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Module for

Integrated design I; Architecture

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Prepared by: Integrated design team

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Section 1, introductory information

General Remark

Integrated design is a comprehensive holistic approach to design which brings together specialisms usually considered separately. It attempts to take into consideration all the factors and modulations necessary to a decision making process.

Design can also be the arrangement of elements and how they perform together. The process of bringing two or more parts together is integration. So when we talk about design integration we are focusing on this aspect, how the different parts come together to serve the design.

is a method for realizing high performance buildings that contribute to sustainable communities. It is a collaborative process that: focuses on the design, construction, operation and occupancy of a building over its complete life-cycle.

Using an integrated approach helps avoid the potential struggles that can occur when design disciplines are combined. Bringing architects and engineers together on day one generates meaningful improvements to the design process and helps maximize efficiency downstream in during construction.

Course Objectives & Competences to be acquired

- Understanding of the integration of architectural design, urban design and landscape design understanding of the social and urbanistic dimension of architecture, knowledge of the interdependence of architecture and urbanism
- understanding of the environmental and landscape elements of architecture
- Ability to design a building in an urban scale with a dimension of environmental and landscape focus

Understanding the Integrated Design Process (IDP)

- IDP can be defined as an interdisciplinary design approach with the emphasis on collaboration. All the stakeholders involved in the project met during the design of the plans and specifications to develop optimum solutions for each discipline. This is a comprehensive process that concentrates as much on design, construction and operation as on the occupancy of the building.
- The objective of this operating mode is to optimize the interaction among the various disciplines and not only each discipline's systems. It enables the client and other stakeholders together to develop and achieve the environmental and economic objectives of a project.

Comparison between IDP and the conventional design process

- IDP is distinguished from the traditional design process by its focus on collaboration and its iterative mode. This approach of active participation by all project stakeholders leads to the consensual search for optimum, innovative, sustainable solutions, considering the building's entire life cycle.
- Although there are different ways of putting IDP into practice, a consensus remains on what makes it different from the classic design process. The table below highlights these differences.

Integrated Design Process	Conventional Design Process
Inclusion of all stakeholders from the beginning	Involves only the members of the expanded team when necessary
Time and energy invested quickly and massively at the beginning of the project	Less time, energy and collaboration in the first steps

Decision-making influenced by a large team	Majority of decisions made by a limited number of stakeholders
Iterative process	Linear process
Comprehensive and systematic thinking	Systems often isolated (silos)
Geared to complete optimization	Optimization dictated by the constraints
Increased search for synergies	Reduced search for synergies
Analysis of costs over the life cycle	Emphasis on the initial costs
Ongoing process after occupancy	Ends with delivery of construction

What are the main principles of integrated design process?

- A great collaboration. ...
- Effective and open communication. ...
- A well-defined scope, vision and objectives. ...
- Innovation and synthesis. ...
- Systematic decision-making. ...
- An iterative process with feedback loop...

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IDP principles

The Integrated Design Process is a philosophy as much as it is a process. The mentality behind IDP is just as important as the methodology leading to its success. Although for some the notion of mentality, or state of mind, may seem vague, it is concretized by a set of principles that underlie a successful integrated design.

A great collaboration

The most important principle for a successful IDP is probably related to the inclusive approach, which translates into the deployment of a large collaborative team. Ideally, the project team includes all the relevant disciplines, which remain involved from beginning to end. A large interdisciplinary team is essential to ensure that all the relevant knowledge and resources are involved.

Effective and open communication

Effective and continuous lines of communication are essential throughout the process. Transparent methods of communication serve to build a relationship of trust and give the participants a greater sense of appropriation of the process and **conflict reduction**. The key decisions should not be made without the team's contribution.

A well-defined scope, vision and objectives

A clear statement of the vision and objectives makes it possible to initiate a results-based approach. To define the results, it is necessary to ask questions together about the scope of the project and the needs it meets. By developing a shared vision of what must be accomplished, the team participates actively and collectively in the achievement of the objectives.

Innovation and synthesis

By favoring open-mindedness and creativity, IDP encourages achievement of the level of innovation and synthesis necessary to meet the complex requirements of high-performance buildings.

Systematic decision-making

A desire for rigor and attention to detail leads to a clear and well-understood definition of the decision-making process. There are many tools that facilitate efficient decision-making and that combine perfectly with IDP. We are thinking about modelling programs (e.g. BIM) and green building certification systems (e.g. LEED).

An iterative process with feedback loops

An iterative process guarantees that the decisions reflect the team's collective knowledge. The interactions among the different fields of expertise are taken into account and the solutions go through the steps necessary for optimization. Regular feedback loops serve to maintain the team's commitment and produce repeated small successes, thus reinforcing the efficiency of the process.

The facilitator: a key member to implement an Integrated Design Process

In an IDP, the project team, in addition to the client (project owner), the project manager, the architect and different experts, must also include a facilitator.

The facilitator manages the Integrated Design Process and ideally has the following characteristics:

- He/she is the guardian of the goals and objectives set during the workshops and updates them throughout the process.
- He/she is skilled in the art of facilitation and group dynamics.
- He/she knows the principles of sustainable development.
- He/she ensures the participation of all the team members and experts assembled.
- He/she ensures a good flow of information during the meetings.
- He/she may be responsible for deadline compliance for specific events, or for the project as a whole.
- He/she has a good level of knowledge both of the Integrated Design Process and green building certification (if necessary).

To summarize, having a facilitator to manage the process allows the team members to concentrate on the tasks and objectives, while favoring teamwork and collaboration.

Conclusion

Following the commitment of different government authorities to this mode of operation, it seems that IDP will be applied to a growing number of projects in the field of industrial, commercial and institutional buildings. The principles of collaboration, pooling of expertise and preparation upstream from the project should allow delivery of projects with increasingly strong performance in a context of limited resources, relying on innovation and accounting for the life cycle. To achieve this, the project teams must be well supported, however.

Section 2, Engage in the Integrated Design Process

The broad obligations and opportunities of architecture were summarized by the ancient Roman architect Vitruvius in the prescription that buildings should provide Commodity, Firmness and Delight. Commodity addresses the spatial and functional utility of a building. Firmness addresses the building's ability to resist [natural forces](#), starting with gravity. Delight relates to the sensory and associative pleasures buildings can provide their meaning.

When the forms of architecture were limited by materials and construction methods, aesthetic principles were narrowly defined by the successors to Vitruvius. In the modern era, many more forms are possible, and the selection or invention of those forms can give a much wider range of meaning.

Choosing traditional forms is of course possible and can follow, or violate the principles of the many styles of architecture which followed Roman classicism. Selection of such a style shows an intention of continuity with the life and buildings of the period selected, and misinterpretation of principles can be seen as exercising bad taste.

Modern architecture proposed a break with stylistic traditions, and invented what have become new ones—some derived from precedent movements like the Bauhaus, others from the work of influential architects like Frank Lloyd Wright, le Corbusier and Mies van der Rohe. Others found possibilities in vernacular architecture, construction methods, or abstract, new forms.

The selection of specific forms conveys meaning to us, whatever choice is made. A glass building can, for example, mean transparency and honesty, while an opaque building means privacy and concealment. Tall buildings have always been expressions of power; colorful buildings can mean levity and whimsy. The building's activities can be shown or concealed, as can the means by which the building operates, like structure and mechanical systems.

New developments in architectural tools including sustainable design, the emergence of building science, and building information modeling (BIM) all lead to new insights in the design and construction processes with aesthetics often revisited. As necessity is the origin of invention, scarcity can also inspire. With a lack of quality large timbers for framing, coupled with rising costs for steel and concrete, new production techniques developed around laminating timbers together in large plates. The cross-laminated timber (CLT) framing system as it is known increased in both popularity and acceptance as an alternative to traditional methods of construction. The impact on aesthetics can be seen in the large expanse and planes of wood layers that convey strength and delight.

Contemporary culture advocates diversity of styles, even in cases of historic preservation. It also encourages the development of new architectural languages. In response to this openness, designers agree that aesthetically successful architecture comes from an integrated approach. By correctly formulating a project's purpose, seeking inspiration in programmatic requirements, and engaging in team-wide design reviews, an architect most effectively arrives at a solution that is as delightful as it is cost-effective, secure/safe, sustainable, accessible, and functional/operational. In much of contemporary architecture, the notion of expressive exteriors becomes tempered by new materials such as: high performing glass that conveys literal openness in an age of digital communication via the Internet or alternative roofing technologies that can extend the livable areas to the top of buildings proving a green space that can hold storm water and offer new amenities.

Returning to Vitruvius, one can conclude that his three standards of architecture reinforce one another. Good architecture achieves useful, humane, and economical results, and a building expresses those qualities regardless of style.

A fully integrated building promises to be durable in way that Vitruvius may not have envisioned: It will inspire a community to find ways to use it even when the original program is no longer relevant.

With an eye to integration, an architect makes aesthetic decisions in full collaboration with the client, building users, other consultants, and the public. Therefore it is important for the client and building users to be well informed about the possibilities of architecture. They can assist the design team in conceiving a building that meets the most needs.

One way to become acquainted with the possibilities of an architectural commission is to study a number of buildings of the same type. In addition, this branch of the WBDG will help those not familiar with architectural design terminology to understand the basic process, techniques, and language by which architectural concepts become reality.

- **Understanding the Language and Elements of Design**

Architects use specific terminology to describe fundamental elements of a building, and to assess its design quality. A client's fluency with this vocabulary improves the architect's application of the elements it represents.

- **Engage the Integrated Design Process**

An integrated design process interlaces the multiple disciplines that inform a building. A series of steps can provide an orderly flow to this dialogue, and the full and constructive participation of all members of the design and delivery team will ensure the best results.

The design awards programs of professional societies, the federal government, and industry trade associations offer additional insight into aesthetic values at a given time in history. For more information see Design Awards.

EMERGING ISSUES

- Building Information Modeling (BIM) and Building Energy Modeling (BEM)
- Building Science/Building Physics

- Life Cycle Analysis/Life Cycle Assessment (LCA)
- Sustainability and High-Performance Buildings
- Security Measures

Functional / Operational

This deals with is designed to provide guidance to architectural and engineering design professionals to better understand the basic processes, techniques, and language by which functional and operational building decisions are made.

A clear understanding of the functional and physical requirements of a project is essential to ensuring its success. A client's / owner's intent to develop a project is derived from a need, a purpose or mission, and a desired result. When the design of a facility satisfies the emotional, cognitive, and cultural needs of the people who use it and the technical requisites of the programs it houses, the project is functionally successful. Program and functionality are also characterized by building type. A building that functions as it is intended is the underpinning of a quality "whole" building. The qualities of such a building may not even be noticed or recognized, but a poorly functioning building can be costly to correct, if the opportunity to correct ever becomes available. When designs fall short of this goal, the cost can be modest to extreme, but the failures are generally noted more significantly than the expected successes.

Information in these Functional pages must be considered together with other design objectives and within a total project context in order to achieve quality, high-performance buildings.

Development in the building sciences in the late 1900's has pointed to the need to refocus on programming, designing, constructing, and operating facilities that function well, while at the same time incorporating new technologies, and creatively meeting other design objectives: sustainability, accessibility, safety, aesthetics, cost effectiveness, productivity, and historic preservation. Addressing these design objectives while achieving energy savings, and improving environmental quality is paramount in designing the "whole" building. Facility Performance Evaluations have shown that early programming and design decisions have

significant impact on the functional quality, and long-term efficiency and effectiveness of buildings, initially and over their life cycle, such as:

1. Adaptability: decisions at the inception of project design to incorporate elements and concepts that will assist with future adaptations to a building can facilitate change in the future:
 - a. Building to readily facilitate horizontal and vertical expansion
 - b. Analyzing the building structural concept, i.e. structural grid, dimensions, and floor-to-floor heights that allow for flexibility in internal layouts
2. Functional Quality: decisions to incorporate the use of hard walls for offices and workspaces vs. flexible 'furniture' systems have a significant impact on functionality of a building.

Adopting an integrated design approach and quality assurance processes that extend through all of the phases of design and construction of a project, from pre-design through owner occupancy and operation, with checks at each stage of the process will help ensure validation of decisions to meet the owner's program and design requirements. Buildings that are more functionally successful also create more inspiring, safe, and productive environments that enhance work and/or livability.

A building is considered to perform at a high level when all key design objectives are considered from the early project development phase, rather than focusing on one design objective while others are trivialized or overlooked all together. For example, most projects have both sustainability and security goals that must be met. Discussing these early on can help ensure a project's functionality goals are met as well as its productivity goals. The ability to measure the performance of sustainable buildings can also help achieve the functional and productive goals of the project.

There are three overarching principles associated with ensuring functional building design and operations:

- **Account for Functional and Psychological Needs**
Identifying the spatial requirements and psychological needs developed in the functional program is a primary element of the planning process that translates to an owner's spatial

and service requirements for a building or facility. Key tasks in this process are: problem definition or statement, establishing goals, collecting and analyzing facts, establishing functional relationships, and uncovering and testing concepts. There is also a need to design for flexibility of programmed space.

- **Ensure Appropriate Product / Systems Integration**

A successfully designed building that functions properly in all respects is composed of building systems, materials, and technologies that are selected and integrated to be mutually supportive as a cohesive "whole" system.

Meet	Performance	Objectives
• Meet	• Performance	• Objectives

Meeting performance objectives is not achieved simply by a "Final Inspection" of the finished product, but is a sustained effort from inception and planning through turnover and operation to assure the delivery of a project that satisfies all of the owner's functional, psychological, and operational requirements for the project. There are many aspects involved in assuring performance objectives are met, from assembling a qualified project delivery team; to adequately coordinating team member roles and responsibilities; to instituting systematic quality assurance programs, like Building Commissioning.

Relationship of Function / Operation and Cost

Building functional and operational goals are most successfully met within the constraints of a project budget when cost estimation occurs early in the design process and is continually refined/updated as design progresses.

Most projects have a budget to meet. Good planning and design practice involves identifying project functional and operational goals and needs during the programming phase. It is often helpful to prioritize goals and needs, and to carefully distinguish needs from wish list items. Many public sector projects have standardized processes with milestone reviews occurring at programming, schematic design, design development, and construction document phases. Updating the cost estimate throughout the design process and at each milestone helps avoid costly surprises late in the design phase. It is much easier to make changes to a project in order to align with the budget early in the design process rather than later.

Cost-cutting, or value engineering, late in the game often sacrifices quality or performance. The designer is afforded a much better opportunity to address cost and budget alignment holistically without sacrificing functional priorities if cost concerns are identified early in the process. For example, the insulated value of a building envelope affects the sizing of the HVAC system. Downgrading the building envelope to save cost after the building has already been designed could result in an HVAC system that is improperly sized to maintain thermal comfort levels, or an HVAC system that needs to run harder than it was designed for, thus reducing the system lifespan and driving up building operation costs.

Several cost control best practices include the following:

- Establish and prioritize project goals, needs, and wants early in the design process. (i.e. during programming)
- Update the cost estimate throughout the design process and definitely at project milestones. (i.e. Programming, Schematic Design, Design Development, Construction Documents)
- Verify the cost estimate with historic project cost data and industry professionals.
- Balance project first costs with life-cycle costs.
- Identify opportunities for flexibility on bid day; use bid lots or bid alternates.

Chapter 1, Architecture session

Design Lessons Learned

Key to improving the facility planning, design, and delivery process is continual improvement of team performance through learning from and avoiding repeated design errors, omissions, or flaws in project execution. "Lessons Learned" is a common term that refers to an organization's compilation and publication of the lessons for the knowledge and benefit of future project teams. Design of facilities that meet or exceed the functional expectations of owners and facility managers will require the application of these principles as well as thorough understanding of historical precedent and knowledge of current design practices for the building type.

Account for Functional Needs

Programming should begin with a clear definition of the activities to be performed and the people who will use the space and surroundings. Accounting for functional and psychological needs is a

primary purpose of the [planning](#) process that defines an owner's functional and physical requirements for each spatial element in a building or facility.

This process seeks to:

- state the problem;
- establish goals;
- collect and analyze facts;
- establish functional relationships;
- uncover and test concepts;
- define space requirements for all spaces;
- And finally state the problem to direct a course of action.

Adequate programming performed in the project planning phase will clearly delineate in-use requirements and relationships of occupant activities and spaces required for all supporting building systems and equipment. Effective programming will include all pertinent stakeholders to identify that all "Whole Building" functions and needs have been identified. Conducting programming and design [charities](#) with these stakeholders is an effective means of enhancing integrated functionality and mutual agreement on a design approach.

A truly functional building will require a thorough analysis of the parts of the design problem and the application of creative synthesis in a solution that integrates the parts in a coherent and optimal operating manner. '[Whole Building' design](#) is characterized by a design solution that functions well from an occupant activity and building systems point of view.

