Sustainability: The Emerging New Paradigm for Environmental Design

TOM J. BARTUSKA
Washington State University

The environmental design professions are being challenged by the societal need to create a sustainable future. These directives come from numerous international and national initiatives. These mandates carry a forceful message that society and the environmental design professions are at a "cross road" and our future must address the challenges posed by this inclusive and elusive concept—sustainability (Boyer, 1996; NSTC, 1995; ACSA/AIA, 1994; ASLA, 1994; UDSDN, 1994; AIA/UIA 1993; CEM, 1993; AIAS, 1992). Many think recreating healthy, sustainable environments will require a paradigm shift as important to society as the Cartesian scientific method or the industrial and computer revolutions.

Sustainability holds great promise, integrating many fundamental issues which challenge contemporary society, locally and globally. The "S" word fosters greater meaning to the value of environmental design—optimizing our vital human-environmental support systems while providing sustained promise to future generations of life on earth. The directives are clear, if not profound, but the process is less established. Society and the design professions must determine and agree upon definitive ways to define, model, measure and achieve sustainability.

For the author, these conclusions have evolved from an extensive, on-going study, including a professional leave (1993); participating in various AIA/ACSA/SBSE programs, competitions, and conferences; carefully reviewing international and national studies; studying built projects that achieve a high level of sustainability; collaborating in the development of various university courses and faculty resource groups at two universities; and most importantly, applying these far-reaching concepts locally—in the studio and within the community.

DEFINING AND MODELING SUSTAINABLE (S) VISIBLE AND INVISIBLE ECOLOGICAL SYSTEMS

Carefully defining sustainability provides an important first step in further developing the environmental design profession's mission in education, research and practice. Developing clear definitions and modeling parameters for sustainable regenerative processes is critical in forging an integrative, operational paradigm for architecture and other environmental design professions. Many of the critical S systems are invisible to traditional architectural discourse.

There are many definitions of sustainability. Primarily this emerging term deals with **sustaining** social, economic and environmental systems and the acquiring **abilities** to achieve these desirable results. In review of the plurality of this term, the regenerative systems of a **site** or the environmental context are critically important variables to most working definitions of sustainability. This emphasis is expressed in the following composite definition:

> Sustainable developments are those which fulfill present and future needs (WECD, 1987), while [only] using and not harming renewable resources and human-environmental systems of a site (air, water, land, energy and ecology) and/or those of other off-site sustainable systems (Rosenbaum 1993 and Vieria 1993).

The **site** is definable, yet its natural cycles are primarily invisible and transcend artificial boundaries (building site, community, regional or global scales). Many sustainable developments strive for self-sufficiency by attempting to operate independently of external

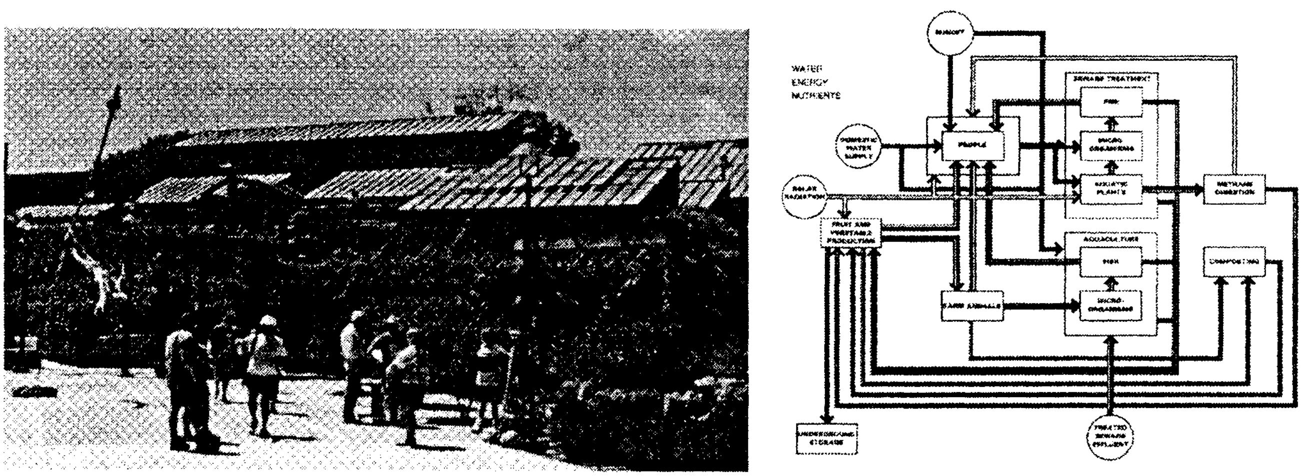

Fig. 1. The Center for Regenerative Studies, Pomona, California - Visible Architectural Development and its Invisible Ecological Systems Diagram (Diagram reprinted with permission from *ARCHITECTURE*, December, Copyright 1994, BPI Communications, Inc.).

utility or energy systems. The amount or percentage a development uses the renewable resources of a site is a useful "indicator" or measurement of its sustainability. These fundamental human-environmental interrelationships of a site can effectively develop critical "inputoutput" modeling techniques which illustrate the challenging requirements for programming, measuring and achieving sustainability. The basic human-environmental variables which form the delicate web of life of a site need to be carefully placed in a sustainable balance. These essential variables are generally "invisible" to architectural discourse and are generalized into five categories: **air, water, land (food and fiber), energy, and human ecology**. They combine to form the dynamic systems of any site (reference concept diagrams within the following charts). This set of critical variables is further defined in the addendum of this paper.

