This note on "Green Building Strategies: Building Energy Use" has been adapted from the High Performance Building Guidelines, City of New York, Department of Design and Construction, April 1999.

Green Design Strategies: Indoor Environment

High performance buildings reflect a concern for the total quality of the indoor environment. By definition, they provide supportive ambient conditions, including thermal comfort and acceptable indoor air quality, visual comfort, and appropriate acoustical quality.

Air temperature, mean radiant temperature, air speed, and humidity are all factors that affect thermal comfort. Dissatisfaction with thermal conditions is the most common source of complaints in most buildings. Small changes (in the order of 1-2 degrees Fahrenheit) in air temperature may significantly affect thermal comfort.

Acceptable indoor air quality was defined in a draft revision to The American society of heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) 62-1989 as *" air in an occupied space toward which a substantial majority of occupants express no dissatisfaction and in which there are not likely to be known contaminants at concentrations leading to exposures that pose a significant health risk."*

Visual comfort is a function of many variables, including lighting quality (e.g., illuminance or intensity of light impinges on a surface, the amount of glare, and the spectrum of the light), visual contact with the exterior, and availability of natural lighting.

Acoustical quality is obtained through appropriate noise attenuation through the building envelope, control of equipment noise, and efforts to block flanking sound paths through fixed walls and floors, and to isolate plumbing noise.

Increased attention to these environmental features can boost quality of life in the workplace by improving overall physiological and psychological wee-being. By making the project team accountable for improving building interiors, the client can achieve better human resource outcomes: avoidance of sick building syndrome, reduced occupant complaints, lower rates of absenteeism, improved occupant health, and potentially improved occupant performance.