There are several key steps in the development of project requirements that fully describe the design problem. They are:

- Understand how the work processes support the mission and purpose of a facility;
- Define spatial requirements for occupant activities and equipment in a Space Program;
- Understand functional relationships among the programmed spaces;
- Anticipate installation, [Operations & Maintenance \(O&M\) practices](#), spatial change, and replacement of building equipment;

- Accommodate information technology (IT), communication, and other building systems equipment; and
- Consider serviceability (clearance) requirements

RECOMMENDATIONS

Understand How the Functional Needs Support the Mission and Purpose Of A Facility

- Set owner's design objectives in the early planning stage.
- Determine facility use, occupancy, and activities to be housed.
- Consider the functional needs in the context of all the other [design objectives](#) to ensure a balanced and integrated design.
- Balance the owners and users' needs and goals for space, quality, [budget](#), and time.
- Reference building type guidelines. See also WBDG [Building Types](#).
- Look beyond the facility to understand the role the [site](#) plays in meeting the functional needs in support of the mission and purpose of a facility.

Define Spatial Requirements for Occupant Activities and Equipment

- Consult all pertinent stakeholders for their requirements.
- Consult planning guides and specialists on programmed activities equipment.
- Document all regulatory requirements, such as building codes, [accessibility](#) laws, anti-terrorism/force protection (ATFP), etc.
- Explore the possible necessity of making spaces [flexible](#) to accommodate changes in business practices, work activities, and technologies.
- Consider building [operations and maintenance activities](#) in the defining of space requirements.
- Look beyond the building to understand the role the site/[landscape](#) plays in defining spatial requirements for occupant activities and equipment.

Understand Functional Relationships between Program Spaces

- Engage user groups in discussions to brainstorm functional relationship solutions.

- Examine patterns of activity in facility programs and consider how those patterns create spatial relationships.
- Account for [physical security requirements](#) in the layout of space planning.
- Consider impacts of [building systems and engineering needs](#) on spatial relationships in indoor and outdoor occupied and unoccupied spaces.
- Leverage opportunities to consider quality environmental elements such as: [natural light](#), spatial volume, views, connection to the landscape and nature, texture, and [materials](#). See also WBDG [Aesthetic Opportunities](#) and [Aesthetic Challenges](#).
- Again, look beyond the facility to understand the role the [site](#)/landscape plays in the functional relationship between spaces and even the larger community.

During Schematic Design Anticipate Installation, Operation, Spatial Change, Reuse, and Replacement of Building And Equipment

- Incorporate infrastructure system needs (structural, electrical, plumbing, and mechanical systems) as integral parts of early design [concepts](#).
- Account for structural loads (dead and live) of building systems and equipment.
- Ensure that all building system equipment and furniture, fixtures, and building equipment (FF&E) can actually be installed, operated, and replaced.
- Consult facility [O&M](#) personnel in the programming and early design stage.
- Plan infrastructure for flexible spatial modifications or "churn" and repurposing of the building in the future.

Accommodate Information Technology (IT), Communication, and Other Building Systems Equipment

- Determine the owner's goals and needs for spatial and mechanical support of the organization's IT program.
- Incorporate [IT system needs](#) as an integral part of the design [concept](#).
- Design for configuration [flexibility](#) within workspaces that promotes [occupant productivity](#).
- Accommodate network support and servicing requirements in the design of spaces.

Consider Serviceability (Clearance) Requirements

- Design for vehicular clearances in the site design (e.g., drives, gates, ramps, parking).
- Design for vehicular clearances in building design (e.g., doors, docks, obstructions).
- Design for proper equipment access for maintenance and removal and replacement of equipment and/or major components, such as filters, boiler tubes or piping.
- Design for equipment and system life cycle.
- Design for [maintainability](#) (including housing of maintenance equipment).
- Consult facility [O&M](#) personnel in the design process.

RELATED ISSUES

- Computer-based space programming applications
- Appropriate accommodation for the changing nature of work (flexibility and [productivity](#))
- Virtual workplaces and increased use of "Hoteling" for [work space](#)
- [Building Information Modeling \(BIM\)](#) (defining object functionality for facility life cycle)
- Adaptability for possible change of building needs and function over time.
- With today's emphasis on [sustainability](#) and green building design, maintain a balanced perspective with the other key [design objectives](#).

Ensure Appropriate Product/Systems Integration

"There is no separation of utility and beauty. You cannot determine where a tree stops being beautiful and starts becoming utilitarian." Richard Neutra



The Constance Perkins House by architect Richard Neutra incorporates his signature blend of art, landscape, and practical comfort.

A successfully designed building has been compared to a beautiful symphony. The parts of a building, like individual instruments in an orchestra, have the capacity to make up a whole that is greater than if they were played alone. Imagine, for instance, that an [office space](#) had a beautifully designed interior and state-of-the-art furniture and computer equipment, but could not be heated and cooled properly. The lack of adequate [climate control](#) would be as apparent as if a loud "off-key" note were played during a symphony.



The Johnson Wax Administration Center in Racine, Wisconsin, USA was designed by American architect Frank Lloyd Wright in the mid 1930's.

The Administration building features dendritic (tree-like) columns that integrate structural, spatial, and roof drainage systems. During construction of the building, code officials halted construction to test the structural adequacy of the columns. The test revealed that the columns were

capable of supporting 5 times the required load, and construction resumed. Spatially, the slender, 30 foot tall columns are topped with disc-shaped concrete canopies that interplay with the glazed roof to define an interior "forest." Additionally, the columns are hollow to collect and convey water from the roof to the storm drain system.

Like musical instruments, building systems, materials, and products incorporated into a design must be "[integrated](#)" in a supporting way to create a unified whole that achieves the desired functional purpose.

An integrated solution results from a methodical design approach that considers the characteristics and properties of each system or product, its role in the greater whole of the design, and its needs for installation, coordination with other building systems. For example, the selection of a ceiling light fixture has implications that must be considered in terms of aesthetics and light as well as [energy use](#), [heat](#), [noise](#), and [radiation](#). An integrated design team will:

- Develop design concepts that meet functional needs of the building program;
- Understand the integral relationship of [form](#) and [function](#);
- Evaluate product/system selection for the specific application;
- Seek design solutions that fully integrate product/systems; and
- Consider how the facility will be [operated and maintained](#).

RECOMMENDATIONS

Develop Design Concepts That Meet Functional Needs of The Building Program

- Understand the full-range of needs (e.g., cognitive, emotional, and cultural) of occupants required to perform [programmed](#) activities (space, environmental qualities, furniture, fixtures, equipment, communications, information technologies, etc.).
- Explore a variety of design solutions and consider the merits of each alternative on the basis of functional performance.
- Facilitate discussions with users to evaluate and test assumptions made involving functional issues. See WBDG [Planning and Conducting Integrated Design \(ID\) Charrettes](#).

- Understand design implications and space needs of unique "mission critical" activities requiring permanent construction as compared to more [flexible spaces](#) that can be configured to support multiple activities and functions.
- Track decisions to maintain focus on design intents.

Understand the Integral Relationship between Form And Function

Functional characteristics of building systems (e.g., air distribution systems) can serve as unique design opportunities in shaping the facility's [form](#) and [aesthetics](#). See WBDG, [Aesthetic Opportunities](#) and [Aesthetic Challenges](#).

- Accept [environmental conditions](#) as a significant influence on the building's [form](#).
- Develop design concepts that provide the user with a clear sense of the facility's functional purpose.
- Use product/systems integration to support functional requirements and aesthetic goals.



Chesapeake Bay Foundation's John Philip Merrill Environmental Center-Annapolis, MD. The glazed wall on the south contributes to passive solar heating and day lighting. The need for sun control resulted in an interior shading system that mimics sailboat rigging and an external structure supporting a "Brise Soleil", or solar shades.

Photo Credit: David Harp/Chesapeake Bay Foundation

Evaluate Product/System Selection for the Specific Application

- Select systems and products that are "use-and user-appropriate" and support functional and psychological goals of individual spaces as well as the entire facility.
- Avoid a "one size fits all" design approach. Also see WBDG [Accessible—Beyond Accessibility to Universal Design](#) and [Design for the Changing Workplace](#).

- Look at design problems as unique opportunities for creativity and innovation in the selection of products and systems. See WBDG [Aesthetic Opportunities](#) and [Aesthetic Challenges](#).
- When resolving conflicts in the design and selection of products and systems, coordinate with consideration of opportunities and impacts affecting design and constructability of all involved building systems.
- Consider energy conservation and [Life-Cycle Cost Analysis](#) in the selection of products and systems especially for facilities with longer expected/designed service life (such as institutional and governmental buildings).

Seek Integrated Design Solutions That Fully Incorporate Product/Systems

Integrated design strikes a balance between all design objectives, including [Aesthetics](#), [Functional/Operational](#) and the integration of products and systems.

- Adopt a '[Whole Buildings](#)' approach Systems integration involves the awareness of all affected trades and [disciplines](#). Design with functional attributes of systems and products in mind.
- Select materials and products that are compatible with design objectives for both appearance and function.
- Carefully research the owner's equipment requirements and integrate them with the design.

Consider How the Facility Will Be Operated and Maintained

- Anticipate the needs of the building-cleaning program, including refuse storage and disposal.
- Provide adequate space for maintenance equipment, materials, and storage.
- Design for regular building systems maintenance, including easy access to light fixtures, HVAC filters, sensors, and surfaces requiring scheduled cleaning.
- Plan for eventual replacement of major systems components.
- Give careful thought to designing delivery drives, loading docks, and storage rooms. Allow ample maneuvering room and clearance width and height.
- See also WBDG [Sustainable O&M Practices](#) and [Reliability-Centered Maintenance \(RCM\)](#).

RELATED ISSUES

- Increased use of extranets and new communication tools that enhance interdisciplinary design coordination
- Use of object-oriented [Building Information Modeling \(BIM\)](#) with documentation systems containing real-time building data in 3-dimensional, 4-dimensional (time), and/or 5-dimensional (cost) construction documents; the ability to check for systems clashes and interferences prior to construction; and the capability to use the BIM model as a [facility maintenance](#) tool throughout the life of the facility.
- Trend towards using "[Total Building Commissioning](#)" throughout the planning, design, construction, operation, repair/alteration, and disposal life cycle

1.1, INTEGRATED DESIGN PROCESS IN ARCHITECTURAL EDUCATION: THE CONSTRUCTION PROJECT STUDIO EXPERIENCE

ABSTRACT:

While the design act constantly approaches a final solution, technology introduces a vast amount of design possibilities. Therefore, it requires a multi-disciplinary design team, transfer of information and ideas between team members, and development of the design project through integration of design ideas and design principles of each expertise area into the design activity. Key role is the leading architect's since it must be ensured that complex interactions between different areas of expertise are handled and appropriate choices are made while sub-systems are developed into a whole. Despite the fact that design synthesis and technological accommodation are so interwoven in the construction industry, in architectural education, the most cited problem is the gap between design studios and the so-called service courses, e.g., building construction, environmental design and structures. Although most design studios in architectural education distinguish between them, in fact, the solution is simple and well-known: an integrated design process in architectural education

The professional architecture office environment is simulated in this studio and each student is expected to design a "well integrated" building. The studio structure orients students in retrieving knowledge, using the retrieved knowledge in decision making, and developing design by

integrating different solutions appropriately. Meanwhile, experts with different disciplinary backgrounds are engaged with the projects, so that the students experience the team work with the role of leading architect. The design progressions are tracked and reported. Analysis of the design activities and the projects as the final output along with the feedback from the experts, allows a design framework to be described regarding both integration of the sub-systems and the iterative nature of design. Finally, the systematic process of the studio is presented and supported with results of a survey.

Keywords—integrated design, architectural education, design process, design activity, construction project.

1. INTRODUCTION

Building is a system consisting of spaces and several sub-systems such as the structural system, service systems and building element systems. Although this definition seems very straightforward, it portrays a quite complicated and creative design act. The architect develops a building concept and built environments according to her/his architectural intent and design goals. During reaching a design solution the architect mostly generates several design candidates. Whatever approach the architect uses, the final design solution involves considerable thought, research and re-design. Even though mostly there are no sharp boundaries, in the early stages of design the architect is mainly engaged with form-giving and spatial organization; but the constructional design, which covers all sub-systems and construction methods, is left for latter phases in a fragmented series. This fragmented approach hinders adequate performance of the building as a whole, since separate and disjointedly designed parts (sub-systems) of a building do not interact with each other properly. A mostly cited solution for improved performances and a successful building is the “integrated design concept”, which stands directly opposite to the fragmented design. There are different approaches to integration in architecture. For example, Bachman illustrates “integration” by a push-pull dynamic, in which technology constantly pushes design possibilities expansively while design continuously pulls them inward toward a final solution (Bachman, 2003). Deutsch defines “integrated design” as a collaborative method, which emphasizes the development of holistic design and involvement of all stakeholders from the earliest stages. All stakeholders have input in decision-making and that will lead to a completed project (Deutsch, 2011). Emmitt and Ruikar

indicate that the integrated design, supply and production processes are facilitated by cooperative interdisciplinary working arrangements and by integrated teams encompassing skills, knowledge and experiences of a wide range of specialists (Emmitt and Ruikar, 2013). Moe characterizes “integrated design” as an activity of incorporating energy, site, and climatic, formal, constructional, programmatic, regulatory, economic, and social aspects into a design project as primary parameters (Moe, 2007). On the other hand, Keeler and Burke are describing “integrated building design” simply as the practice of designing sustainably (Keeler and Burke, 2009). In integrated design concept each sub-system is integrated with each other, therefore, it necessitates systems thinking in all stages of design and construction, including conception, delivery, and use phases, that is to result in several re-design periods. During those re-design periods, each designed element is revised and integrated into the whole step-by-step like a knitting. On the other hand, managing all these aspects requires more in-depth knowledge and longer spans of time. Thus, it is necessary to implement division of work at the office, where designers with different expertise areas perform specific tasks and create an interdisciplinary working environment. This environment is created by the leading architect. Structural engineer, mechanical engineer, electrical engineer, experts in acoustical systems, day-lighting and energy efficiency are needed to collaborate and sustain a simultaneous and continuous input flow. Meanwhile, the architect has to design spaces and building element systems in consistency with the overall performance concept which is adopted also in design of structural and service systems. In architectural education students barely design a well-integrated building mostly because of the segregation of the design studio and the technical service courses. Most architectural design studios stay at conception and initial design stage. Eventually, students graduating with this formation hardly adapts to the office working routine and have difficulties while working with other actors, since they have not gained the ability of constructional design and have not experienced collaborative design before. The importance of including “integrated design” in curricula of architectural schools is indicated by several authors for paving the way for an effective collaborative approach in professional practice (Deutsch, 2011; HitchcockBecker, 2011; Kacmar, 2009; Keeler and Burke, 2009; Lovell, 2010; Snyder et al, 2009). Furthermore, The U.S. National Architectural Accrediting Board indicates that an accredited degree program must demonstrate that each graduate possesses skills in the following area: Ability to demonstrate the skills associated with making integrated decisions across multiple systems and variables in the completion of a design project, including problem identification, setting evaluative

criteria, analyzing solutions, and predicting the effectiveness of implementation (NAAB, 2014). In this paper a trial to establish a framework of a “technical design studio” for integrated design in architectural education is introduced and its implementation in a one-semester studio is presented. For this reason, the seventh-semester - “Construction Project” studio at Istanbul Technical University (ITU), Department of Architecture is programmed to teach students knitting the design abilities and technological knowledge in one project.

