Climatic Factors in Regional Design:
An Interactive Media Tool for Reconstructing Regional Identity in Environmental Control

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Climatic Factors in Regional Design is an interactive computer module that reinforces lecture materials and serves as a reference tool by identifying regional design strategies practiced prior to World War II when "modern" technology was unavailable. Technological "advances" made since mid-century have virtually eliminated features of regional identity included in climatically-adapted buildings. This module is part of a curriculum which recognizes that sustainable design begins with the architectural form as the primary component of an environmental control system and that mechanical systems only supplement that system. For future designs to succeed, architectural forms as environmental control systems need to be incorporated within the *initial design* concept rather than tacked on at the end or ignored. *Climatic Factors in Regional Design* is divided into these sections:

- Introduction
- Regional Design
- Microclimate
- Regional Guidelines
- Design Strategies
- Glossary
- Sample Examination

The module contains 260 screen displays and more than 300 illustrations, figures, and diagrams. The module was developed using the academic version of Authorware by Macromedia.

The skills reinforced by *Climatic Factors in Regional Design* facilitate the paradigm that future architects will use regional design principles which many pre-1940s designers understood and will eventually become an intrinsic part of the practitioners' approach to sustainability.

INTRODUCTION

Climatic Factors in Regional Design is an interactive computer module that has been designed with the premise that sustainable architecture begins with the use of architectural form as the *initial* component of the environmental control system and the mechanical and electrical systems only serve to supplement that system. Demand for sustainable and environmental ethics has architects scurrying for "new" design strategies. However, the pace of technological development over the past several decades has outstripped many designers' ability to anticipate the interdisciplinary aspects of the impact of their design decisions. These impacts include not only the subsequent constraints and demands placed on mechanical, electrical, and structural designers but also the resultant effects on the environment through the very manufacture and fabrication of the materials used to construct the building and the actual operation of the building itself. This observation is particularly valid in the area of environmental control within the building. Instead of perpetuating the perception that future designs are to be just a continuation of the practice of relying on allied disciplines with engineering training in the latest technologically driven products to solve environmental control problems, architectural educators have an opportunity to restructure architectural education delivery to open new pathways for reestablishing regional design identities. This opportunity is shaped by two factors. First, at the heart of the problem is the current design amnesia which prevents many architects from designing buildings which maximizes architectural form as an environmental control system. Second, is the realization that good design is not solely concerned with just an aesthetic solution and that the burden of functionality is not just the responsibility of other disciplines.

ENVIRONMENTAL CONTROL THROUGH ARCHITECTURAL FORM

Two successive and interweaving paradigms can be seen, in part, as the genesis for how modern architectural practice came to arrive at this point today. The first paradigm revealed itself during the initial robust period after World War II. Technological developments achieved just before, during, and just after the war were being massively produced for architectural applications. Clients demanded buildings that took advantage of the latest technologies and the architectural community, buoyed by the high level of confidence common

to that period, complied. This is the point of departure where architects rapidly began to lose finite control over the overall building design as engineering subspecialties grew stronger and more visible while the technological improvements of the era provided the power to overcome many thermal and lighting constraints imposed on the building design by the local microclimate. Many pre-war architectural design practices like daylighting, passive solar heating and cooling, and regional design began to disappear as larger and larger buildings controlled by the latest environmental control technologies made them outdated in both the architects' and their clients' minds.

Modern design stylisms and practices evolved and a younger generation of architects matured within the first paradigm. This is when the second paradigm emerged. As the importance of using architectural form as an environmental control system diminished and along with it regionally identifiable design vocabularies, familiarity or the perceived need for familiarity with this design concept diminished as well. Over time, therefore, a collective amnesia evolved with regard to recognizing the importance of fully understanding how to use the architectural forms which effectively maximize environmental comfort and minimize energy usage within the initial design synthesis of a building. By instead handing over their designs to engineers and telling them to "make it work," architects came to depend significantly on engineers to solve "problems" created simply by an environmentally insensitive design and thus buildings became further insensitive to the unique features of regional design that had made them effective as environmental control systems. As a result, architects, while seemingly "freed" from the design constraints imposed by the environment, have lost the design opportunities afforded by ecologically sensitive design.