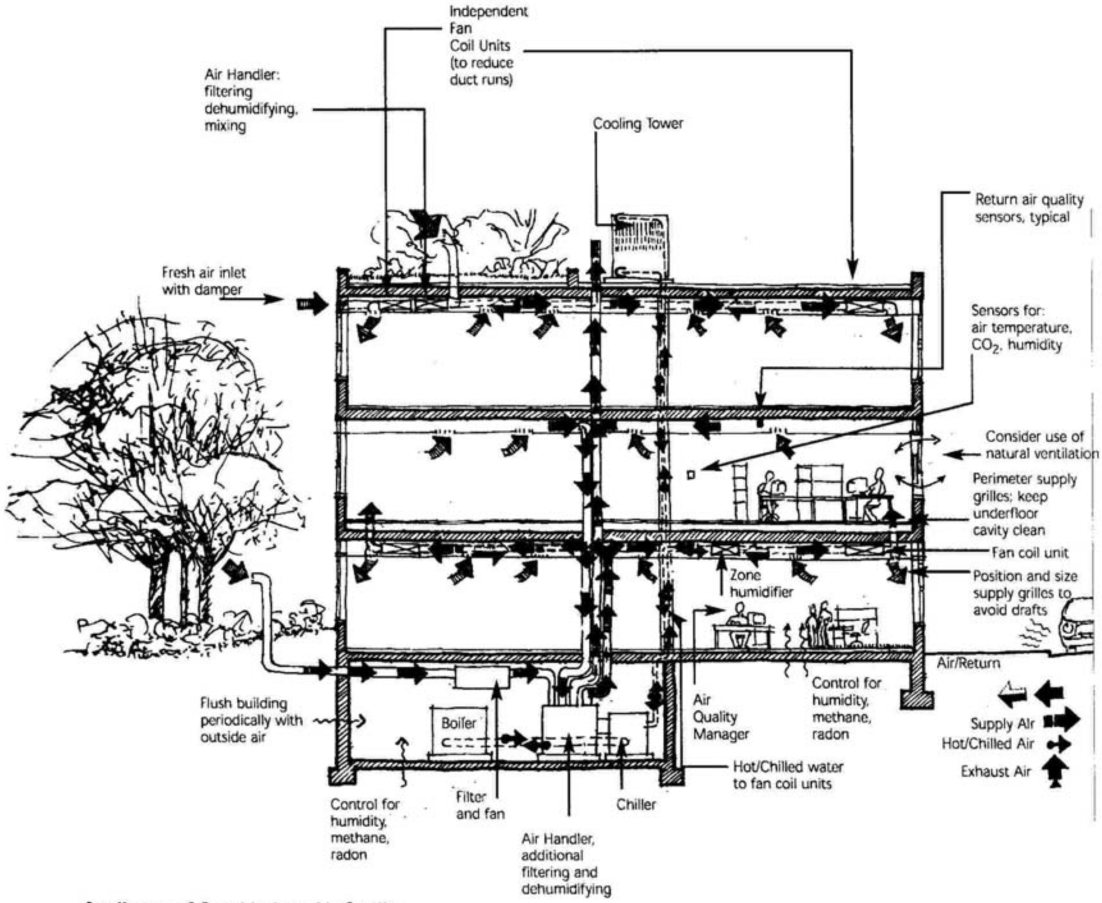
Indoor Air Quality

Good indoor air quality encompasses such factors as maintenance of acceptable temperature and relative humidity, control of airborne contaminants, and distribution of adequate ventilation air. It requires deliberate care on the part of the entire project team. Achieving thermal comfort begins with good design and continues with proper building management, and seeks to avoid uneven dryness, or high relative humidity (that can promote growth and mildew). Through careful selection of materials, designers will avoid introducing potential pollution sources. Mechanical engineers and allied tradespeople must select and install reliable ventilation systems that dilute the by-products of occupant activities and, to the greatest extent possible, supply fresh air on demand in the right quantities, in the right locations. During construction, air passageways need to be protected and mechanical systems must be balanced and commissioned to achieve optimal operation. Facility managers and maintenance staff also play a role in keeping areas clean while minimizing the use of irritating cleaning and maintenance supplies.

Even if all objectives are met, attaining an indoor air quality that's acceptable to all may be difficult to achieve, owing to the diversity of sources and contaminants in indoor air, as well as occupant perceptions and individual susceptibility.

Good Indoor Air Quality (IAQ)

A healthy and comfortable level of indoor air quality is the goal for all occupied spaces, as good IAQ supports and enhances the activities and well-being of the occupants.



Attributes of Good Indoor Air Quality
Illustration: Johannes Knesl

Technical Strategies

Dealing with air quality as an add-on issue during design or construction is difficult, expensive and less effective than including good indoor air quality strategies at he outset. These fall into several categories and are prioritized as follows:

1) Source control *(a primary strategy)*

a) Evaluate sources of contamination from neighboring buildings and soil contamination, such as radon, methane, and excessive dampness. Incorporate measures to prevent soil gas from being drawn into the building. Waterproof the slab-on-grade to limit moisture transport.
b) Locate and design air intakes to optimize air supply source(s) for the ventilation system. Isolate building air intakes from building exhaust air, vehicular exhaust, cooling tower spray, combustion gases, sanitary vents, trash storage, and other hazardous air contaminants.
c) Reduce potential pollution sources through effective moisture control.
d) Specify materials with low volatile organic compounds (VOCs) and low odor emissions.
e) To avoid occupant exposure to airborne pollutants, perform cleaning and pest control activities when the building is largely unoccupied.

2) Ventilation *(a secondary strategy)*

a) Develop ventilation strategies that support operable windows, where appropriate to the site and function.

b) To avoid stagnant air in occupied spaces, design for at least 0.8 – 1.0 c.f.m. / square foot air movement.
c) Isolate potential pollution sources through separate zoning of areas where contaminants are generated.
d) Design mechanical systems that can provide and maintain the required ventilation rate. Design ventilation system for high air change effectiveness; avoid short-circuiting supply air to return registers.
e) Specify ventilation systems that feature an economizer cycle. This will allow m100% of outdoor air into the supply airstream and enables periodic building flushing, as well as cooling during mild weather. Design and control HVAC economizers so as to prevent moisture problems.
f) Consider supplying ventilation air primarily to occupied zones using distribution systems such as underfloor ducting. The resulting floor-to-ceiling indoor airflow pattern (also known as displacement ventilation) can be used to reduce pollutant concentrations in occupied spaces.
g) Avoid rooftop units because of inaccessibility for maintenance. (Such placement may preclude use of rooftop space for other purposes.) Wherever possible, install air handling units in accessible locations.
h) Use rainwater louvers and limit intake velocities to discourage water intrusion.
i) To prevent wetting downstream surfaces, select proper air velocities through cooling coils and humidifiers.
j) Provide filtration capable of 60% (or greater) dust spot efficiency installed to intercept all make-up and return air. If the outdoor air has high dust levels, use higher efficiency air filters (80-85% ASHRAE standard efficiency with 30% efficiency pre-filters.)
k) Consider use of low pressure drop, high efficiency air filters.
l) Avoid the use of fibrous duct liners and loose mineral fiber for internal ductwork insulation. These products have high potential for dirt accumulation and dampness leading to mold growth, and may be prone to fiber release into conditioned spaces. Use non-porous duct liners, external thermal insulation, or acoustical baffles in lieu of linings in strategic locations.
m) Prevent condensation of water vapor inside the building envelope by proper use of moisture barriers, appropriate locations and amounts of thermal insulation, control of indoor-to-outdoor pressure differences, and control of indoor humidity.
n) Commission the ventilation system to assure that design conditions are met, proper air delivery occurs in each zone and optimum performance is achieved under full and partial load conditions.
o) Isolate potential pollution sources through use of appropriate filtration systems and separate zoning of areas generating contaminants.
p) Vent kitchens, toilet rooms, smoking lounges, custodial closets, cleaning chemical storage and mixing areas, and dedicated copying areas to the outdoors, with no re-circulation through the HVAC system.
q) Avoid use of ozone-generating devices to clean or purify indoor air.