2. FRAMEWORK OF A “TECHNICAL DESIGN STUDIO” FOR INTEGRATED DESIGN

A literature review is carried out while developing the theoretical framework of a “technical design studio” for integrated design. In literature, different approaches are reported that include “integrated design” in curricula of architectural schools. In this context, Kacmar investigates integration strategies of technical topics into the design studio at architectural schools in the US and presents a great variety of approaches characterized by each school’s and faculty’s identity. Technology faculty having design studio, teaching technology concurrently within a studio by two faculties with different backgrounds or using technology related software in the design studio, are just a few to mention (Kacmar, 2009). Also, Nichols and Holliday address in their paper the response to the curriculum consolidation regarding the newly offered “integrated design and technology” courses at the School of Architecture at Texas A&M University (Nichols and Holliday, 2011). Hitchcock-Becker examines the disconnection, which exists for most students between formal and systems design, and makes suggestions for a comprehensive curriculum that employs goal-oriented learning methods and full integration of technical courses with design studios at the School of Architecture at Kent State University (Hitchcock-Becker, 2011). Mimicking the real world at different levels is another approach in integrating technical topics with the design studio. For example; Keeler and Burke describe the studio environment for “integrated building design” as mimicking the reality of professional practice, (Keeler and Burke, 2009). Snyder, Dicker and Tushaus present the "IP/BIM Studio" experience, seeking to blur interdisciplinary boundaries with stressing innovation and invention in design by drawing ideas and expertise from a wide array of collaborators such as architectural professionals, engineers, contractors, software specialists in the design studio (Snyder, et al., 2009). Also Nichols and Holliday report a successful integrated design and technology studio, in which an atmosphere of a

design office is created (Nichols and Holliday, 2011). The U.S. National Architectural Accrediting Board (NAAB) emphasizes the importance of the integrated design in education and indicates methods of implementation. According to NAAB, graduates of NAAB-accredited programs must be able to demonstrate that they have the ability to synthesize a wide range of variables into an integrated design solution with learning aspirations including (NAAB, 2014):

- ♣ Comprehending the importance of research pursuits to inform the design process
- ♣ Evaluating options and reconciling the implications of design decisions across systems and scales
- ♣ Synthesizing variables from diverse and complex systems into an integrated architectural solution

♣ Responding to environmental stewardship goals across multiple systems for an integrated solution In this context, works of Rush (Rush, 1986) and Bachman (Bachman, 2003) related to integrated design are also investigated and analysed. For a successful integrated design, the leading role of the architect among other stakeholders participating in the process, is highlighted by Emmitt, describing the architect as an orchestra conductor (Emmitt and Ruikar, 2013) or by Deutsch, giving the architect his role as a master-builder (Deutsch, 2011). Those different approaches are analysed and outcomes are melted in a pot to suit them for a one-semester studio in the last period of undergraduate architectural education. In this context, it is revealed that a “Technical Design Studio” for Integrated Design should have following features:

- ♣ The studio is mimicking the reality of professional practice.
- ♣ The architectural students are the focal point of the studio to be taught in the role of orchestra conductor and master-builder in order to be the leader of the integrated design process.
- ♣ In the studio, students are interacting and cooperating with all stakeholders, like clients, partners, architects, engineers, consultants.
- ♣ All stakeholders, taking part in the process, are design experts with the required level of knowledge on building systems and their integration to each other.

- ♣ All stages of building design covering, planning, concept design, design development, technical design, and detailed design are included in the integration process.
- ♣ The body of current regulation is integrated into design.
- ♣ Technological knowledge is integrated into design.
- ♣ The process is covering technical integration of building systems, visual integration of building systems and integration of performances.
- ♣ Sustainability is integrated into design.

THE “CONSTRUCTION PROJECT” STUDIO EXPERIENCE

The undergraduate program of the department of architecture at Istanbul Technical University (ITU) comprises eight semesters. An Architectural Design Studio at each semester is accompanied by service courses in technology, design, architectural history, restoration, and urban planning. In addition to the Architectural Design Studios, there are also the “Architectural Survey and Restoration Studio” in the sixth semester and the “Construction Project” Studio in the seventh semester. The main objective of the Construction Project Studio is to provide the ability of finding architectural solutions in consideration of technical, aesthetic, and legislative factors. Found solutions in the process of design and/or development of sub-systems are enhanced in accordance with building function and the integration of those sub-systems. The afore-mentioned framework of a “technical design studio” for integrated design is adapted to one of the “Construction Project” studios in the 2015/16 fall semester. The core team of the studio consisted of six seventh-semester students and two studio instructors with technology background. Five experts on technology and two architects from professional practice joined the team at different stages of the design work. Three of the students worked on “architectural office” projects and the other three on “boutique hotel” projects on sites in the city of Istanbul. Mimicking the reality of professional practice was designated as a tool of integration, consequently, the Construction Project studio was matched up

with the professional architectural office. Students were encouraged to establish a fictive “architectural office” taking the role and responsibilities of a senior partner.

	architectural office environment	studio setup
stakeholders / actors	leading architect	student
	client (in boutique hotel projects)	studio instructors
	partner (in architectural office projects)	studio instructors
	local authority	studio instructors
	experienced architects in the design team	studio instructors
		two senior architects from professional practice
	experts on technology	structural engineer
		expert on fire protection
		expert on thermal performance, energy efficiency and mechanical systems
		expert on acoustics
		expert on day-lighting and artificial lighting
terms/concepts	interdisciplinary working environment and collaboration	periodical meetings with designers from different expertise areas and consultancy
	a defined project delivery period and program	submission date; one semester
	division of work / team work	consultancy and using experts' feedback to develop design projects

. Construction Project studio matched up with the professional architectural office.

In this regard, as in professional practice, students communicated periodically with designers and experts from different disciplinary backgrounds. They got consultancy about structural system, building physics and service systems through this communication. Using feedbacks taken from experts, they integrated technological features into their design and developed their projects unremittingly. Due to the wide array of technological knowledge, students got a chance to push the boundaries of building design and achieved both constructible and unique projects in character. Students were oriented to develop their design works consistent with design goals to a final state. The studio instructors played mainly the role of the “client” in boutique hotel projects and the role of the “partner” in architectural office projects. They sometimes became also a “general consultant”. In this way, students in the “leading architect” role and the instructors were in a convenient communication which is based on client’s demands and architect’s ability to convince the client to realize his/her own architectural intent. This interacting and orienting design process can be explained in three interwoven phases:

1. Preliminary design
2. Systems' design
3. Detailed design

1. Preliminary Design

In preliminary design phase, students were given a design brief and expected to develop the design brief with their architectural intentions that is to write an architectural program and a scenario for users. Eventually, they came up with detailed and distinctive architectural programs, in which space types, sizes and numbers are defined and organization schemes are illustrated. In the meantime, students conducted the analysis of given sites and the environment. They also studied codes and standards, hence, put forth the limitations and narrow down the project scope into a more definite state. Analysis findings were used to develop the form of the building, its orientation on site, and spatial organization within the building. Students conveyed their ideas to the “client” or “general consultant” through prepared architectural programs, drawings and 3d models of the building along with its environment, and graphical illustrations of organizational schemes. Students and the instructors discussed the preliminary project twice a week, so that the project evolved iteratively into a satisfactory state both for the “architect” and the “client” (Figure 1).

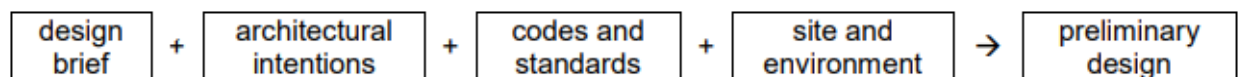


Figure 1. Applied framework of preliminary design.

2. Systems' Design

A building should meet certain comfort conditions, which external environmental conditions and user requirements are translated into. Therefore, preliminary design outputs of environment and site analysis, and design brief gain importance in systems' design. Since comfort conditions can only be provided with design of single building sub-systems, comfort conditions are turned into specific performance requirements of building sub-systems (Figure 2).

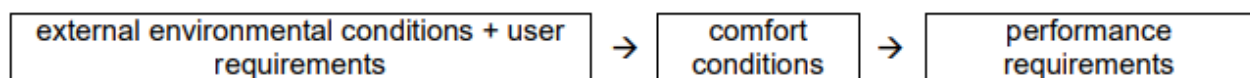
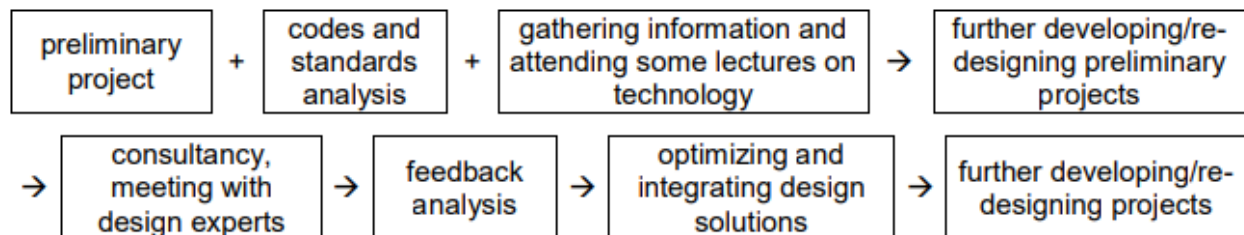


Figure 2. Defining performance requirements in systems' design

Additionally, for a building to be constructed, its sub-systems must be designed in a constructible way and they must show integrity. In the Construction Project studio, experts in different areas of technology were invited to criticize students' projects and to give further advice as a simulation of interdisciplinary working environment in real-world. In this way, students experienced collaborative design in architectural education. While developing the project, students used analysis findings of codes and standards as an input and they gathered basic information about structural systems, service systems, energy efficiency, and thermal/visual/acoustical comfort by refreshing the knowledge provided from technology courses in previous semesters and also attended some lectures given by experts on technology. With this accumulated knowledge, students developed their preliminary projects further and re-designed it for a number of times, also strived for concretizing performance concepts while organizing spaces. Eventually, they prepared separate presentation drawings and illustrations for each expertise area by bringing the particular features of the project into the forefront, and met with the design experts. These experts gave consultancy on structural systems, fire protection, thermal performance and mechanical systems, acoustics and lighting. Students then needed to analyze feedbacks to incorporate them into their projects. Although some of the advices were easy to integrate, some of them were opposing with each other because of the very nature of design. Students had to solve these problems by optimizing the design alternatives and integrated them into the projects. This integration process, again, resulted in multiple re-designing sub-processes (Figure 3).

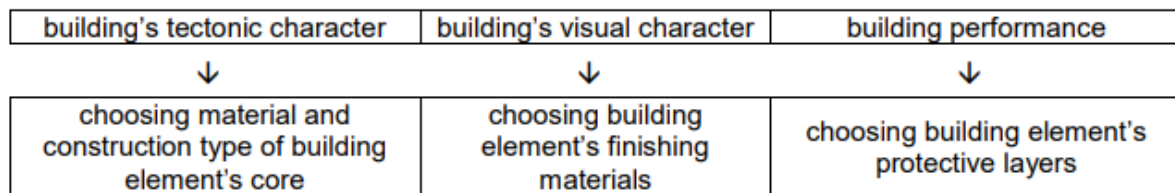


Applied framework of systems' design.

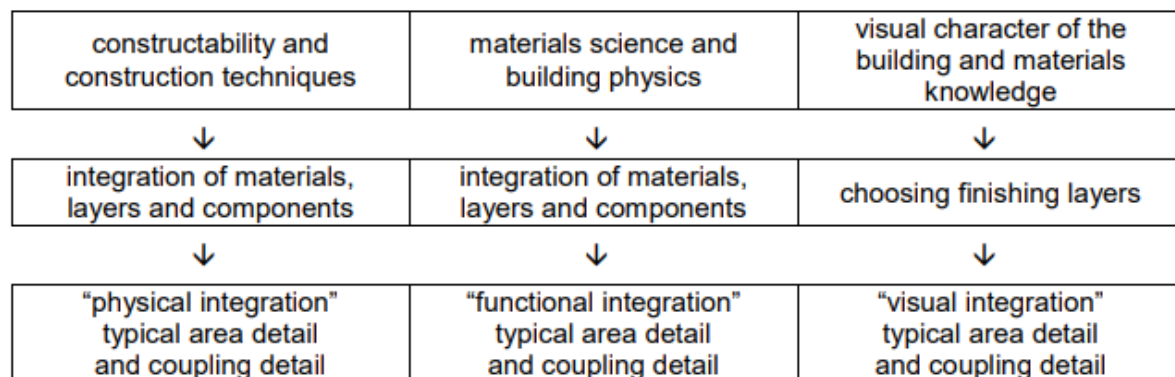
3. Detailed Design

Apart from structural system and service systems, design of building element systems is under sole responsibility of the architect. The architect designs typical area details of external wall systems, floor systems, roof systems, internal subdivision systems, stairs, and wall openings, that is, the materials and order of layers and components to be assembled are specified by the architect. Then the coupling details are designed where building elements intersect with each other. Both typical

area detail design and coupling detail design require integration of materials physically and integration of building technology knowledge cognitively. Therefore, information on various issues should be retrieved, such as: material properties, materials' behavior when they come together, and building physics. However, detail design, finds again, a little space in architectural education. In the “Construction Project” studio details were designed consistent with the decisions made during preliminary design and systems' design stages (Figure 4). In detail design of building element systems, comfort conditions are turned into performance requirements. For functional integrity of the building, performance requirements are met by details. However, a perfect design of a typical area detail is not enough for a “successful” building. The coupling details, where different building elements intersect, must be well designed too, that is to say, other than physical integration of layers, performance continuity must be provided. In addition, both in typical area detail design and coupling detail design, appearance is important. While it is handled by aesthetic choices of finishing layers in typical area detail design, in coupling details there is almost always an additional component. In order to implement that additional component, some complementary components may be required for constructability..



Building element design framework consistent with the preliminary design.



Physical, functional and visual integration in detailed design.

4. OUTCOMES OF THE “CONSTRUCTION PROJECT” STUDIO

The holistic integrated design process necessitates systems thinking starting from building level, and continuing with building sub-systems level, building element level, and detail level. In all design stages knowledge of building physics, materials science and construction techniques must be existent in order to integrate design intents and user requirements appropriately into the building.

5. EVALUATION OF THE “CONSTRUCTION PROJECT STUDIO”

The integration process in the “Construction Project Studio” is evaluated through two different perspectives. The standpoint of students is revealed through a questionnaire. The questionnaire comprises both “open-” and “closed ended” questions for collecting data on the influence of demands, regulatory framework, collaboration with experts, and the implementation of the integration process. All six students were respondents of the questionnaire. The integration process is also evaluated from the studio instructors’ point of view. The results of the conducted questionnaire and observations of the studio instructors are analyzed and outcomes are summarized under five topics, influencing the design process and integrated design solution:

♣ **Influence of demands of clients/partners:** Clients/partners influenced design processes in all stages. Architectural programs of buildings were developed on the design brief given by clients. For this reason, it is indicated that spatial organizations are highly affected by clients’ demands. Their influence on the character and form of the buildings is stated to be above average. Still, it is said that students developed their projects according to their own architectural intentions. Parallel to the effects on visual character, performance and energy efficiency concepts of the buildings are not implemented without clients’/partners’ approval, therefore, it is reported that design and integration of sub-systems are highly affected by clients/partners.

♣ **Influence of regulatory framework:** It is indicated that integration of environment Earthquake Resistant Design Code, local's Regulation on Fire Protection and other local regulations, into design had great influence on building form, spatial organization and façade character. On the other hand, “Building energy performance standard” and “Regulation on sound control” are said to be affecting both visible and invisible issues in building design.

♣ **Effects of collaboration with design experts/consultants:** Students stated that the consultants’ feedbacks, except of the structural engineer’s comments, affect form and character of the buildings

at intermediate level or less. In contrast, decisions on structural systems and maximum spans have a great impact on building form and character. Additionally, floor and building height are affected considerably not only by the structural system but also by the integration of the mechanical system. On the other hand, according to student statements there are almost no changes in spatial organizations after meetings with consultants. Only one student remarked that reorganizations were done in regard with acoustical problems and lighting issues. Envelope design is one of the most affected components of the projects by inputs of experts/consultants. Building elements are changed in their layers considering the acoustical and thermal effects. Wall openings' sizes are revised according to required lighting levels and solar control elements are re-designed according to feedbacks on energy efficiency. Increase in buildings' overall performance is reported as a result of constant changes in envelope design. Moreover, feedbacks on mechanical systems and climatization have a great impact on buildings' performance. Another important claim is that, as long as the re-design process continues due to consultant comments, details are needed to be revised as well.

♣ **Physical, functional and visual integration of sub-systems:** wet areas, envelope, and room-corridor/office spaces-circulation: Wet areas: Mechanical systems are found to be in priority in visual integration, their components' physical integrations must be done in an aesthetic manner. If mechanical system components are left exposed and this condition is found to be visually too complicated, generally the problem is solved by adding a suspended ceiling to hide the most components. Second complicated visual integration is of structural system. It becomes a design problem on the façade elevation when plug-in wet area modules are physically integrated. Spatial design of wet areas and dimensioning of structural system components are done several times, alternatives are generated, and eventually most visual appealing alternative solution is chosen. Fire protection measures are also found to be more of a visual integration subject rather than of functional integration. Wet areas' sprinkler systems are functionally integrated with the building without a problem, however, their visual integration on the ceiling next to lighting fixtures and mechanical/electrical system components is a time consuming task for the students. Acoustical comfort, on the other hand, is more of a functional integration subject, because acoustical problems are solved in layer compositions of building elements. Energy efficiency becomes an integration issue in some occasions. Lighting fixtures and water management systems, e.g.: grey water, are not only a functional design problem, but also need to be implemented at right places and be integrated

visually. The envelope: Prioritized visual and functional integrations in envelope design occur in structural systems, day-lighting and energy efficiency concepts. Load transfer between envelope and structural system is the first and a functional requirement for their physical integrations. Second, decision on visibility of structural system components plays role on connection techniques and materials. In establishing day-lighting systems for functional integration of energy-efficiency concepts, form and locations of wall openings play the primary role in visual character of the façade. Also the transparency rates of wall openings affect the appearance of the building considerably. Furthermore, application of different finishing layers leads to differentiated layer compositions and performances. While adjusting the layer compositions, it is necessary to pay regard to acoustical and fire performances of the envelope. Mechanical systems are in none of the projects physically integrated with the envelope, therefore, visual and functional integrations of mechanical system components to the envelope are not in question. Room – corridor / office space circulation area: Structural and mechanical systems are prior to visual and functional integrations in those adjacent spaces. Particularly, in spaces, where structural and mechanical system components are decided to leave exposed, locating those components and creating a balanced appearance are the most controversial visual integration issues. Furthermore, this integration generally affects the floor height and influences the perception of spaces. Second, integrating functional measures related with acoustics and fire protection has an impact on visual character of spaces, since relevant problems are mostly solved by selecting appropriate materials. For instance, covering steel structural columns with an inflammable material changes the whole character of space. Deciding on color or texture of a resilient finishing layer serves both for functional and visual integration of acoustical performance. Day-lighting is stated to be the least effective integration in those spaces. However, wall openings' locations and dimensions are designed according to space requirements and finishing layer materials and colors of internal building elements are chosen consistent with day-lighting concepts.