An excellent example of how this has been illustrated are the numerous energy conservation measures implemented after the energy crises of the 1970s. Attempts to introduce early energy conservation strategies revealed a myriad of "flaws" within the theretofore accepted modern design practices and initially resulted in a host of comfort problems. Because of the way the buildings had been designed and constructed and due to the overriding expense involved with changing the basic form of the architecture, many later solutions were technological devices appended onto the existing systems. In essence, the process was analogous to the way the existing mechanical and electrical systems had been designed in the first place. The rate of subsequent construction activities exceeded that of the integration of the architectural aspects of ecologically conscious design research and the ongoing "make it work" process continued with designs becoming further complicated by the use of even greater technologically advanced mechanical and electrical systems. Meanwhile, much remains to be done to accelerate the research and acceptance of design practices which integrate the concept of using architectural form as an environmental control *system* at the start of the design and not relying *solely on* technological adjuncts *downstream* to solve *problems* that could *have* been mitigated by the architectural *form itself.*

In reshaping curriculum delivery to enable students to re-explore the "natural" design concepts employed prior to World War II, architectural educators can provide the professional foundation for an updated design vocabulary. This will result in the integration of "lost" fundamental concepts into current design practices which meet the socio-environmental demands of society or perhaps even more suitably evolve into a new design sensitivity which will mitigate resource depletion in the initial design rather than creating and passing along problems for subsequent designers and users of the building to overcome by using still more increasingly sophisticated man-made technology.

CLIMATIC FACTORS IN REGIONAL DESIGN: RECALLING LOST DESIGN PARADIGMS

Due to the increasing awareness that many building design practices of the latter twentieth century have not been sustainable, *Climatic* Factors *in Regional* Design was created to provide an interactive computerized module for an environmental controls curriculum for architectural design students. This module includes both microclimate and regional design methodologies for seventeen climatic regions in the United States. Climatic Factors in Regional Design identifies architectural forms involved in vernacular regional building design practices that were common before the more "modern" energy intensive technologies were developed after World War II. Unknown or largely ignored in modern design are many pre-1940 regional design strategies which had been commonly employed for the environmental control of buildings due to the absence of "modern" technology. HVAC systems that are now commonplace had not been fully developed at that time. Building designers of that era relied upon responses to the natural benefits of regional climatic design to enhance comfort within the building. Advances in mechanical and electrical systems that have occurred since the mid-twentieth century have resulted in an ever-increasing dependence on technology for environmental control and a significant reduction in the capability of a building to serve as the control system itself. This has subsequently disconnected buildings from their sites and regional locations and has resulted in buildings losing the subtleties unique to regional climate as more and more designers dismissed regional design precepts as obsolete thinking. Accordingly, energy consumption, long seen as insignificant in the design of new "modern" buildings, became increasingly greater as buildings became more climatically disjointed. It is not surprising, therefore, that generations of post-war architects practicing in this modernist paradigm, for the most part have become lost in a collective design amnesia where the architect ignores climatic factors and simply passes the building design over to engineers and other disciplines who are told to "make it work."

This climate disjointedness was made sorely evident by

the energy crises of the 1970s but the real estate boom of the 1980s far outstripped the implementation rate of environmentally oriented architectural design research guidelines. Only the more technologically oriented mechanical and electrical control overlays were typically implemented which thus further complicated building designs. Today's designer faces an extremely complex environmental control paradigm. Technology however can not anticipate every circumstance. One factor interrelates with so many others that a seemingly simple solution generates numerous previously unforeseen problems. For example, the many energy conservation strategies of the 1970s resulted in numerous thermal comfort and indoor air quality problems. These problems emerge from solutions to the energy conservation problems that were, borrowing a term from the environmentalists' vocabulary, were based on "end of the pipe" methodologies. Now recently growing societal recognition of the importance of sustainability has prompted a more willingly acceptance of environmental stewardship. With this emerging paradigm, the latest generation of designers finally are seeking more comprehensive design solutions which to view design comprehensively at the start of a project design.

MODULE DESIGN PREMISE

Although initially conceived as part of an academic curriculum, it is hoped that eventually this module will be expanded to serve a reference tool for professional designers. This is particularly important to those professionals who develop conceptual designs for projects located in regions away from their usual domain of climatic design familiarity. It is this longer reaching aspect that will perhaps provide the greatest benefit from the development of this module.