3) Control Systems

a) Sensors for relative humidity, temperature, and carbon dioxide should be installed as close as possible to where occupants are located.
b) Locate sensors to cover areas of similar load conditions 9similar occupancy and similar solar exposures).
c) When demand control ventilation (DVC) systems are used, ensure that carbon dioxide sensors are operating in a reliable manner. This is achieved through routine calibration.
d) Periodically audit all computer-controlled HVAC systems (e.g. direct digital control systems with graphic interfaces) to verify performance and calibration.
e) Consider personal workstation control of HVAC systems. However, personal controls may result in greater maintenance requirements for dispersed HVAC equipment and controls; such equipment should thus be designed to be accessible for preventive maintenance.
f) Specify controls on variable air volume (VAV) systems to ensure that the amount of outdoor air delivered to the occupants is maintained, even when the total air supply is decreased.
g) In VAV systems, special controls may be needed to ensure that minimum outside air intake into the air-handling unit is achieved during all operating conditions.

h) In VAV systems, at minimum, install temperature sensors in return air sections of air handling units to maintain air temperature at acceptable levels.

4) Construction Methods/Precautions

a) Prevent storage of soft products on site during wet processes, unless separated and sealed; e.g., ‘shrink-wrapped.’
b) Schedule installation of wet materials (sealants, caulking, adhesives) and allow them to dry or cure before installing dry materials that could serve as ‘sinks’, and absorbents of VOC’s.
c) Ensure that construction materials such as concrete are dry before they are covered (e.g., with floor tile or carpeting) or enclosed in wall cavities.
d) Ensure that the contractor uses metal ductwork instead of substituting fiberglass.
e) Control fiber or particle release during installation of insulation and require general area cleanup prior to building occupancy.
f) Flush the building with 100% outside air for a period of not less than 30 days beginning as soon as systems are operable and continuing throughout the installation of furniture, fittings, and equipment. A delay in building occupancy can significantly reduce odor and irritancy complaints.

5) Occupant Activity Control

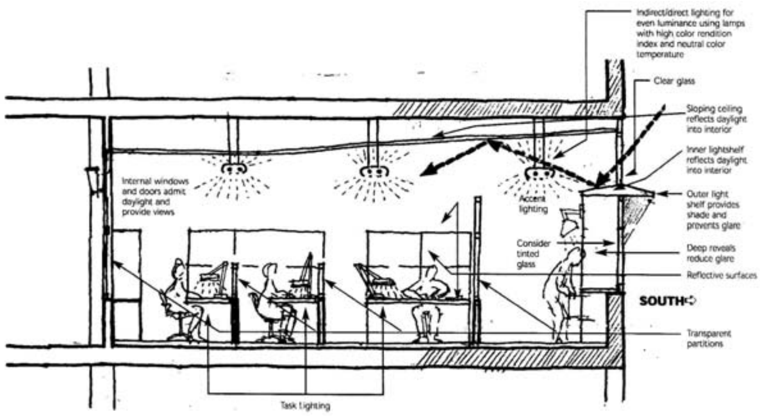
a) Maintain a ‘no smoking’ policy.
b) Designate an Indoor air quality manager who receives ongoing IAQ training.

6) Emerging Technologies

a) The technology surrounding ion generators may be of interest to the building owner in specific situations; however, the evidence is not sufficiently conclusive to support a recommendation for the use of these devices at this time. Any such device should not generate ozone above the FDA limit of 50 ppb in any occupied space.

Good Visual Quality

The daily rhythm of natural light sets our biological clock. Its seasonal rhythm influences our mood, and its presence is necessary for a number of health-sustaining biological processes. Since most of us spend more than 90% of our time indoors, buildings should provide as much daylighting to as many occupants as possible. Daylighting, controlled by building openings, glazing types, and the configuration of reflecting surfaces, offers a rich spectrum that improves visual acuity. Its dynamic changes over the day provide visual stimulation, and keep us connected with the outside world. Electrical lighting systems should complement natural light.



Elements of Good Visual Quality

Light Sources

Achieve a quality of light that is beneficial to building activities and occupants by combining natural light with complementary electrical light sources.

"if one word could summarize the approach used on Audobon House, it would be ***optimization.*** *If one word could summarize the lost opportunities in how we typically build, it would be* ***compliance****."*

Randolph R. Croxton

FAIA, Audobon House

Audobon House
In the Audobon House building in New York City, daylighting has been incorporated through skylights and borrowed light accessed through openings in the walls of perimeter offices. In addition, the floor layout enables daylighting and views through windows at the ends of corridors and at strategic locations in the circulation system. The south-facing open work areas are equipped with automatic dimmer controls that regulate electrical lighting in response to available daylight. Room surfaces have been chosen for reflectance of indirect light sources to maximize the efficiency of the daylighting and electrical light balance.

Technical Strategies

1) **Daylighting apertures.** Maximize daylighting through appropriate location and sizing of windows, roof monitors, and skylights, and through use of glazing systems and shading devices appropriate to orientation and space use.

2) **Light shelves, surface reflectance.** Extend window light throw through the use of light shelves, prismatic glazing, or louvers, and through appropriate room surface reflectance and colors.