♣ Developing the design and reaching the integrated final solution: In the preliminary design phase students give shape to building masses based on site analysis, interactions between functions and functional areas. They implement the limitations deduced from codes and standards. However, it is stated that integration of structural and mechanical systems in latter design stages change the floor height and, eventually, the building height as a contradictory condition to regulatory rules. It

is said by all students that the final design solution is reached at the end of many revision and re-design sub processes, in which optimizations are done during integrating all sub-systems.

6. CONCLUSION AND DISCUSSION

In consideration of the importance of the “integrated design concept” in architectural education a framework of a “technical design studio” for integrated design is developed. Mimicking the reality of professional practice with students interacting and cooperating with almost all stakeholders of the construction process and putting the students into the focal point to be taught in the role of a master-builder are the main features of the proposed “Technical Design Studio”. The framework for integrated design is adapted to one of the “Construction Project” studios at ITU, Department of Architecture. Throughout the semester six seventh-semester students worked on “boutique hotel” or “architectural office” projects together with two studio instructors, five experts on technology and two senior architects from professional practice, playing roles of different stakeholders. The process covered almost all design phases, starting with preparations and concept design, finishing with the detailed design. In collaboration with the instructors and experts, students integrated current regulation and technological knowledge into design. The process included functional, physical and visual integration of building systems. In evaluating the integration process the standpoint of students is revealed through a questionnaire. The results of the conducted questionnaire and observations of the studio instructors are analyzed and outcomes are summarized as follows:

- ♣ Not only spatial organization, character, and form of the building, but also the integration of sub-systems are highly influenced by demands of clients/partners, which is a role played by the studio instructors.

- ♣ Collaboration with design experts/consultants was influential on envelope design and detailing, but had less influence on building form and spatial organization.

- ♣ The integration of regulatory framework into design had a great influence on building form, spatial organization, and façade character, but had less influence on material selection and detailing.

- ♣ Functional and visual integration were of priority particularly in structural systems in all spaces, whereas day-lighting had almost no influence on room-corridor / office spaces-circulation design.

Mechanical systems were not even physically integrated into the envelope, and energy efficiency became the least important concept to integrate especially in wet areas.

- ♣ The final design solution was reached at the end of many revisions and loops of re-design sub-processes, in which optimizations were done during integrating all sub-systems.
- ♣ Mimicking the reality of professional practice was found stimulating in realizing the whole design process in the limited time of one semester.
- ♣ Collaboration with experts was found encouraging in designing, developing, selecting and integrating all sub-systems of the buildings with a high level of confidence. In conclusion, it can be said that the developed framework of a “technical design studio” for integrated design was successful in its implementation. However, because of the limited number of students involved in the design process, generalizations should be avoided in interpreting both the outcomes of the studio and results of the questionnaire. For refining the proposed framework of the “technical design studio”, further applications and evaluations are needed.

Chapter 2, Landscape

A quality landscape and a sense of urbanism can, and should, go hand in hand. The landscape, development block, and movement framework are the three main design elements of an urban project of any scale. By landscape, we mean many things; it is the open spaces, water, movement corridors and way-leaves; it is parks, squares, and streets; it is the street furniture; it is hard and it is soft.

In design terms, there are distinct task areas, for example:

- The intrinsic landscape characteristics, for good or ill, of the site and its setting;
- Open space planning, the typology hierarchy, function and frequency of existing and desirable facilities;
- creating a landscape structure for the site as a whole; and then
- The detailed treatment of individual schemes and elements.

Landscape analysis and design skills are of key importance from the beginning of any project. At an early stage, it is also important to begin to consider the responsibilities for care and maintenance.

A key design principle is to treat everything as landscape; buildings define the edge of space; landscape occupies the space, whether it is a park, a street, a fence or a pavement. This means designing the landscape structure before the traffic engineer becomes involved and avoiding SLOAP (Space Left over after Planning).

Landscaping and landscape go together

A basic tenet is to work with and value what is already there. Opportunities occur to use the intrinsic landscape positively in the design of new places. A fine tree can provide instant maturity in a new square. A copse of good trees or a fine old garden can provide the basis of a local park. Hedgerow trees and lanes can be used to line a new parallel road, and if there is an old lane, use this for access or a footpath. Visual links between say a hill, a fine building or historic feature beyond the site can be used to create ‘view corridors’, in which open space uses, pedestrian uses, or a new avenue can run. And conversely, certain areas of sites, skylines or overlooked areas for example, may be best left undeveloped. Think about the playing fields, parklands, schools and so on in these locations.

A scheme of a significant scale will involve the incorporation of open space facilities, for which there are likely to be planning standards in terms of type of facility, its extent and their catchment areas. But achieving safe and usable open space and maximizing the benefit of looking onto it from adjacent buildings, for instance, should be more important than simply meeting prescriptive standards for provision. The urban design challenge is to design the scheme so that there is a cohesive landscape structure, within which these standards can be met while making a positive contribution to the sense of place, in both overall and local terms.

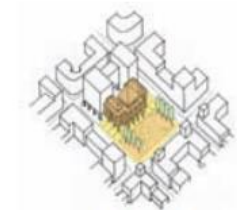
In creating the plan, adjust and iterate between considerations of this kind, together with the movement structure and development block forms, until it all begins to settle down, and to look and feel right.

At this stage, the scheme will require the production of a landscape strategy, as one of the main organizing elements of the development.

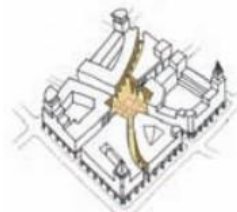
Open space and landscape design

Provide a variety of open spaces

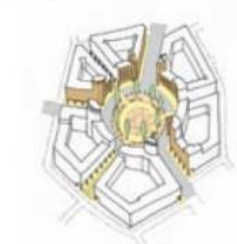
It is necessary to assess the quality of existing provision in the wider context (particularly for a large site or area), and use this as the basis for deciding on the elements of a proposed open space hierarchy.



Square centred on key civic building



Court located in block interior



Circus at street intersection



Plaza as extended forecourt space

Principle open space types	Character and function
Greenway	A network of spaces encompassing cycle and footpath routes, but also acting as 'wildlife corridors' – enabling wildlife to travel through urban areas. Typically these follow streams or disused railways, for example, with green fingers penetrating from the countryside, through the town/city edge and into the urban core.
Water way	Includes lakes, ponds, rivers, canals and streams, which provide rich wildlife habitats, offer recreational value and can be used as movement corridors.
Meadow	A public space for informal recreation, located on the edge of a neighbourhood. Often part of a flood plain comprising natural grasses and wildflowers.
Woodland / Nature Reserves	A wood or coppice of trees left in the natural state, interlaced with internal footpaths, sometimes designated as a nature reserve, with restricted access to areas rich in wildlife.
Playing field	Open spaces formally laid out for active recreation, such as football or rugby- including golf courses. Management / ownership can be shared between schools, clubs and the wider community to ensure facilities are well used.
Churchyard, cemetery	Located adjacent to a church and often providing a green oasis at the heart of a community.
Allotments	A semi-public agglomeration of gardening plots rented to individuals by the local authority.
Green	An informal grassed public space associated with the focal point of village life, that sometimes incorporates a football or cricket pitch.
Square	A formal public space, no larger than a block and located at focal points of civic importance fronted by key buildings, usually hard paved and providing passive recreation.
Plaza	A public space associated with the extended forecourt of commercial (office / retail) buildings, with formal landscaping.
Communal garden	A semi-private space not accessible to the general public, usually located within the interior of a perimeter block, providing a centrally managed green space for residents.
Private garden	A private space located within the plot of an adjacent building.
Playground	A small area dedicated for child's play, that is fenced and located within close walking distance to nearby houses, overlooked by residents.
Courtyard	A private open space often for vehicular servicing/parking
Atrium	A glass covered semi-public or private space serving as a thoroughfare, seating area and sun trap for building occupants or visitors.

Create park life

A variety of parkland distributed within the urban area ensures a range of recreational needs within close proximity to homes and workplaces. A hierarchy of parks classified according to scale, function and locational suitability. This includes rules of thumb for appropriate size and distance from home. Surround parks with different types of land uses to help spread activity and ensure they are well used at different periods of the day.

Wildlife and ecology

Balance human access and wildlife shelter

In creating a network of open spaces, there is an inherent conflict between human beings and other animals. We need to make it easier to live apart, whilst being close together. This means identifying some spaces within the network with limited access that provide rich habitats for wildlife. Railway embankments, for instance, act as good wildlife corridors as they are undisturbed by people and many animals are unaffected by train movement.

Topography

Work with the earth

Working with the grain of the landscape, in topographical as well as climatic, hydrological and ecological terms, can have economic benefits as well as reinforcing the sense of place. Wherever possible align building



Orientate according to site contours

footprints, streets, sewers and other watercourses to follow slope contours. This allows building profiles to grow out of the ground, minimizes cut and fill and enables natural gravity-flow drainage to be utilized.

Microclimate

Consider the influence of the elements

Design creates microclimate - affecting temperature, sunlight and wind movement. Careful landscape design can considerably enhance comfort on exposed sites and aid passive solar design of buildings. Taking account of existing local microclimate also ensures that problems such as

frost-pockets are avoided. An assessment of the local microclimate should be followed by landscape proposals that:

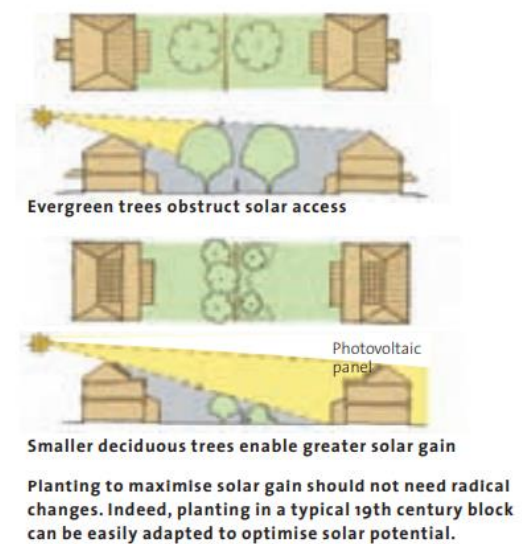
- Use deciduous trees to provide shade in summer and allow for sunlight to filter through in winter;
- Avoid excessive overshadowing of buildings, whether by earthworks, vegetation or walls, by placing trees away from southerly elevations in particular;
- Provide shelter from uncomfortable cold draughts that also contribute to building heat loss, particularly cold northerly winds and strong prevailing winds from the west and south-west, by incorporating hedges and trees as windbreaks.

Plant with the sun in mind

When selecting trees, consider their full mature height. Check that trees close to buildings will not grow to block out sunlight or overshadow solar panels (or indeed cause problems to foundations).

The life of plazas

We started by studying how people use plazas. We mounted time-lapse cameras overlooking the plazas and recorded daily patterns (Fig. 1). We talked to people to find where they came from, where they worked, how frequently they used the place and what they thought of it. But, mostly, we watched people to see what they did. Most of the people who use plazas, we found, are young office workers from nearby buildings. There may be relatively few patrons from the plaza's own building; as some secretaries confide, they'd just as soon put a little distance between themselves and the boss. But commuter distances are usually short; for most plazas, the effective market radius is about three blocks. The best-used plazas are sociable places, with a higher proportion of couples than you find in less-used places, more people in groups, more people meeting people, or exchanging good-byes. A high proportion of people in groups is an index of selectivity. When people go to a place in twos or threes or rendezvous there, it is more often because they have decided to. Nor are these sociable places less congenial to the individual. In absolute numbers, they attract more individuals than do less used spaces. If you are alone, a lively



place can be the best place to be. The most used places also tend to have a higher than average proportion of women. The male-female ratio of a plaza basically reflects the composition of the work force, which varies from area to area—in midtown New York it runs about 60 percent male, 40 percent female. Women are more discriminating than men as to where they will sit, more sensitive to annoyances, and women spend more time casting the various possibilities. If a plaza has a markedly lower than average proportion of women, something is wrong. Where there is a higher than average percentage of women, the plaza is probably a good one and has been chosen as such.

During peak hours the number of people on a plaza will vary considerably according to seasons and weather. The way people distribute themselves over the space, however, will be fairly consistent, with some sectors getting heavy use day in and day out, others much less. After the main crowd has left, the choices can be significant. Some parts of the plaza become quite empty; others continue to be used. At Seagram's, a rear ledge under the trees is moderately, but steadily occupied when other ledges are empty; it seems the most uncrowded of places, but on a cumulative basis it is the best used part of Seagram's. Men show a tendency to take the front row seats, and, if there is a kind of gate, men will be the guardians to it. Women tend to favor places slightly secluded. If there are double-sided benches parallel to a street, the inner side will usually have a high proportion of women: the outer, of men.

Standing patterns are similar. When people stop to talk on a plaza, they usually do so in the middle of the traffic stream. They also show an inclination to station themselves near objects, such as a flagpole or a statue. They like well-defined places, such as steps, or the border of a pool. What they rarely choose is the middle of a large space. There are a number of explanations. The preference for pillars might be ascribed to some primeval instinct: you have a full view of all corners but your rear is covered. But this doesn't explain the inclination men have for lining up at the curb. Typically, they face inwards, toward the sidewalk, with their backs exposed to the dangers of the street.

Indoor spaces

As an alternative to plazas, builders have been turning to indoor spaces. There are many variants: atriums, galleries, courtyards, through-block arcades, indoor parks, covered pedestrian areas of one shape or another. Some are dreadful. In return for extra floors, the developers provided space and welshed on the amenities. But some spaces have been very successful indeed, and there is enough

of a record to indicate that the denominators are much the same as with outdoor space. Here, briefly, are the principal needs.

Sitting

Movable chairs are best for indoor parks, Most of the popular places have had excellent experience with them; some places. In all cases the total amount of sitting space has met or exceeded the minimum recommended for outdoor spaces .one linear foot for every 30 square feet (2.8 sq. m) of open space. There is a tendency, however, to overlook the potentials of ledges and planters. Too many are by inadvertence higher than need be.

Food

Every successful indoor space provides food. The basic combination is snack bars and chairs and tables. Some places feature café operations as well.

Retailing

Shops are important for liveliness and the additional pedestrian flows they attract. Developers, who can often do better renting the space for banks or offices, are not always keen on including shops. They should be required to.

Toilets

If incentive zoning achieved nothing else, an increase in public toilets would justify it. Thanks to beneficent pressure, new indoor parks in are providing a pair or more, unisex-style as on airplanes. One benefit of an indoor space is the through-block circulation it can provide for pedestrians. Planners believe this important, and developers have been allowed a lot of additional floor space in return for it. But walking space is about all that developers have provided, and it has proved no bargain. Unless there are attractions within, people don't use walkways very much, even in rainy or cold weather. Not so paradoxically, the walk-through function of a space is greatly enhanced if something is going on within it. Even if one does not tarry to sit or get a snack, just seeing the activity makes a walk more interesting.

Chapter 3, Urbanism session

3.1 Elements of the concept of urban space

Definition of the concept “urban space”

To clarify the concept of urban space without imposing aesthetic criteria, we are compelled to designate all types of space between buildings in towns and other localities as urban space. This space is geometrically bounded by a variety of elevations. It is only the clear legibility of its geometrical characteristics and aesthetic qualities which allows us consciously to perceive external space as urban space. The polarity of internal-external space is constantly in evidence in this article, since both obey very similar laws not only in function but also in form. Internal space shielded from weather and environment is an effective symbol of privacy; external space is seen as open, unobstructed space for movement in the open air, with public, semipublic and private zones.