For future building designers to succeed, environmental conservation and control integration need to be incorporated within the *initial design* concept rather than tacked on at the end as commonly seems to happen. There is a significant opportunity to reduce sustainability problems through the integration of practices which utilize architectural form as the primary environmental control system. The synthesis skills enhanced by *Climatic Factors in Regional Design* will facilitate the concept that future designers will rely on many of the physical principles which pre-1940s designers understood well. These skills will become an essential component of the students' and, it is hoped eventually, the practitioners' design approach. Consequently, the paradigm that technology will resolve all problems caused by climate disjointed design strategies that has fostered the current design amnesia can be reduced if not eliminated entirely from professional practice.

DEVELOPMENT BACKGROUND AND DESIGN PROCESS

The module was created using the interactive software program Authorware Star by Macromedia Corporation[1] for pc-compatible platforms. Other software used to develop the graphics in the module included Hewlett Packard Deskscan II, Adobe Photoshop v.3.5 and MicroSoft Word v. 6.0. The hardware used in developing this module included a pc-compatible desktop microcomputer with a pentium chip operating at 133 MHZ with 32 Mb of RAM, an SVGA high resolution color monitor, removable external high density memory drive, and a high resolution scanner with a transparency media adapter.

This project was funded by the Higher Education Technology Initiative Starter/Mentor Grant Program to encourage the use of interactive computer media in the classroom. The original foundation for the development of this module was drawn from early work performed during the 1970s energy crises by the AIA Research Corporation. This work was published and distributed nationally as *Regional Guidelines for Building Passive Energy Conserving Homes*.[2] Subsequently, this book provided the background material for the chapter on climate in *Heating Cooling Lighting: Design Methods for Architects*[3] which is a textbook used in the environmental controls course for which this module was initially developed.

The development process consisted of the creation of a test version of the module which was distributed to the students enrolled in the environmental controls course. This distribution included placing the module on a student accessible network or providing copies of the module on a 100 Mb Zip disk. The students were then asked to complete an evaluation of the module which included questions on contents, structural format, module flow, and graphics. These comments were then collected and reviewed by the author and the comments were incorporated into the final version of the interactive module.

MODULE DESCRIPTION

Users can use a menu display to move through *Climatic Factors in Regional Design* in any order, either sequentially or randomly, desired. In this manner, the user can initially read the material and then move through the module as needed to review components of interest. The user may leave the module and resume his or her examination at a later time, returning to specific components as reference needs warrant. The module contains 260 separate screen displays and more than 300 separate illustrations, figures, and diagrams. The menu driven series of screen displays presents specific information related to the major topic of the individual component. The module components are described below:

- *Introduction:* This provides an overview of the program which includes the user instructions, acknowledgments, listings of hardware and software resources, and the bibliographic resources used in generating text and screen images throughout the module.

- *Regional Design:* This explores vernacular architecture as immigrants from Europe adapted their traditional building practices to meet the climatic and resource demands of

their settlement region. The climate adapted vernacular section includes representations of the climatic driven architecture built in North America in the period 1600-1940 A.D. and describes forms and materials used, regional parallelism, and regional design examples. The climate disjointed design section describes the development of mechanical systems technology and the typical forms derived from its use and illustrates architecture from around the United States constructed since 1945. The regional design section illustrates architectural forms as an environmental control system and examples of this design approach from around the United States constructed since 1970.

- *Microclimate:* This describes how to evaluate the local climate and such microclimatic factors as earth (topography), wind, fire (solar access), and water. The illustrations include photographic and computer generated graphics which illustrate the basic principles and methods used to define the microclimatic advantages and disadvantages of a proposed project site. Each of these topics is divided into subtopics to enable the user to navigate through them in any order desired.

- *Regional Guidelines:* This is the key feature of the module as a learning and reference tool. It describes annual profiles for climate, design priorities, psychrometrics, comfort conditions, temperature, relative humidity, wind speed, sunshine percentage, degree days and the typical building forms found in seventeen climate regions in the United States. These subtopics are individually accessible on single screens for viewer clarity in the interpretation of the graphic information and, as with the rest of the program, may be accessed sequentially or in any order desired by the user. The regional climates are referenced by a climatically representative city in each region to typify the climate of the region. The seventeen regions and their climatically representative cities are:
  1. Hartford, Connecticut
  2. Madison, Wisconsin
  3. Indianapolis, Indiana
  4. Salt Lake City, Utah
  5. Ely, Nevada
  6. Medford, Oregon
  7. Fresno, California
  8. Charleston, South Carolina
  9. Little Rock, Arkansas
  10. Knoxville, Tennessee
  11. Phoenix, Arizona
  12. Midland, Texas
  13. Fort Worth, Texas
  14. New Orleans, Louisiana
  15. Houston, Texas
  16. Miami, Florida
  17. Los Angeles, California

  Weather information (e.g., annual temperature extremes and precipitation, snow fall, wind direction, degree-days, etc.) should be obtained from a site-specific local NOAA meteorological station to confirm weather impact on actual design parameters. The most critical subtopics are the design priorities and the typical forms. In the first subtopic, illustrations reveal prioritized architectural elements that should be included in some aspect to facilitate a successful design. In the second subtopic, illustrations reveal more generally the built form that has evolved within a region based on vernacular component adaptations.