3) **Light distribution.** Where appropriate, encourage use of relatively low general lighting levels and of predominantly reflected light, mainly from the ceiling. This will bring about a light distribution closer in character to daylight and make for a softer visual environment with less potential glare. These conditions are conducive to working on computer screens and allow the individual characteristics of furnishings to come to the fore.

4) **Avoiding glare.** Avoid arrangements of light sources and reflecting surfaces that cause direct or indirect glare (excessive brightness contrasts) and veiling reflections of light sources in visual task areas. Means include use of indirect luminaires or cut-off fixtures; the designer will also want to avoid overlighting of spaces. Use of deep window recesses, low partitions, and strategically located high-reflectance surfaces will also help avoid excessive contrasts and overly dark zones.

5) **Light levels.** Achieve a good balance between uniform light levels and localized variations to create a dynamic and comfortable visual environment. Consider:

   a) Low-level ambient lighting augmented by high quality, flexible task lighting.
   b) Varied lighting schemes that respond to general building organization and special features.
   c) Allowing the lighting patterns to reflect changing activity scenarios during the working day.

6) **Luminaire arrangements.** Arrange luminaires in types and patterns that clearly respond to the fundamental building organization, floor layout, and entry paths of daylight while allowing for flexibility of space usage. Wherever practicable, wire luminaires in parallel to the walls with windows, so they can be dimmed or turned off row by row.

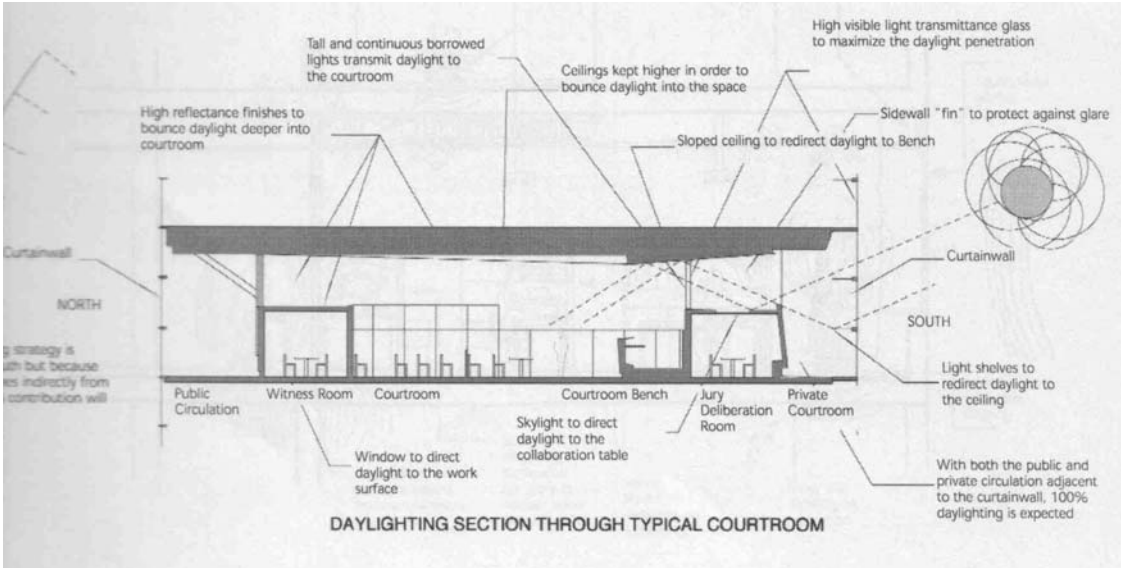
7) **Diffusers.** Select diffusers that reduce glare and sufficiently illuminate ceilings and walls to create a visual field similar to prevailing daylight conditions.

8) **Color.** Provide lamps with high color rendering index, such as tri-phosphor fluorescent lamps. Lamps in the warm-white to neutral-white color temperature range effectively complement skin tones.

9) **Ballasts.** Use high frequency electronic ballasts to minimize flicker as lamps and ballasts wear.

10) **Views.** Design a building organization and floor layout that gives each occupant adequate visual access to the outdoors and to the general organization of the building.

11) **Window cleaning.** Schedule regular window cleaning to maximize the amount of daylight entering, particularly where windows are close to sources of air-borne dust, fumes, or gases that reduce the transmission of light.