The basic concepts underlying the aesthetic characteristics of urban space will be expounded below and systematically classified by type. In the process, an attempt will be made to draw a clear distinction between precise aesthetic and confused emotional factors. Every aesthetic analysis runs the risk of foundering on subjective questions of taste. Visual and sensory habits, which vary from one individual to the next, are augmented by a vast number of socio-political and cultural attitudes, which are taken to represent aesthetic truths..

The following classification does not make any value judgments. It enumerates the basic forms which constitute urban space, with a limited number of possible variations and combinations. The aesthetic quality of each element of urban space is characterized by the structural interrelation of detail. I shall attempt to discern this quality wherever we are dealing with physical features of a spatial nature. The two basic elements are the street and the square. In the category of “interior space” one would be talking about the corridor and the room. The geometrical characteristics of both spatial forms are the same. They are differentiated only by the dimensions of the walls that bound them and by the patterns of function and circulation that characterize them.

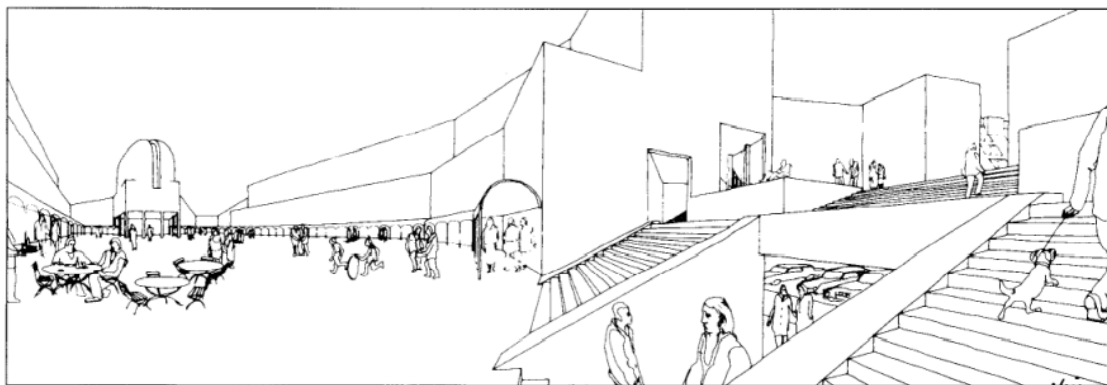
Typical functions of urban spaces

The activities of a town take place in public and private spheres. The behavioral patterns of people are similar in both. So, the result is that the way in which public space has been organized has in all period’s exercised a powerful influence on the design of private houses. One might almost infer

the existence of a kind of social ritual, which produces a perfect match between individual and collective. What concerns us above all here are those activities which take place in town in the open air: i.e., actions which a person performs outside the familiar territory of his own home and for which he utilizes public space, as, for example, traveling to work, shopping, selling goods, recreations, leisure activities, sporting events, deliveries, etc. Although the asphalt carpet that serves as a channel for the movement of cars is still called a “street,” it retains no connection with the original significance of the term. Certainly the motorized transportation of people and goods is one of the primary functions of the town, but it requires no scenery in the space around it. It is different in the case of the movement of pedestrians or public transport vehicles which move at a moderate speed, like carriages polluted in a different way: by horse manure, stinking sewage and uncollected refuse, A problem of urban hygiene, as old as the town itself, the only difference being that people can be poisoned by carbon monoxide but scarcely by horse manure.

The square

This spatial model is admirably suited to residential use. In the private sphere it corresponds to the inner courtyard or atrium. The courtyard house is the oldest type of townhouse. In spite of its undisputed advantages, the courtyard house has now become discredited. It is all too easily subject to ideological misinterpretation, and people are afraid that this design may imply enforced conformity to a communal lifestyle or a particular philosophy. A certain unease about one's neighbors has undoubtedly led to the suppression of this building type. Yet in the same way as communal living has gained in popularity for a minority of young people with the disappearance of the extended family, the concept of neighborhood and its accompanying building types will most certainly be readopted in the near future.



The square as intersection of two roads, fixed point of orientation, and meeting place.

The street

In purely residential areas streets are universally seen as areas for public circulation and recreation. The distances at which houses are set back from the street, as regulations often demand, are so excessive that attractive spatial situations can only be achieved by gimmickry. In most cases, there is ample space available for gardens in addition to the emergency access required for public service vehicles. This street space can only function when it is part of a system in which pedestrian access leads off the street . This system can be unsettled by the following planning errors:

1. If some houses and flats cannot be approached directly from the street but only from the rear. In this way the street is deprived of a vital activity. The result is a state of competition between internal and external urban space. This characterization of space refers to the degree of public activity which takes place in each of these two areas.
2. If the garages and parking spaces are arranged in such a way that the flow of human traffic between car and house does not impinge upon the street space.
3. If the play spaces are squeezed out into isolated areas with the sole justification of preserving the intimacy of the residential zone. The same neurotic attitude toward neighbors is experienced in flats. The noise of cars outside the home is accepted, yet indoors children are prevented from playing noisily.
4. If no money can be invested in public open spaces, on such items as avenues of trees, paving and other such street furniture, given that the first priority is the visual appeal of space.
5. If the aesthetic quality of adjacent houses is neglected, if the facing frontages are out of harmony, if different sections of the street are inadequately demarcated or if the scale is unbalanced. These factors fulfill a precise cultural role in the functional coherence of the street and square. The need to meet the town's function of "poetry of space" should be as self-evident as the need to meet any technical requirements. In a purely objective sense, it is just as basic.



3.2 Typology of urban space

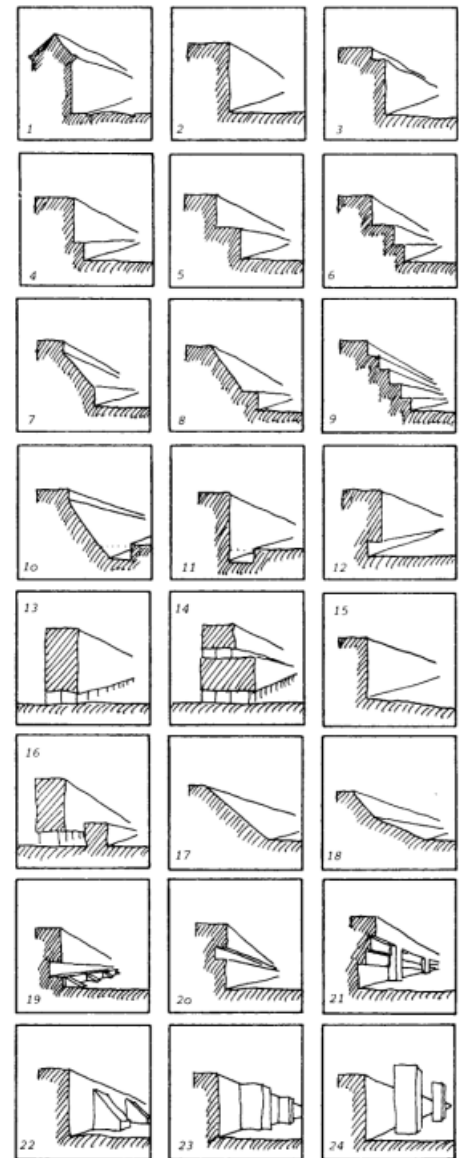
In formulating a typology of urban space, spatial forms and their derivatives may be divided into three main groups, according to the geometrical pattern of their ground plan: these groups derive from the square, the circle or the triangle. Without doubt the scale of an urban space is also related to its geometrical qualities. Scale can only be mentioned in passing in this typology. Scale and the significance of proportions in external space do not affect the arrangement of the typology



How building sections affect urban space

The basic elements can be modified by a great variety of building sections. The figure depicts twenty-four different section types that substantially alter the features of urban space, as follows:

1. Standard traditional section with pitched roof,
2. with flat roof.
3. with top floor set back. This device reduces the height of the building visible to the eye.
4. with a projection on pedestrian level in the form of an arcade or a solid structure. This device distances the pedestrian from the real body of the building and creates a pleasing human scale.
5. Half way up the building, the section is reduced by half its depth; this allows for extensive floors on the lower level and flats with access balconies on the upper level.
6. Random terracing.
7. Sloping elevation with vertical lower and upper floors.
8. Sloping elevation with protruding ground floor,
9. Stepped section.
10. Sloping section with moat or freestanding ground floor.
11. Standard section with moat.
12. Building with ground floor arcades.
13. Building on pilotis.
14. Building on pilotis, with an intermediate floor similarly supported.
15. Sloping ground in front of building.



Building sections

16. A free-standing low building placed in front of a higher one.
- 17/18. Buildings with a very shallow incline, as, for example, arenas.
19. Building with arcade above ground level and access to pedestrian level.
20. Building with access balcony.
21. Inverted stepped section.
22. Building with pitched projections.
23. Building with projections.
24. Building with free-standing towers

Elevations

Notes on sketches in Fig. (Reading left to right):

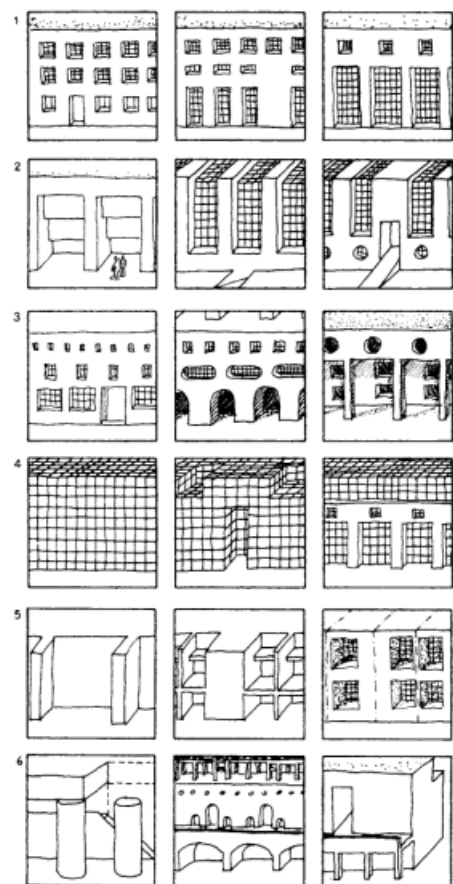
1. Pierced façade: the lowest level is more generously glazed in each sketch, reducing the solid area to a simple load-bearing structure.

2. The glazed area within the load-bearing structure can be modified according to taste. The following three pictures show a reverse of the design process portrayed in 1. A solid base forces the glazed area upward.

3. The window type can be modified horizontally and vertically according to the imagination of the designer.

4. Faceless modular façade as a theoretical (abstract) way in which the building might be enclosed. The modular façade can be adapted to all variations in the shape of the building. Solid sections of the building can be combined with the grid.

5. Windowless buildings: windows are placed in niches, etc., and the process starts again from the beginning.



Elevations

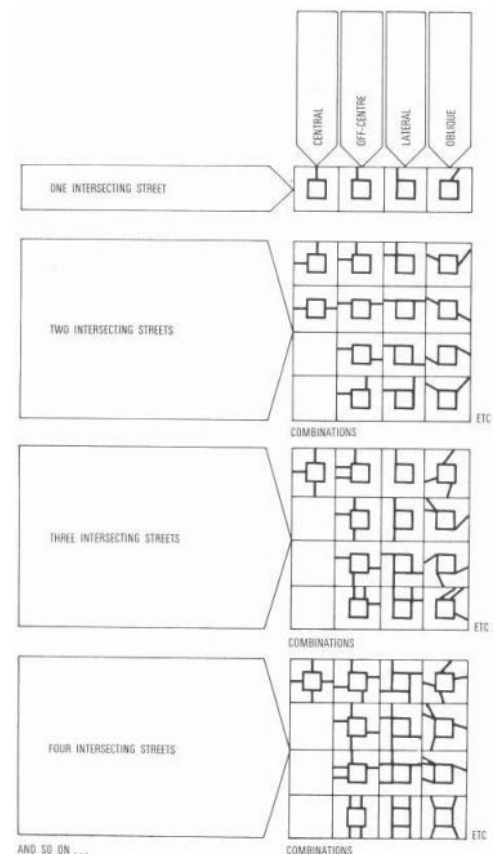
6. Exploration of different geometries: a thematic interpretation of the elevation: lowest level=heavy; middle section=smooth with various perforations; upper part=light, transparent. One of the sketches of squares shows a variation on this theme on three sides of a square. Arcades are placed in front of houses, with different architectural styles juxtaposed.

Intersections of street and square

All spatial types examined up to now can be classified according to the types of street intersection laid out in Figure. As an example, a set of permutations set up for up to four intersections at four possible points of entry. The vertical columns of this diagram show the number of streets intersecting with an urban space, horizontally, it shows four possible ways in which one or more streets may intersect with a square or street:

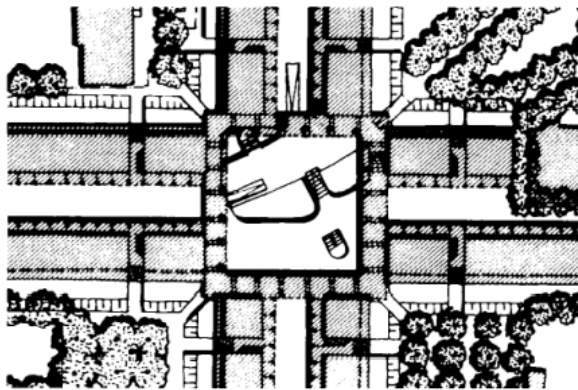
1. Centrally and at right angles to one side.
2. off-center and at right angles to one side.
3. Meeting a corner at right angles.
4. Oblique, at any angle and at any point of entry
5. Spatial types and how they may be combined.

The morphological classification of urban spaces may be summarized as follows: The three basic shapes—square, circle and triangle are affected by the following modulating factors: angling; segmentation; addition; merging; overlapping or amalgamation of elements; and distortion. These modulating factors can produce geometrically regular or irregular results on all spatial types. At the same time, the large number of possible building sections influences the quality of the space at all these stages of modulation.



Intersections of street and square.

All sections are fundamentally applicable to these spatial forms. In the accompanying sketches the intention is to make clear as realistically as possible the effect of individual spatial types so that this typology can be more easily accessible and of practical use to the planner. The terms “closed” and “open” may be applied to all spatial forms described up to now: that is, spaces which are completely or partially surrounded by buildings. Finally, many compound forms can be created at will from the three spatial types and their modulations. In the case of all spatial forms, the differentiation of scale plays a particularly important role, as does the effect of various architectural styles on the urban space architectural design possible in the first place, and above all else, determine the use or function of a building, which is the essential prerequisite for architectural design. The logic of this procedure would therefore demand this sequence: function, construction and finally the resultant design.



.The square as intersection



Combination of three different façades



*Combination different façades, but
Overgrown with plants.*

3.3 Character of new urbanism

The Block, the Street, and the Building

1. A primary task of all urban architecture and landscape design is the physical definition of streets and public spaces as places of shared use.
2. Individual architectural projects should be seamlessly linked to their surroundings. This issue transcends style.
3. The revitalization of urban places depends on safety and security. The design of streets and buildings should reinforce safe environments, but not at the expense of accessibility and openness.
4. In the contemporary metropolis, development must adequately accommodate automobiles. It should do so in ways that respect the pedestrian and the form of public space.
5. Streets and squares should be safe, comfortable, and interesting to the pedestrian. Properly configured, they encourage walking and enable neighbors to know each other and protect their communities.
6. Architecture and landscape design should grow from local climate, topography, history, and building practice.
7. Civic buildings and public gathering places require important sites to reinforce community identity and the culture of democracy. They deserve distinctive form, because their role is different from that of other buildings and places that constitute the fabric of the city.
8. All buildings should provide their inhabitants with a clear sense of location, weather, and time. Natural methods of heating and cooling can be more resource-efficient than mechanical systems.
9. Preservation and renewal of historic buildings, districts, and landscapes affirm the continuity and evolution of urban society

INTEGRATED SYSTEM

SITE SYSTEMS

Systems integration at the site level deals with issues of context: environmental, social, urban, cultural, and whatever special conditions are presented by the exact situation of the building project

and its neighboring surroundings. Site systems are the first level of interface between the building solution and the site context. Elements

- **Topography** — building set on, above, or into differing grade levels; retaining walls and modifications to natural grade
- **Surrounding structures** — shade, wind, and view determined by immediate surroundings
- **Footprint** — orientation, elongation, and massing of the building
- **Perimeter** — defining the boundaries of the site with fences, gates, walls, hedges, and/or landscaping
- **Landscape** — vegetation, bodies of water, and other natural features
- **Paving** — parking, access, driveways, pedestrian paths, terraces, patios
- **Storm water** — rainwater drainage, detention ponds, swales, gutters and downspouts, area drains, curbs, and gutters
- **Utilities** — service connections, transformers, meters, waste disposal
- **Site lighting** — general illumination, façade lighting, lighting for pathways, security, signage
- **Appurtenances** — gazebos, porte-cocheres, arbors, fences

Microclimates and Environmental Site Design

From the environmental perspective, the site forms microclimatic conditions by modifying the regional climate. Then the relationship of a building to its site begins as a series of formal responses: thermal, aerodynamic, solar, luminous, and so on. For example, a building on the north side of a hill is in a very different microclimate than a building on the south side of the same hill; a building surrounded by asphalt is in a very different condition than one surrounded by trees. To a large degree, these microclimatic modifications can be controlled by careful design and deployment of the site systems. This means that the site can be treated as an outer layer beyond the envelope and act to interpret environmental conditions favorably.