- *Design Strategies:* This illustrates strategies which generally can be used to allow the architectural form to serve as a significant component of the thermal environmental control system. This incorporates many regionally specific strategies into a generic series of strategies that overlap between regions. For example, the subtopic "to make cooler" illustrates several strategies that are common in multiple regions so that the user can derive forms from other regions which were only singularly illustrated in the region specific topics (e.g., the guidelines for several regions suggest underground or earth-contact construction and illustrate it differently in each region). This enables the user to adapt the concept into a form that may inspire new design concepts and building element configurations that may be as equally effective as the one specifically illustrated within the region of interest.

- *Glossary:* This defines terms used in other components of the module. It contains both visual examples and text descriptions of the term being defined.

- *Sample Examination:* This provides examination questions for users to check their retention of the materials in the module. At the end of the examination, the total score is given.

USER REACTION AND COMMENT

Student reaction to the module has been extremely positive. The module has been viewed as a means of getting into other portions of the country to explore not only differences in climatic design but also similarities as well. Comments on the ability to review and translate many of the concepts into designs for their studio projects are most the most frequent. Other comments include those related to how the module will assist in their future designs and enabling them to become familiar with regional design for areas where they have no prior experience. The common reaction seems to be that the module provides an instantaneous capacity to understand the climatic forces that affect regional design and to develop strategies which inform a sustainable design based on the energy consumption implications of the architectural form.

Most negative comments were related to limitations of the

software itself (e.g., structural limitations, limited hypertext features, no printout capability, etc.). Several expressed a desire for features which more closely follow applications found on the internet and for internet access to the module. Both of these aspects are being pursued. However, the Authorware Star software did not accommodate these features at the time of the module development. The author has since purchased the full commercial version of Authorware which does include these features and will pursue these aspects in future work. Other comments were related to compatibility with older personal computers. The module does not work properly on monitors with lower resolution monitors or on microcomputers with less than a pentium processor. This was noted by several students who did not own the higher end technology. This is a minor defect since the primary delivery system consisted of personal computers in the school's computer laboratory which except for one older unit are configured to accept this module properly.

CONCLUDING REMARKS

The pace of change in computer technology has created an opportunity to (re)integrate many of the foundational design issues that make regional climatic design uniquely identifiable. As just the first step along a potentially vast media continuum, *Climatic Factors in Regional Design* illustrates previously common lower technology design strategies and facilitates reincorporating them into modern designs ahead of the many now common place "higher" technology systems. The principles and concepts identified in the module enable the use of architectural form as a primary part of the environmental control system and thereby reduces the overall energy consumption and environmentally impact of the building. This in turn allows the usage of the mechanical and electrical systems as supplements to those portions of the building specifically deficient in environment control rather than simply have these systems dominate the overall design. However this approach neither precludes nor abrogates the designer's responsibility to balance the environmental control needs with the opportunity to refine a design aesthetically. In this context the architectural form is not merely an "machine for the environmental control system" but takes advantage of regional design opportunities that serve to inform the final design aesthetic.

NOTES

[1] The Authorware Star program is an academic version of the more powerful Authorware program both of which are copyrighted by Macromedia Corporation. Academic pricing agreements preclude the commercial distribution of modules developed using these programs and as such the modules are intended for use only as part of course related usage by the author. The program does prepare a "packaged" module that can be used without the Authorware program being installed on the host computer. This feature enabled installation of the module on the local area network that is accessible only by students registered in the school.

[2] AIA Research Corporation, *Regional Guidelines for Building Passive Energy Consewing Homes,* HUD Document #HUD-PDR-355. Washington, U.S. Department of Housing and Urban Development Office of Policy Development and Research, 1978.

[3] Norbert Lechner, *Heating Cooling Lighting: Design Methods for Architects.* (New York: John Wiley, 1991).