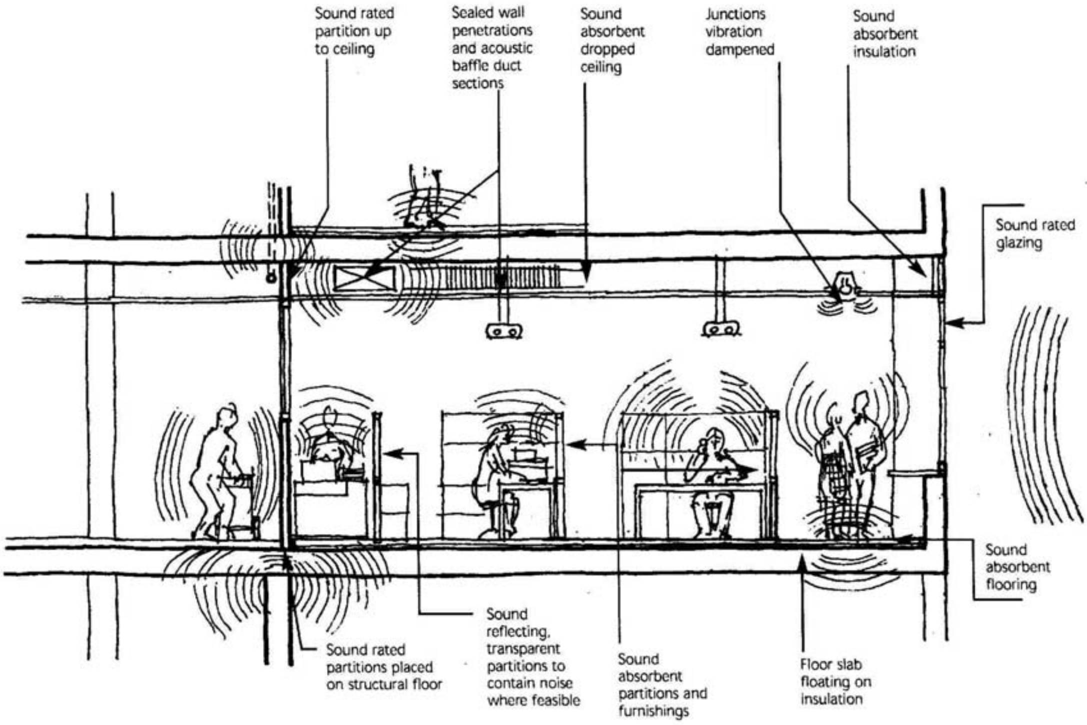


DAYLIGHTING SECTION THROUGH TYPICAL COURTROOM

Acoustic Quality

A good acoustic environment keeps noise at levels that do not interfere with activities within programmed space. The primary acoustical and speech therapy requirements in offices include the ability to speak without having conversations overheard by co-workers, and freedom from distractions caused by nearby conversations or other intruding noises. Architecturally, there are three aspects to consider: sound isolation, building services noise and vibration control, and room acoustics. Sound and vibration isolation requirements for a given space will depend on desired ambient noise levels, the extent that external sources (e.g. normal traffic, fire/ambulance/police, car alarms, air traffic) impinge upon the space, and the level of noise and vibration from nearby sources and activities. Building services that may contribute excessive noise and vibrations include HVAC systems (air handling units, variable air volume and fan-powered terminal units, boilers, pumps, pipes, valves, restrooms, laundries, and other uses) and electrical systems (dimmers, lighting fixtures, transformers, and generators).

Noise abatement begins with avoiding noise-generating factors, containing inevitable noise at the source, and locating sensitive spaces away from known noise sources. Sound-attenuating barriers and absorptive room surfaces must control noise transmission through the building structure and within rooms. To achieve positive acoustical quality in a room, spatial configuration and materials must be designed for appropriate resonance patterns. In overly quiet rooms, white noise can be used to mask private conversation.



Noise Control

Create a sound environment that is healthful, comfortable, and appropriate to intended use by controlling noise and carefully attending to the acoustic design of space.

Technical Strategies

1) Control Noise at the Source

a) Site, orient, and lay out the building such that external noise sources can be attenuated by distance or by topographical features or walls.
b) Select mechanical and plumbing devices, ductwork, and piping that generates less noise and dampens the noise generated.
c) Locate noisy mechanical equipment, office equipment, and functions away from noise sensitive uses. Avoid locating mechanical equipment above or adjacent to noise sensitive spaces.
d) Prevent noise transmission by absorbing noise and vibrations at the source. Consider placing vibrating equipment on isolation pads, and enclosing equipment in sound-absorbing walls, floors and ceilings.

2) Attenuate Noise Along the Path of Transmission

a) Place acoustic buffers, such as corridors, lobbies, stairwells, electrical/janitorial closets, and storage rooms, between noise producing and noise sensitive spaces. This will alleviate the need for more complex acoustic separation solutions.
b) Prevent transmission of sound through the building structure through use of floating floor slabs and sound-insulated penetrations of walls, floors and ceilings.
c) Prevent transmission between exterior and interior by ensuring appropriate fabrication and assembly of walls, windows, roofs, ground floor and foundations.

d) Prevent transmission between rooms by wall, floor and ceiling assemblies by specifying materials with appropriate sound transmission class ratings. Consider using set-off studs with sound-attenuating insulation, floating floor slabs, and sound-absorbent ceiling systems.
e) Situate mechanical room doors across from non-critical building areas. Consider the use of sound-rated acoustic doors and acoustic seals around these doors.
f) Avoid locating outside air intake or exhaust air discharge openings near windows, doors, or vents where noise can re-enter the building.
g) Consider wrapping of enclosing rectangular ducts with sound isolation materials.
h) Consider the use of sound attenuators (‘duct silencers’ or ‘sound traps’) and acoustic plenums to reduce noise in ductwork.