The integration of site systems should maximize the results of these modifications. Trees established for shade also affect wind patterns and views into and out of the building. Paving is used to drain storm water from parking and surrounding areas. Solar orientation and the placement

of glazing impact the availability of lighting and the issues of view and privacy. Natural bodies of water and storm water detention ponds can work as cooling towers for the HVAC system. This list can be elaborated at length, as can be seen in the next section of this chapter, but bear in mind that potential benefits depend heavily on the particulars of the building program.

Architecture as an Armature for Nature

Ultimately, site design determines a building's place in nature. As soon as the building is completed, nature begins to reclaim it by acts of weathering, erosion, and chemical and biological change. High levels of maintenance will be required if the building and site elements are to resist nature's reclamation. Without continuing maintenance, nature will mark the building with its weathering processes. The architect has to design according to assumptions about ongoing maintenance over the building's lifetime to accommodate this aging. Durable materials that defy the weather are more expensive than those with shorter lives; exposed materials require more detailing than painted ones.

Many attitudes about design are prone to regard the site as a resource for the building. The imposition of the architectural footprint on the land is given dominance over the condition of the site in terms of everything from orthogonal geometries to border plantings. The counterposition asks about the notion of buildings as systems that will gradually be reclaimed by nature anyway. It proposes that a building is, in fact, an armature for nature and so replaces industrial mechanics with natural ones wherever feasible:

- Paving blocks or stones replace concrete and asphalt paving

- Water gardens replace runoff and storm water retention ponds

- Hedgerows replace border plantings and fences

- Natural landscaping is used in favor of pesticides, fertilizers, watering, mowing and raking

- Earth-integrated buildings are designed in underground, earth-covered, or earth-bermed configurations instead of on graded sites

- Habitats for native species are incorporated in favor of exterminated lawns

Integration Potentials

There are an infinite number of possible integrations between the five major building systems, between the subsystems of each, and among subsystems of different major systems. There can be

no exhaustive list, and, more important, developing the correct list for each building project is a matter of careful decision making in design. It is quite possible, however, to generate a beginning list based on what has been defined here as shared mandates between the major systems. Examples of the integration potential of overlapping shared space, shared image, and shared function among the ten possible pairs of major building systems are outlined below.

	Site	Structure	Envelope	Services
Interior	Indoor/out relationships	Exposed structure Integrated lighting	Daylighting	Exposed ducts Masking background Air-handling luminaries
Services	Cooling ponds Earth tube cooling	Duct routes Interstitial mechanical Plenums	Passive design Solar roofs Vented skin Double envelope	
Envelope	Earth shelter Natural habitat Noise barriers Storm water	Building shell Shading Light diffusing		
Structure	Underground Terraced			

Some Integration Opportunities as Shared Mandates between the Ten Possible Pairings of Five Major Systems

Urban Spaces and Open Spaces

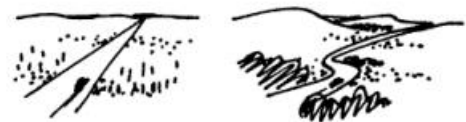
Urban shape, pattern, grain, size, density, and texture are primarily aspects of solid form—the building masses of the city. In architecture it is rather helpful to conceive of a building not only as a solid but as spaces modeled by solids. It is also helpful to consider a city this way. The spaces of the city range from the space of the street to the space of a park system and, ultimately, to the vast space in which an entire city exists. It is helpful to think of these spaces as two generic types: formal or “urban spaces,” usually molded by building facades and the city’s floor; and natural or “open spaces,” which represent nature brought into, and around, the city. Basically an urban space must be distinguished by a predominant characteristic, such as the quality of its enclosure, the quality of its detailed treatment or outfitting, and the activity that occurs in it. An urban space

should, ideally, be enclosed by surrounding walls, have a floor which suits its purpose, and have a distinct purpose to serve. If, however, any one of these qualities is sufficiently strong, it alone may establish the sense of urban space. A group of office buildings may contain a space around a poorly designed plaza or a complex road intersection, the floor space being devoted entirely to traffic. This is an urban space which has a sense of place in the city. It is both a landmark and a traffic node, as well as an office node. An urban square may be beautifully landscaped as a restful urban park, but it may lack entirely the peripheral building facades which are needed for a sense of enclosure. Here we have a poorly enclosed space, but a space nevertheless. In another instance, a particular place in the city may function as the locale of an important activity while possessing neither physical enclosure nor appropriate floor.

Open spaces, being nature brought into the city or open expanses allowed to remain in their original state, cannot be described in quite the same manner used for urban spaces. Their scale is given by the trees, shrubs, rocks, and ground surface rather than their gross width and length. Their appearance is characterized by the sight of natural verdure rather than surrounding buildings. However, a vista of a distant building may accent a particular spot and a bridge or pathway may complement nature's forms. Open spaces in the city have a wide variety of purposes. They are a complement and foil to urban form. They are also reservoirs of land for future use. For an urban design survey, one should study the spaces of the city as an overall structure. In doing this it is helpful to classify spaces according to their actual use and to consider formal urban spaces and the natural open spaces together.

Routes

Landscape, architecture, and cities are seen as sequences as we travel along routes of movement. Routes of movement affect considerably the appearance of the landscape through which they pass and the architecture and cities which they serve. Routes of movement are a principal determinant of urban form. In making an urban design survey of the routes of a city, one should begin with the area well beyond the city limits, far out in the country. The



Routes traverse the countryside in many ways.



Routes can approach architecture or cities in many ways.

primary function of a highway is to allow traffic to move, but a large part of that job depends on how clear the route is in relation to the city. This aspect of highway engineering—the “imageability” of the highway—is a matter of revealing its clarity of form and direction to the user. Too many highways have very poor physical relationships to the areas they serve. Rather than helping to define these areas, they often slash through them, actually acting as a blighting and disintegrating force.

Routes in the Countryside

In the open landscape, existing and proposed routes should be examined and assessed with a view to how well they relate to the natural terrain. How artfully or awkwardly do routes traverse the landscape, revealing its prominent features? Are vistas taken advantage of, or ignored? Some vistas might well be presented with dramatic suddenness; others might be introduced gradually, or be seen only in part.

Approach Routes and Surface Arteries

Approach routes present cities to us. They must satisfy the visual requirement of presenting architecture and cities in their best light, while enabling us to find our destination readily. The two requirements go hand in hand. An approach route must both inform us and conduct us. The major routes through the city are surface arteries—high volume traffic streets which carry buses and autos. They can be evaluated according to how they tie into the expressway pattern, their clarity of form, their relation to the cityscape, the shape of the building sites they pass by, and the way they pass through existing districts.

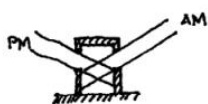
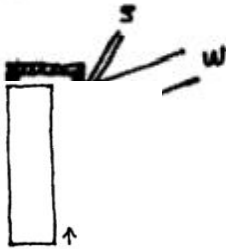
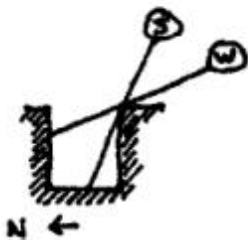
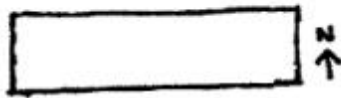
3.4 DESIGN IMPLICATIONS OF THE SOLAR ENVELOPE

Architects generally ignore the temporal dimension that nature adds to our perceptions of space. They acknowledge that buildings may be transformed or deteriorate over time but on the whole

their artistic idea of space is complete and static, the final product of many imaginative decisions. By contrast, guaranteed access to sunlight opens the possibility that a spatial concept linking solar rhythms to life's rituals can give new life and freshness to design. Space is generated by flux itself.

Rhythm

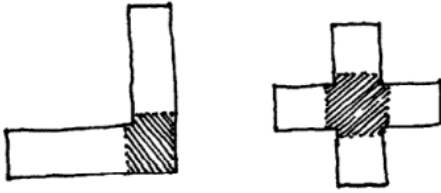
Rhythm itself is a mysterious fact of aesthetic experience (Gross 1966). This observation has generally been made about poetry or music. But rhythm has the quality of being actual in all our movements and in the events around us. Rhythm is the way our bodies and emotions respond to the passage of time. It is therefore a universal means of affecting experience and conveying meaning in our lives. Consider how the rhythms of sunlight alter our understanding of space. Whether we occupy an inside or an outside space, two scales of time can be noted. One measures a day of experiences and actions; the other, a year. People cannot really know their possibilities, or the possibilities of a place, by passing through just once. They must remain awhile.



Any space that is oriented from east to west strengthens our experience of the seasons. One main wall is nearly always dark; on the other side of the space, a shadow line moves gradually up the wall and then down again. To experience the whole cycle takes exactly one year. The basic movement is always the same. As the sun's path drops lower in the sky during late summer and fall, the shadow moves up. As the sun's path rises in the sky during late winter and spring, the shadow moves down. Changing the orientation of the space will evoke a different cycle and rhythm.

Any space that is oriented from north to south sharpens our experience of a day. Both main walls are lighted, but at different hours. Every morning, light from the east will cast a shadow that moves quickly down the opposite wall and across the floor.

Every afternoon, light from the west will cast a shadow that crosses the floor and climbs the opposing wall. To experience the whole cycle takes from before sunrise until after sundown.

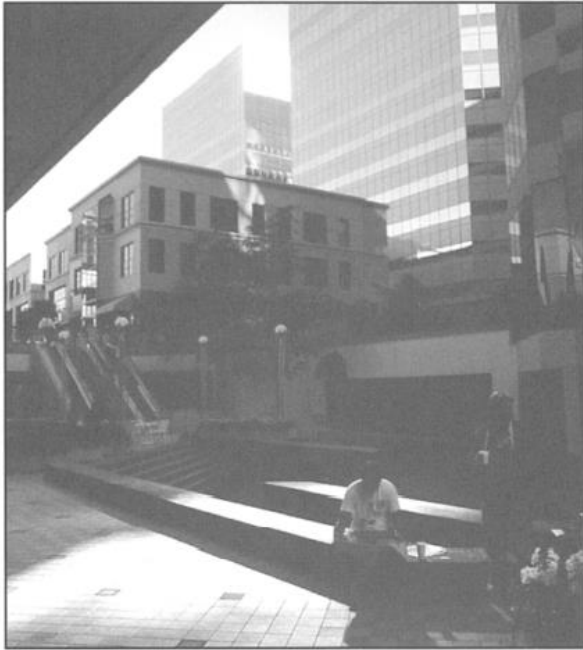


Where east-west and north-south spaces pierce each other, we can experience two measures of time. The common volume intensifies both a seasonal and a daily cycle. It combines them, laying one over the other. The result is a crossing in space that proportions time. Its celebration has often lifted architecture out of the region of fact into the realm of art.

CONCLUSION

Not only does the solar envelope allow for potential development increasing density while maintaining access to sunlight but also opens new possibilities for architecture and urban design to design with nature and unique circumstance. The outcome of a research and design studies reported above shows that buildings under the solar envelope are neither too big for human scale nor too small for urban growth; their scale is consistent with some of the most admired cities in the world. These results suggest that the solar envelope can provide urban legibility while, at the same time, satisfying many conditions of a sustainable future.

Urban design and climate



Many features of the physical structure of the city can affect the urban microclimate. Therefore it is possible to modify the urban climate through urban policies and design of neighborhoods and whole new cities. With such modifications it is possible to improve the comfort of the inhabitants outdoors and indoors and to reduce the energy demand for heating in winter and for cooling in summer. The following urban design elements that affect the urban climate are discussed in this article, with reference to the research literature:

- Size of the city
- Orientation and width of the streets
- Density of the built-up area
- Height of buildings
- Building color
- Effect of parks and other green areas on the urban climate

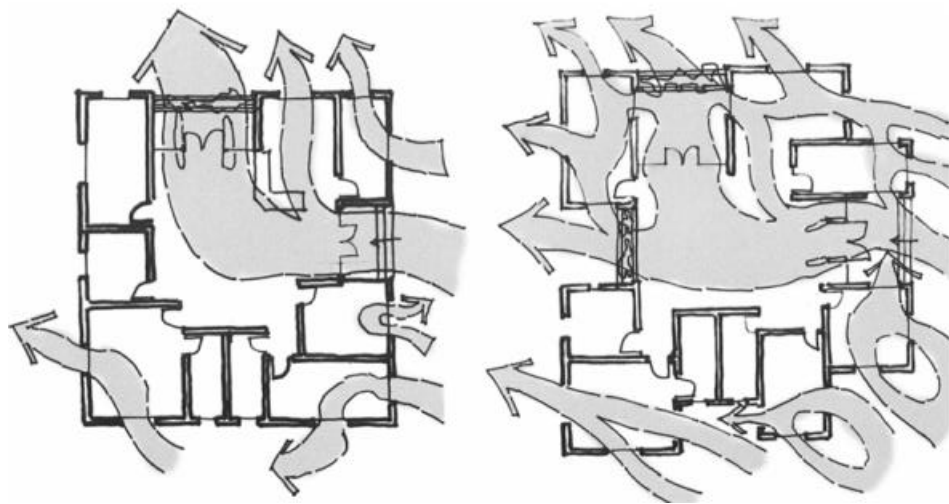
Key words

albedo (color), climatology, cool roofs, density, evaporative cooling, heat island, landscape, orientation, shading, ventilation, wind protection.

Literature reviews in building climatology documenting experimental studies of the effects of building shape and orientation, landscape, ground and building surfaces, on the microclimate. The microclimate as defined by Geiger (1965) is the conditions at or immediately near surface levels as affected by its physical attributes.

GREEN AREAS AND THE URBAN CLIMATE

Urban “green” areas, in public open spaces like parks as well as in private planted areas around buildings, can have a marked effect on the climatic conditions to which an individual building is exposed and on the urban climate at large. The type and details of the plants around a building can affect its exposure to the sun and the wind, its indoor comfort conditions and energy use. The accumulated effect of trees and other plants in the urban area can modify the urban temperature, the urban wind conditions and the solar exposure of buildings and of pedestrians in the streets, in public parks and other open spaces.



Comparison of ventilation potential of two designs: one compact and one spread-out, with the same area and program. (After Givoni 1998).

After general discussion of the climatic effects of plants, this section presents quantitative information obtained in experimental studies in which the effects of various plant types were investigated. This presentation is divided into three sections:

- Shading effects of plants.
- Effect of plants on ambient and surface temperatures.
- Effects of plants on the wind speed.

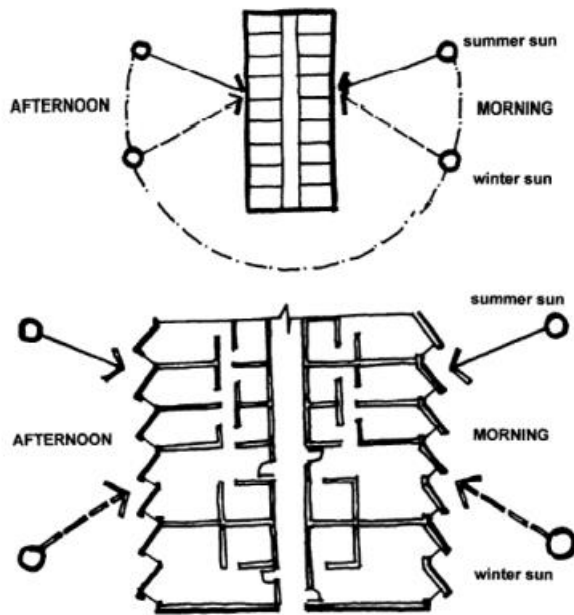
Climatic effects of plants upon comfort and energy use

Trees and other plants modify the climatic conditions to which buildings, as well as persons staying outdoors, are exposed. Trees and vines provide shade over windows and walls of buildings, as well as shading persons staying outdoors. All plants reduce the ambient air temperature and increase the moisture content of the air. Most plant types reduce the wind speed near the ground.

The effects of green spaces on the urban climate depends on the fraction of “green” areas, public as well as private, relative to the whole built-up urban area. The effect of urban plants can be different, under different planting schemes, especially with respect to solar exposure of pedestrians and the wind speed in the streets, depending on the particular choice of the plants and the details of the landscaping.