3) Noise Control in the Space Itself

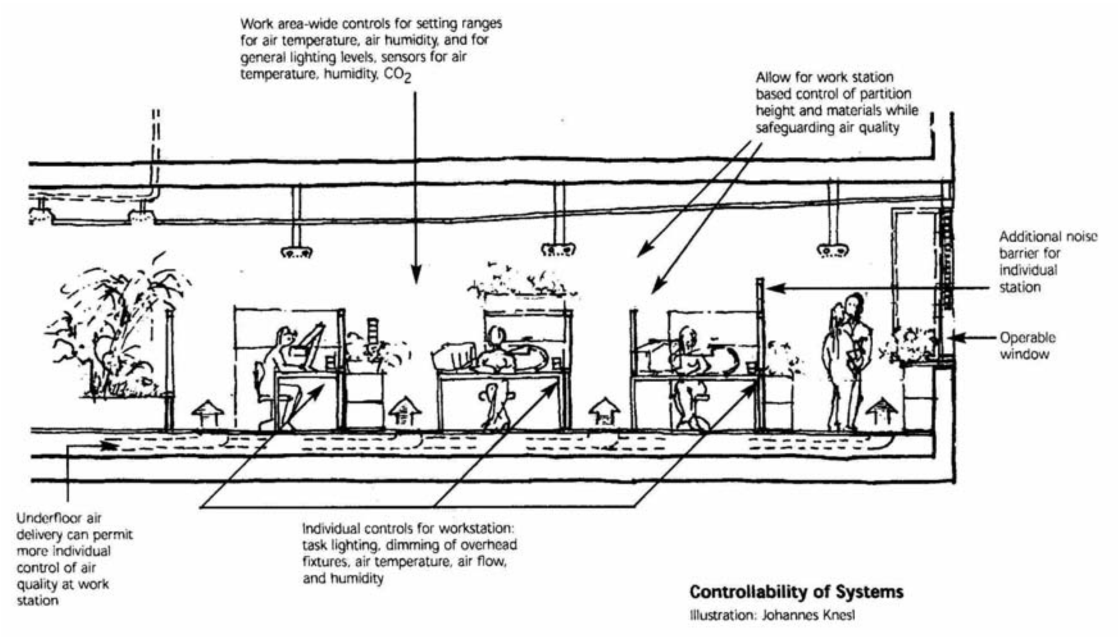
a) Absorb or block excessive background noise or interfering single-source sounds in open office environments through use of resilient flooring (carpeting and tiles), ceiling (suspended ceiling tiles, absorbent ceiling geometry); and sound absorbing or reflecting partitions and furniture (chairs, desks, and shelves).
b) If appropriate conversational privacy cannot be achieved, consider using white noise.
c) In an open plan office space, offset workstations so that co-workers are not in direct line of sight and sound. Maximize distances between workstations and general office equipment. To promote sound isolation and reduce sound reflection, install partial-height freestanding walls between workstations or work groups. The walls should feature solid core construction and sound absorbing panels on both sides.
d) Achieve favorable room acoustics by configuring room geometry, positioning furnishings and furniture, and specifying appropriate surfaces. With these tools, achieve a level of room resonance quality that supports the programmed uses, such as face-to-face communication, conference or audio-visual presentation.

Controllability of Systems

To achieve a healthy and comfortable environment, it is critical to ensure that user groups and facility maintenance staff can knowledgeably operate the building systems and equipment. As much control as possible should be given to individual users, without compromising the effectiveness and efficient control of the overall system.

Technical Strategies

1) **Simplification.** Provide building users and maintenance staff with a level of control over automated building systems that is appropriate to their level of technical expertise.
2) **Personal control.** Build in a capacity for personal control over the immediate indoor environment. Assure that the global indoor environment is within acceptable limits by bringing air supply points and controls for air quality as close to individual workstations as possible. Balance control system advantages against energy use and maintainability. The objective is to enable users to control the lighting level and distribution in their area using task and accent lighting, dimmer switches, and daylighting controls such as individually operable blinds.



Controllability of Systems
Illustration: Johannes Knesl

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Alternative Building Forms & Massing: Pro's & Con's – Horizontal or Vertical

Lecture Series 2004

In the First World countries of the West, the trend in the recent past has been to steadily move away from hospitals organized primarily around vertical circulation systems. This trend has been most marked in the UK, where the Nightingale-inspired horizontal pavilion hospital never died out, as it did in many other countries.

Wexham Park Hospital at Slough, designed by Powell and Moya (with John Weeks) in the late 1950's, was a seminal building. It's village form led in one direction to Week's Northwick Park Hospital (already discussed in a previous design tip), and, in the other, by the development of it's wide span structural design, to the Greenwich Hospital (also discussed previously).

This eventually led to the development of the Nucleus hospitals by the NHS in the UK, which are mainly of two or three-storey construction, comprising standard departments on either side of a hospital street, a zone combining main circulation and services distribution.

Developments in some other countries have been influenced by British ideas – for example, that of Greenwich on the USA Veterans Administration system, and particularly its prototypical hospital at Loma Linda in California. The same logic that drove the British sequence of developments has been evident in other countries.

The inherent problems of vertical organization, and particularly of a tower block of wards, is that of a limited envelope with no means of lateral expansion. The considerable portion of each floor taken up by lifts, stairs and service shafts, is not only inherently wasteful and expensive, it also makes the plan form more rigid, and inhibits subsequent alteration. Growth of a vertically organized hospital tends to take the form of clusters of smaller blocks at its base, with increasingly difficult service and circulation routes.

Tall buildings are more likely to need expensive climate control, to consume more energy, and have greater problems of evacuation in cases of fire than have lower ones, in which horizontal evacuation is through successive protected zones further away from the source of the fire.

The advantage frequently claimed for tall hospitals is that they occupy less land. This is only valid for inner urban hospitals, such as the (moderately) tall Chelsea and Westminster Hospital, London, where the floor area is similar at all levels. The commonest type of tall hospital, especially in the USA, is the "tower on podium" form, popularized by Gordon Friesen with his mineworkers hospitals, and based on a production engineering principle of supplies fed the wards from a basement service center. The podium of these hospitals usually spreads to occupy a site similar to those of compact low-rise hospitals. The flexibility limitations of such hospitals become more evident as the proportion of the total built volume comprising wards is tending to diminish.

The tower and podium form is common in other building types, notably – and for similar reasons – hotels. Lever House in New York had a great influence, and not only on other office buildings. Although the earliest Friesen hospitals pre-date Lever House, the prevalence of hospitals of this form in the USA from the 1950's onwards may be partly attributable to a much admired "classic" of modern architecture.

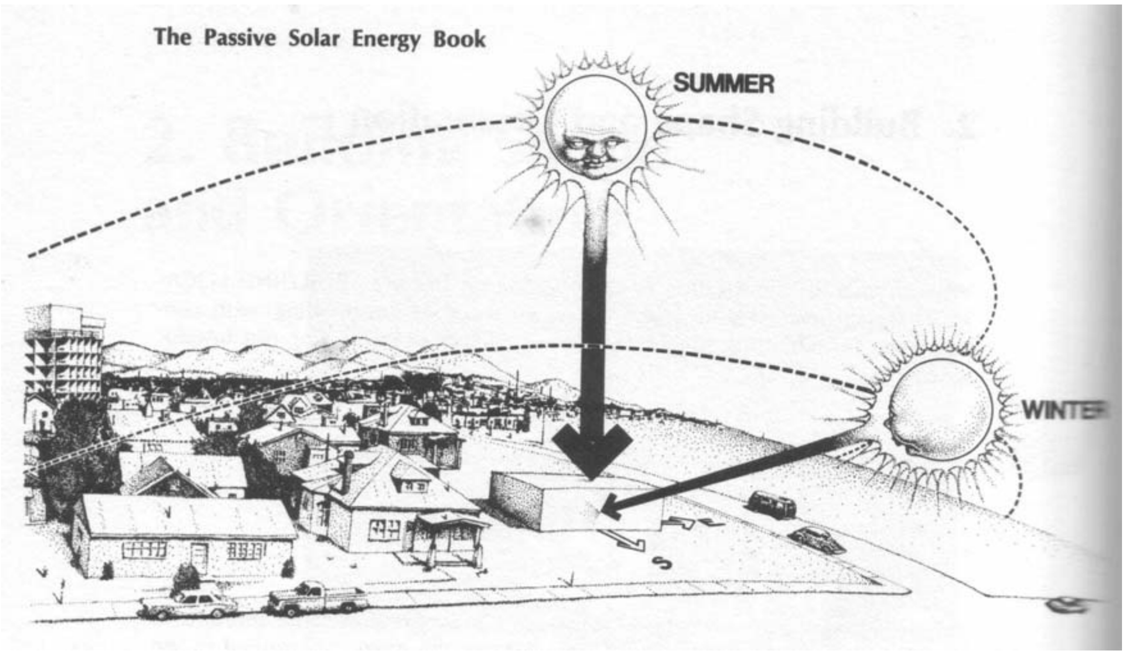
It is arguable, however, that hospitals, with their functional complexity and unknown ultimate form, are more suitable for the alternate organic stream of modern architecture, typified by Wright, Aalto and Scharoun, than for the purist geometry typical of Mies and his followers. It may be significant that Aalto's Paimio sanatorium is the only hospital among the undisputed masterpieces of modern architecture.

Many times, the building form and massing could largely be determined by the climate of the location of the proposed hospital, that is, the designer's response to these characteristics of the site. The amount of care taken in placing and orienting a building on the site with respect to open spaces and the sun is perhaps the single most important decision you will make regarding the building with respect to its response to the climate.

With an idea for the location of the building on the site, it is necessary to determine the rough shape of the building before laying out interior spaces. Buildings shaped without regard for the sun's impact require large amounts of energy to heat and cool. Large amounts of energy are used to heat and cool buildings all over the world. In spite of worldwide dwindling energy resources, many buildings today are still shaped without regard for the sun's impact on, and potential contribution to, space heating and cooling.