Plants can affect the indoor temperature and the cooling and heating loads of buildings in several ways:

- Trees with high canopy, and pergolas near walls and windows, provide shade and reduce the solar heat gain with relatively small blockage of the wind (shading effect) .
- Vines climbing over walls and high shrubs next to the walls, while providing shade, also reduce appreciably the wind speed next to the walls (shading and insulation effects) .
- Dense plants near a building can lower the air temperature next to the skin of the building, thus reducing the conductive and the infiltration heat gains. In winter they, of course, reduce the desired solar gain and may increase the wall’s wetness after rains.
- Ground cover by plants around a building reduces the reflected solar radiation and the longwave radiation emitted toward the walls from the surrounding area, thus lowering the solar and longwave heat gain in summer.
- If plants lower the ambient temperature around the condenser of an air-conditioning unit of a building, the coefficient of performance (COP) of the cooling equipment would be improved.
- By reducing the wind speed around a building in winter, plants can reduce the infiltration rates and the heating energy use of the building (insulation effect). However, trees and shrubs can also direct the wind to a desired spot, e.g., an opening serving as an inlet for ventilating a building, or to a bench in a park.
- Evergreen trees on the southern side of a building reduce its potential to use solar energy for heating. Trees and high shrubs at the western and eastern sides of a building can provide effective protection from solar gain in summer.



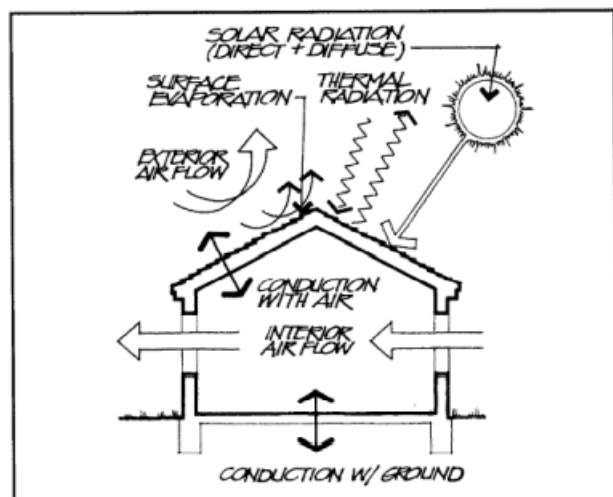
Quantitatively, the effects of plants depend on the density and thickness of the foliage layer and the type of the leaves of the plants. These properties change with the age of the plants and with the seasons. The seasonal changes are greatest, of course, in the case of deciduous plants.

3.5 Bioclimatic design at the site planning scale

Abstract

Bioclimatic design

Based on analysis of the climate and ambient energy represented by sun, wind, temperature and humidity—has developed out of sensitivity to ecological contexts and the need to conserve energy and environmental resources. This article demonstrates site planning approaches for wind protection in under heated conditions (typically winter) and for cooling in overheated periods (typically summer). Key words evaporative cooling, ground cover, land form, microclimate, passive heating and cooling, shading, solar radiation, temperature, vegetation, ventilation wind shadow.



Paths of heating energy exchange at the building microclimate.

evaporative cooling, ground cover, land form, microclimate, passive heating and cooling, shading, solar radiation, temperature, vegetation, ventilation wind shadow.

Urban designers can create favorable microclimatic conditions in and around buildings and outdoor spaces to dramatically increase comfort and reduce building energy requirements. In winter (or under heated periods), the objectives of bioclimatic design at the site planning scale are to protect outdoor spaces, entryways and structures from the winter wind and to promote gain of solar heat. In summer (or overheated periods), these objectives are the reverse, to resist solar gain by shading and to promote cooling by ventilation. Evaporative cooling by ground cover and water can be made effective in temperate and hot dry climates.

Bioclimatic design techniques at the site planning scale include:

Wind breaks (winter)

- Use neighboring land forms, structures, or vegetation for winter wind protection. Sun shading (summer): Because sun angles are different in summer than in winter, it is possible to shade spaces and building openings from the sun during the overheated summer period while allowing the sun's heat to reach spaces and window surfaces in winter. The concept to provide sun shading does not need to conflict with winter solar design concepts.
- Use neighboring land forms, structures, or vegetation for summer sun.
- Provide seasonal shading, including deciduous trees.

Natural ventilation (summer and seasonal): Natural ventilation is a simple concept by which to cool outdoor spaces and buildings.

- Use neighboring land forms, structures, or vegetation to increase exposure to summer breezes. Plants and water (summer): Several landscaping techniques provide cooling by the use of plants and water near building surfaces and outdoor spaces for shading and evaporative cooling.
- Use ground cover and planting for site cooling.
- Maximize on-site evaporative cooling. Each locale has its own bioclimatic profile of assets and liabilities, the responses to which are oftentimes evident in indigenous and local long-established building traditions. Recently developed energy design tools make it possible to utilize hourly weather data to accurately analyze climate.

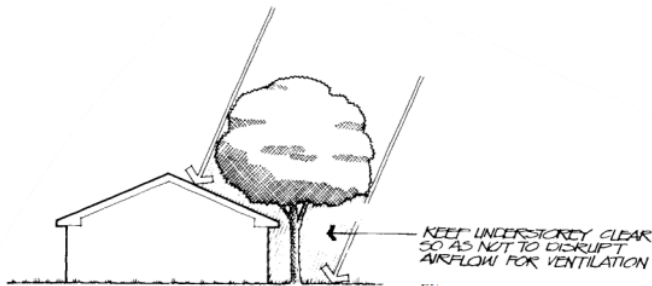
Use neighboring land forms, structures, or vegetation for winter wind protection

General Rules of Windbreak Design

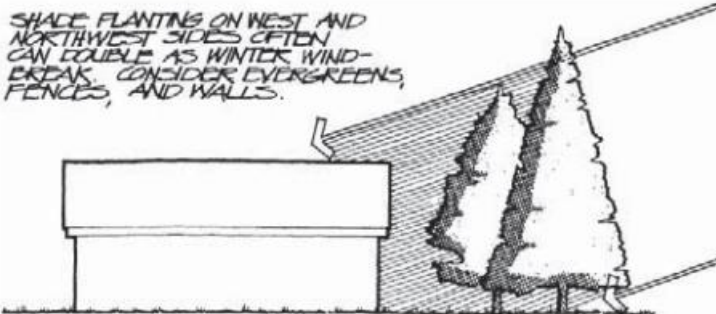
An analysis of the building site should be made to determine if there are existing wind protected areas. In siting a house, the builder should avoid open areas, hilltops and valley floors that are directly exposed to prevailing winter winds. Existing hedgerows, hillocks and tree stands may be available as windshields. The arrangement of housing units in cluster plans and planned unit developments can be used to take advantage of these.

Cold air flows downhill just like water, so that although a valley may seem to be shielded from cross winds, it may actually be in the midst of a steady downstream nighttime cold air current. The best protected sites, occur on leeward slopes .

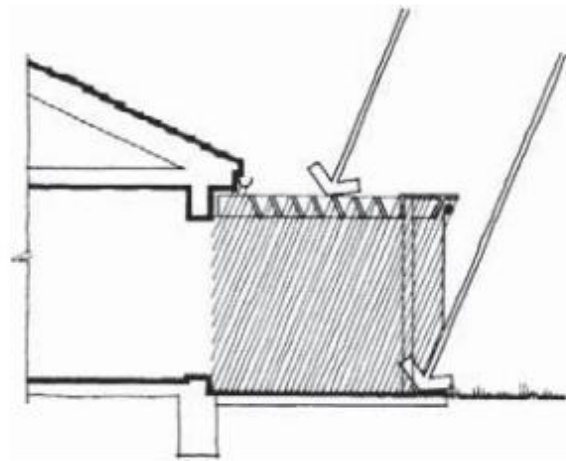
Use neighboring land forms, structures, or vegetation for summer shading.



Plant tall canopy trees on south side of house to shade roof and walls.

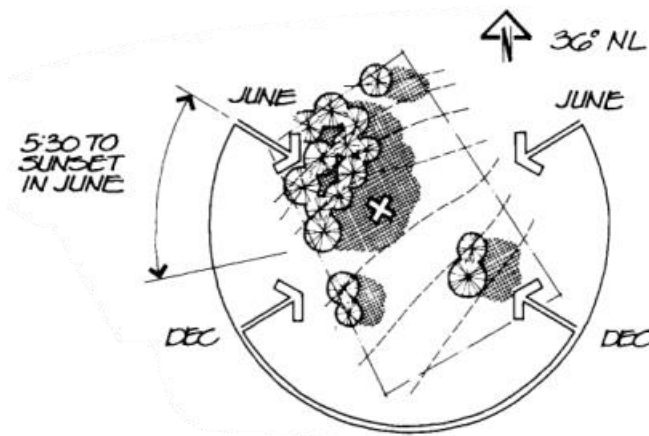


Plant dense trees, shrubs, hedges on west side of house to intercept afternoon sun.



Attached overhead shading structures can provide multiple benefits. Not only does this patio cover shade the wall, it also reduces reflected gain from loading on the wall.

Use neighboring land forms, structures, or vegetation for summer shading



“X” marks the spot for existing onsite sun protection. Look for sites shrouded by trees on west side. In this example, trees are on upslope, enhancing their shading ability. Don’t sacrifice winter southern exposure, though!

Opportunities for sun control and shading exist in almost all aspects of site planning and development, from the initial selection of a building site or the plotting of the lots in a subdivision to the final selection of plant materials and details in landscaping.

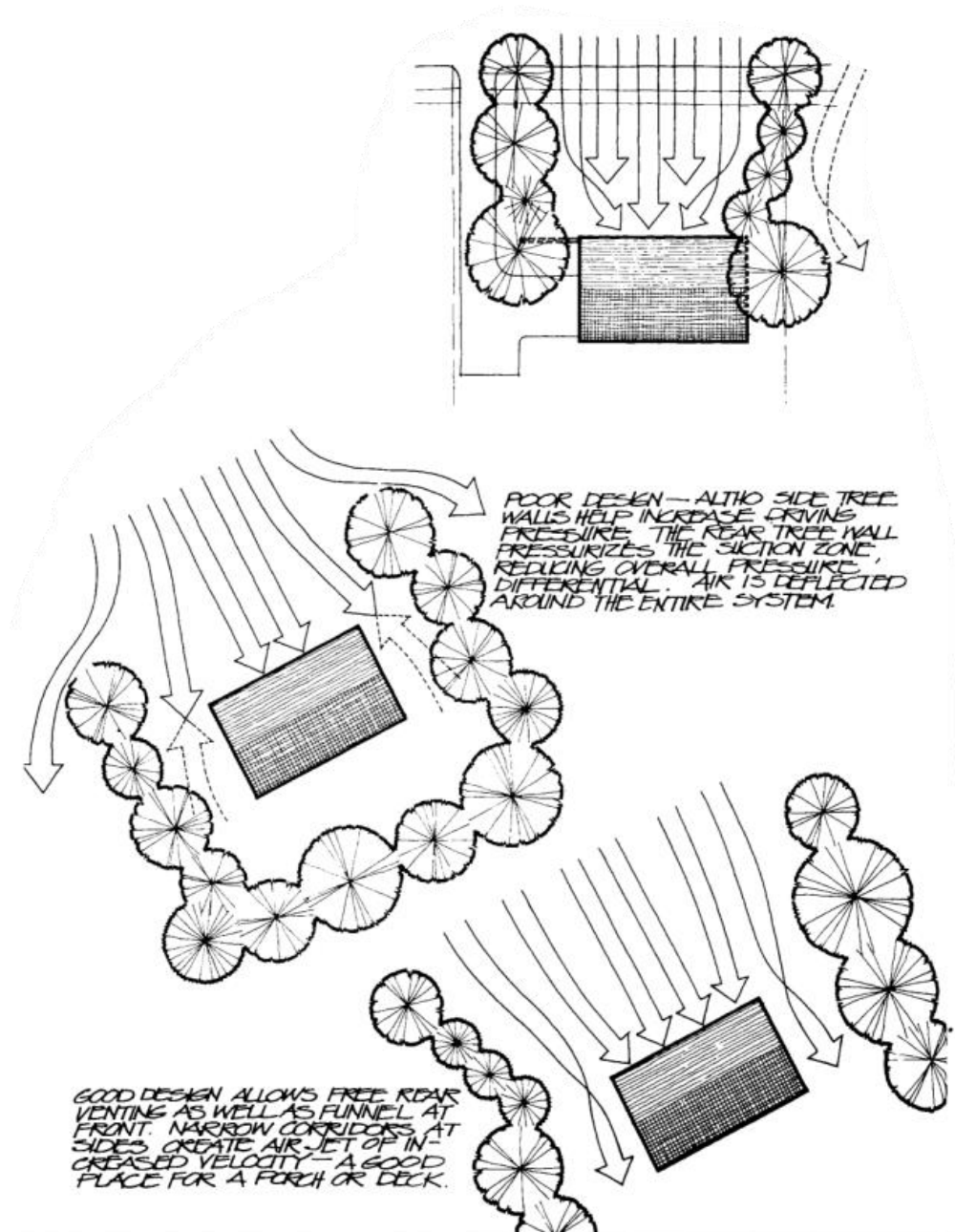
Siting

For a custom house on property that is large enough to offer several building sites, the choices should be analyzed for natural shading from existing trees and land masses. These can be utilized to reduce solar gain from low afternoon summer sun by siting the building to the east of such features.

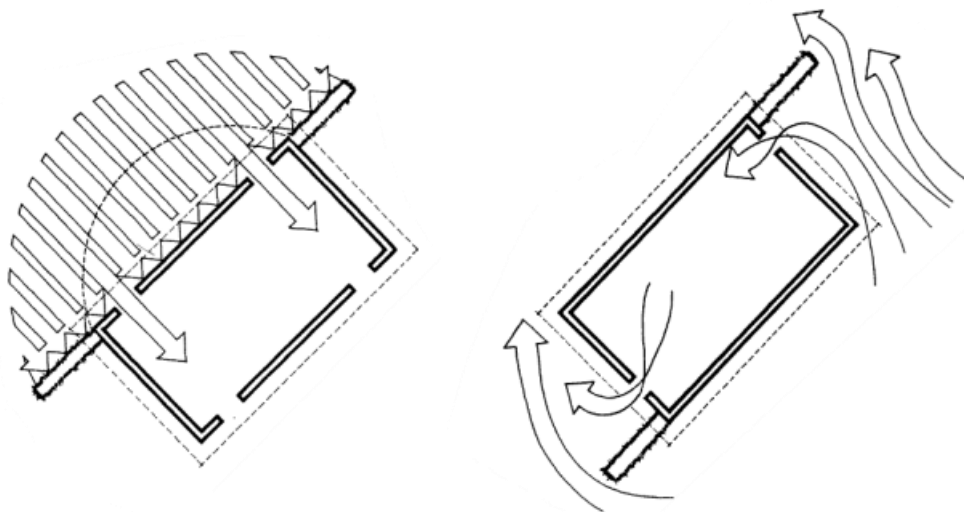
Use neighboring land forms, structures, or vegetation to increase exposure to summer breezes.

Wind Funnels

Tree planting can be used to guide wind into unit. Here tree funnel lines are “disguised” as driveway and property line planting to better blend with sitting

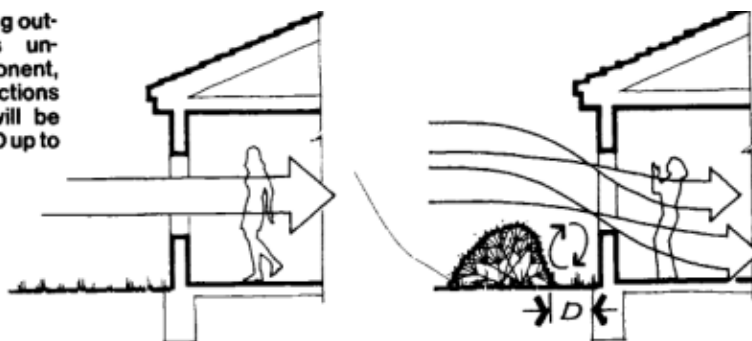


Use neighboring land forms, structures, or vegetation to increase exposure to summer breezes.