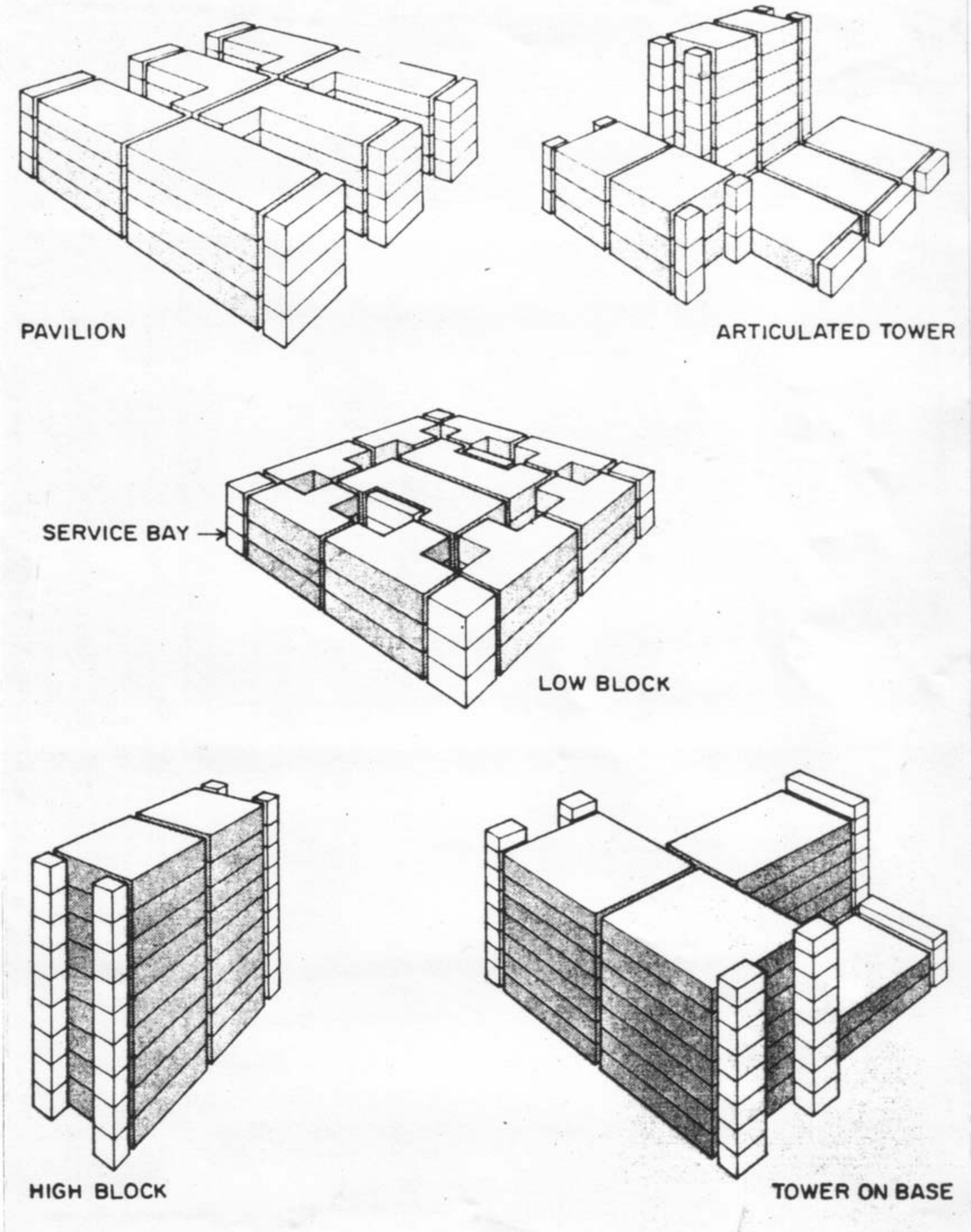
This is an approach to architecture made necessary and timely in an era of rapacious energy consumption. We need more than ever before to follow a way of building that is strongly related to site, climate, local building materials and the sun. It implies a special relationship to natural processes that offers the potential for an inexhaustible supply of vital energy. Much vernacular architecture has always reflected a strong relationship to daily and seasonal climatic and solar variations.

Nowadays the architect's approach to problem solving has been characterized by an emphasis on technology to the exclusion of other values. In the built environment this concern manifests itself in the materials we build with, such as plastics and synthetics. Especially in healthcare facility design, there is great dependence on the mechanical control of the indoor environment rather than the exploitation of climatic and other natural processes to satisfy our comfort requirements. In a sense, we have become prisoners of complicated mechanical systems, since windows must be inoperable and sealed in order for these systems to work. A minor power or equipment failure can make these buildings uninhabitable. Little attention is paid to the unique character and variation of local climate and building materials. One can now see essentially the same type of building coast to coast.



Orientation of the building with respect to the movement of the sun

Shown below are various configurations of hospital built form:



Various types of hospital configurations.
Source : Hospitals and Health Care Facilities by Redstone.