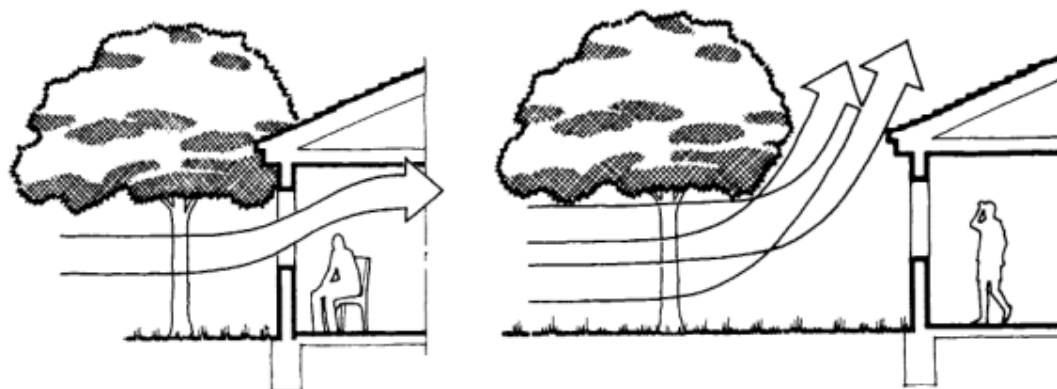


Wind dams

Hedge and shrub planting outside window relieves unwanted pressure component, fosters downward deflections of air stream. Effect will be produced for distances D up to 15 to 20 ft.

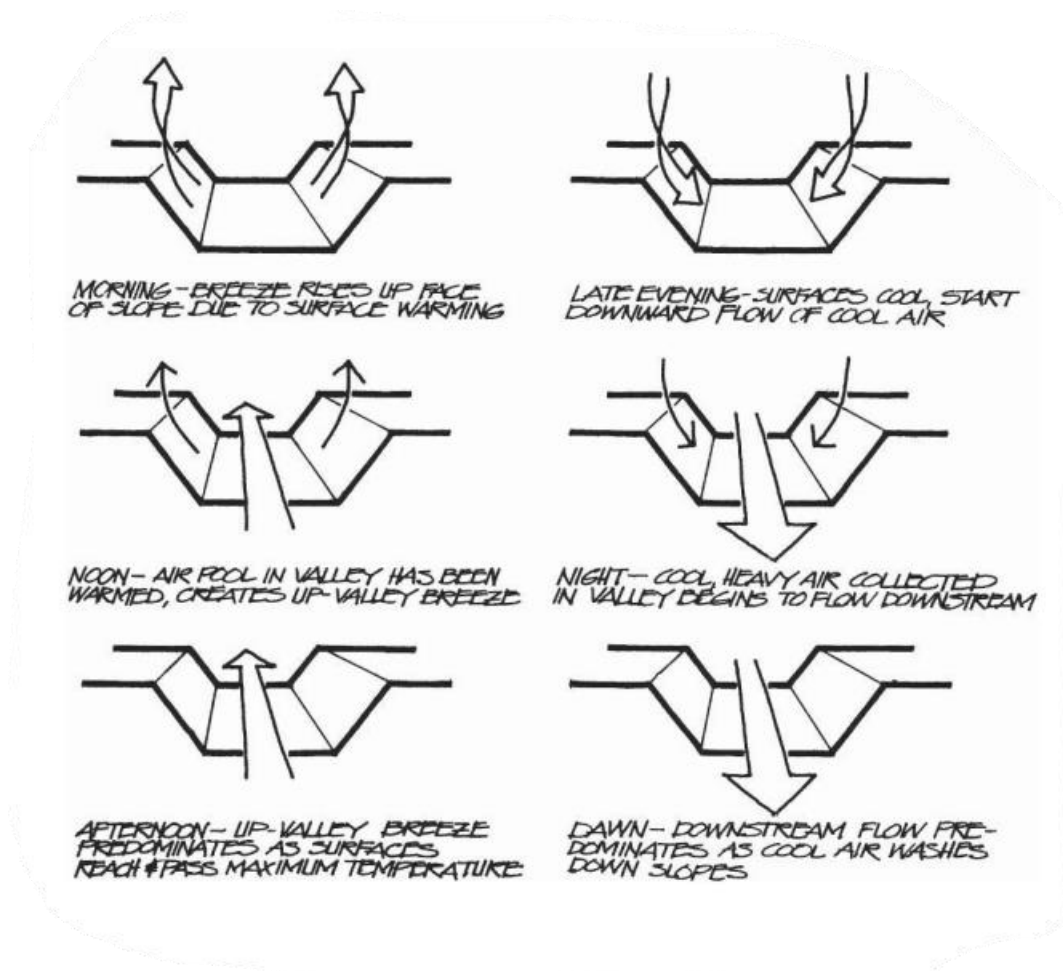


Influence of tree canopy outside the window is to "lift" or warp the airstream upward by relieving downward pressure (opposite of shade-effect). If tree is immediately outside window it will produce a ceiling wash flow. At a distance from the house, canopy may warp the airstream sufficiently to miss the house altogether.



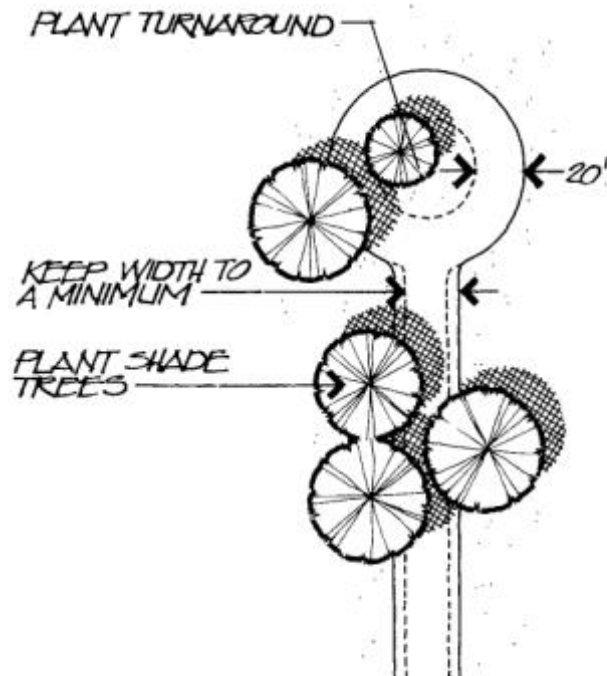
Wind deflectors

Use neighboring land forms, structures, or vegetation to increase exposure to summer breezes.



Use ground cover and planting for site cooling

Neighborhood air temperatures can be kept low by minimizing the expanse of paving, and by shading paved areas. Many of the guidelines above save dollars or boost sales appeal.



Site Planning Suggestions:

Keep paved area to a minimum—an 8 ft. dia. turnaround with a 20 ft. ring road is recommended.

If spillover parking areas are required use a porous paving block instead of asphalt.

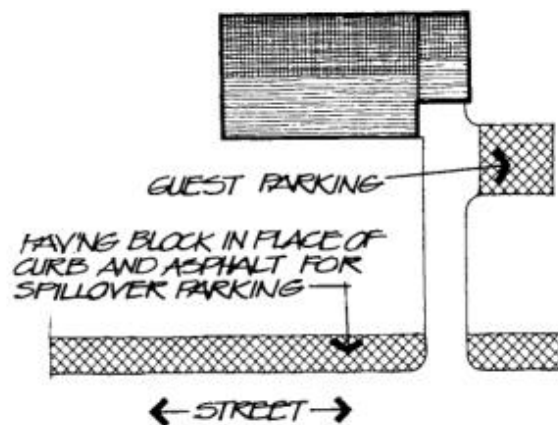
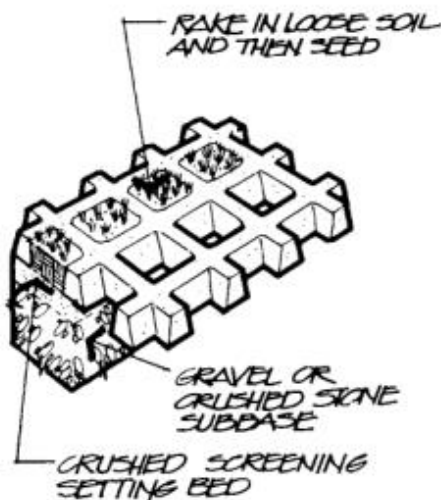
Plant shade trees to shade paving.

Use 18-20 ft. street width for large lot (34 acre or more) developments.

Use 26 ft. street width for 14 acre lots on cul-de-sacs and short loops.

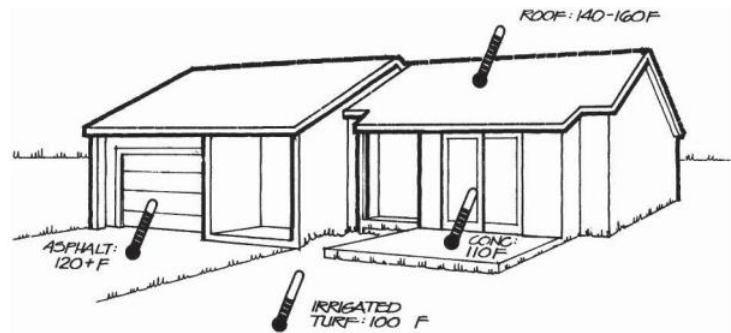
Avoid 34-36 ft. street widths—these are never warranted in well planned new developments.

Porous concrete paving can be precast or cast-in-place with forms made for this purpose (“grass tone,” shown below, and “grass Crete” are examples) use it for stabilizing shoulders and for spillover parking spaces both on and off lot.



Use ground cover and planting for site cooling.

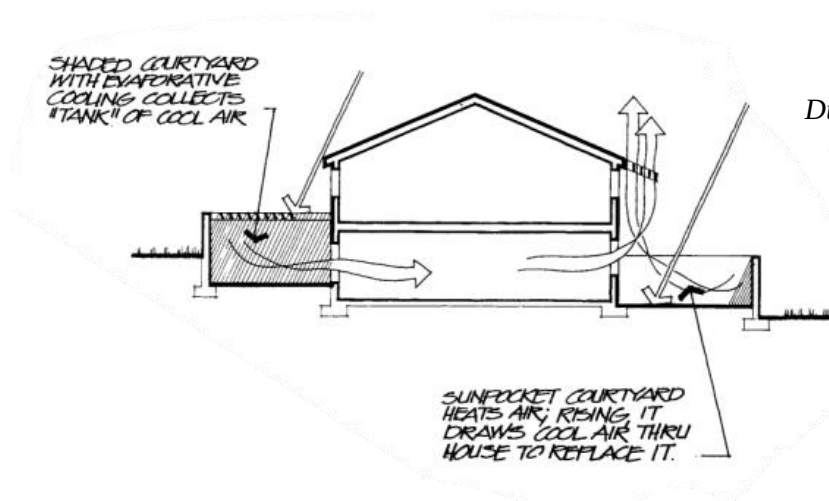
The climatic benefit of landscaped ground cover is seldom considered. On a sunny summer day, an acre of turf may evaporate about 2400 gallons of water



The relationship of lawn and other living ground cover surfaces to non-evaporating surfaces (driveways, streets, roofs) will in part determine neighborhood air temperatures. These, in turn, will influence the cooling load on houses in the area, as well as the suitability of natural ventilation as a cooling strategy. Additionally, plants help create fresh air.

Non-living surfaces are much hotter than grass (which would be cooler yet, if well irrigated) since they don't dissipate heat through evaporation. A black roof is hotter than an asphalt driveway, because the ground underneath the paving stores heat. The hottest roof will be one with insulation right under the roofing—having negligible mass. The coolest roofs will be sprayed, ponded, or covered with irrigated sod.

Outdoor evaporative cooling mechanisms can help to provide outdoor comfort as well as to lower indoor cooling costs by lowering air temperature surrounding the building. This reduces the cooling load transmitted through the building shell and makes natural ventilation more desirable and more effective.



Dual courtyard design can be used to drive flow-through ventilation, when one is used to cool air, and the other to heat it.

Energy and resource efficiency

Depending on the site, in many cases there is a hierarchy of considerations as to how to use renewable energy resources. Often, the order of consideration is:

- Sun;
- Rainwater;
- Ground;
- Wind.

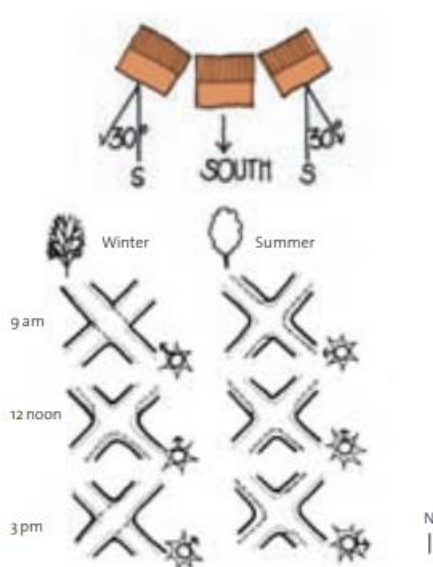
Whilst maximizing the contribution of these resources, it is important to minimize environmental demands and ensure the efficient conversion or disposal of waste.

Solar design

Turn towards the sun

There are four main ways of using the sun in buildings: daylight; passive solar gain; photovoltaic (PV) modules; and active solar panels. Day lighting reduces the need for artificial lighting and passive solar gain reduces the need for space heating. Photovoltaic modules convert solar radiation directly into electricity and are a rapidly developing technology. The key to optimizing the solar potential of the site is to orientate buildings broadly to the south. This tends to result in an East - West street pattern. It is possible to move up to 30° away from due south and yet have 90-95% of

the maximum output of a PV module or a solar collector. A common goal is to stay within 15-20° of due south.



Make sure that overshadowing doesn't unduly undermine solar access and vary building scale and positioning accordingly.

Let the light in

As a general rule, the more sun the better (potential problems of overheating and glare can be dealt with during the building design stage). Contrary to some attitudes and guidelines, it is possible to achieve high levels of natural light penetration with tight urban form.

Water

Collect, store and recycle rainwater

Retaining surface water reduces the need for drainage infrastructure and energy for pumping, with their extensive capital and maintenance costs. Streams, rivers, canals, ponds and lakes can be incorporated into surface water retention systems, whilst simultaneously providing attractive visual landscape features and valuable ecological habitats. They can also be linked to the recycling of grey water (run-off from roofs and other hard surfaces) for the irrigation of plants.

Earth

Use the potential of the ground

Consider the potential of underground energy sources for environmentally friendly heating and cooling systems. This has two aspects:

1. Temperature difference

The temperature at a depth of 10m is about 14 °C. It is possible to use heat pumps that take advantage of the temperature difference between the ground and the air for both heating and cooling but the heat transfer fluid needs to be checked as suitable for the environment.

2. Aquifers

Buildings that produce a great deal of heat internally can be cooled using borehole water from aquifers, found in much of the country. The most common way of doing this is by sinking two boreholes into the aquifer, one for a supply of cool water and the other as a discharge point.

Wind

Work with the wind

Wind is both a friend and foe. In the summer mild breezes ventilate buildings and improve comfort whereas in the winter winds increase heat loss. Harness the potential of the wind for natural ventilation and as a possible energy source. Design and position buildings to minimize funneling

and the creation of uncomfortable microclimates. Landscape also has a role to play in influencing wind patterns. Throughout the year at suitable sites wind energy can even provide a source of electricity.



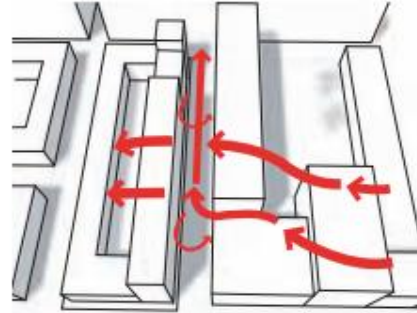
A highly integrated street pattern encourages high levels of air movement. Winds are 'smoothed' over low, densely built areas.



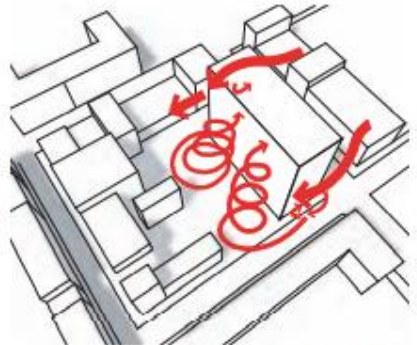
With greater spacing winds are forced down to make open spaces potentially uncomfortable



This is intensified by tall freestanding buildings, creating eddies that also result in building heat loss



Building form can also affect the quality of public space by channelling wind along streets ...



... or creating vortices in plazas in front of tall buildings (from Lang, 1994)

Waste

Do more with less

How to do more with less is the basic issue. Either through design or by the way we live. But less what? Here we're interested in less land, less energy, less water and fewer materials so that we can minimize demands on the environment. Designs can be made more energy and resource efficient by:

1. Landscape – minimizing the use of water or fertilizer.
2. Infrastructure – reducing the demand on site lessens the amount of infrastructure needed. Reducing the building energy demands can reduce gas main sizes and using rainwater on site minimizes surface water drainage pipes.

3. The buildings – minimizing demands on resources in terms of:

- Space and water heating (eg. insulation, double-glazing);
- Electricity / fuel;
- Water;
- Construction materials.

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