The Invisible S-Paradigm for Environmental Design

Central to sustainability is the emergence of an **ecological or biological paradigm** which permeates all human-environmental relationships, locally and globally. Our traditional "modernist" paradigm fosters linear logic (Cartesian thinking) and can help us address the parts, but has difficulty in solving problems in a holistic and sustainable way. If this "S" concept sustains interest and intellect, it marks a dynamic move to a "new age of synthesis" (Hall, 1994), "a turning point," recreating "a compelling vision of a new reality—a reconciliation of science and the human spirit for a [sustainable] future" (Capra, 1982).

Sustainability is integrative, interdisciplinary and requires **ecological or biological** systems thinking.. This ecological emphasis on design and the way society should understand and manage its human-environmental relationships occurs within the definitions, modeling variables, projects and educational recommendations. Unfortunately, most architects are poorly educated in biological/ecological systems thinking. The significant paradigm changes that need to be integrated into public and professional education are dramatically apparent by the following comparative list of paradigm characteristics.

Although all the above dialectic issues are important to understand, space within this paper does not allow for their full exploration. As a representative example, the last set may illustrate the challenges posed by these contrasting paradigms ("appearance/visible performance/invisible design parameters"). Unfortunately, visual perception dominates most humans and they have a lack of sensitivity, a "disability," in understanding the invisible parameters which are critical to a more inclusive design paradigm. The visual sense dominates our **immediate** perception, whereas, the other senses are critical to a more **lasting synergetic and sustainable** response. This dilemma (visual dominance/disability) is celebrated in the study of design. The visual arts are, of course, an important qualitative characteristic of architecture and visual sensory delights dominate the mind's-eye of young students of design. They flock to computer graphics courses, but by-pass the invisible processing power of the computer to model the critical, long-term performance of buildings.

Visible and invisible parameters are both important to the ecology of a place. Sustainability focuses on long-term human-environmental interchanges: all are mostly invisible processes (air, water, food and fiber exchanges of the land, energy and ecology). These are like "Vital Signs" (Benton, 1994) and are critical to a bio-logical and architectural reality. Can we "make nature visible" (Van Der Ryn, 1996) and nurture interest in the invisible, life-giving qualities in the environments we create? Do we "watch out" (US caution signal), or can we "mind our way" (UK caution signal) or "walk slow" (Asian Proverb)? Can we monitor, like MPG ratings for automobiles or energy ratings on appliances, the energy performance of buildings along with their glossy photographs? Besides the $/square foot analysis, can we provide ratings for embodied energies and toxic chemicals used in construction? Can we balance the CO_2–O exchanges in the buildings we create and use by planting trees (Barnett, 1994)? Can we create truly self sufficient projects which have zero emissions, where waste from one system is the food for other systems? Can we create indicators for human performance and health? These are challenging questions which must be answered in the affirmative if we are to advance our profession's contributions to a sustainable built environment, society and world.

Traditionally, designers have been highly trained by visible qualities, but need to also develop a working knowledge of the invisible properties and systems introduced earlier. These vital and invisible variables reflect the sustained health and performance of the built and natural environment.

THE MULTIPLE DIMENSIONS OF SUSTAINABLE DESIGN AND THE M^2=X GENERATIONS

The sustainable paradigm fosters considerable reflection and recreation. We are in a period of seriously questioning our contribution to the health and vitality of society. The vital human-environmental dimensions of environmental design need to be clearly established. The visible and invisible variables of human and environmental health are interrelated as illustrated in the following comparative hierarchy (relating to the seriousness of human and environmental health).

Exploring these various quantitative and qualitative dimensions of sustainable design blurs traditional boundaries, challenging ones awareness and understanding. Teaching young minds to grasp a new paradigm is difficult at best and will take incremental shifts in linking traditional knowledge into a cohesive and collaborative process.

Fostering a more inclusive "bio-logical or eco-logical" view of reality is further challenged by those with a M^2 or myopic view of

Established Paradigm (Modernists/Post-Modernists)	**Sustainable Paradigm** (Ecological/Bio-logical)
Cartesian Approach	Systems Approach
Linear Logic, Hierarchical	Bio-logic, Cyclic Optimization
Reductionistic Simplicity, Harmony	Holistic Complexity, Integration
Economics	Ecology, Energy
Human Centered	Human and Environmental Balance
Discipline directed, Individual Creativity	Interdisciplinary Collaboration
Building or Object Focus	Site and Object Interdependent
Appearance, Visual Design Parameters	Performance, Invisible Design Parameters
(Space/Form, Proportions/Rhythms, etc.)	(Air, Water, Land, Energy & Ecology)

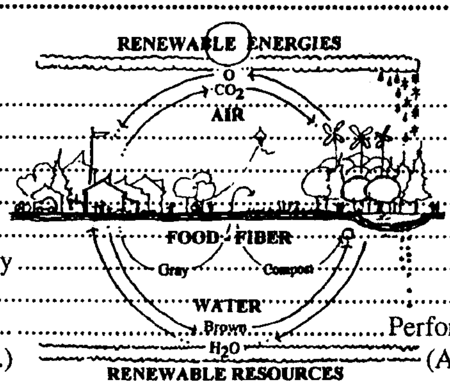

Fig. 2. Comparative listing of the traditional-established and the emerging sustainable paradigms.

Human Health (Medical Analogy)	**Environmental Health** (Sustainable Analogy)
Appearance	Performance
Height to Weight Ratio	Net to Gross ratio
Calorie Efficiency	Energy Efficiency
Temperature and Blood Pressure	Passive and Active Systems
Blood Tests	Water Quality
Waste Tests	Waste Processing/Recycling
Lung Capacity/Exchanges	Air Quality/Ventilation
Specialized Testing (Ex-rays, Cat scans)	"Vital Signs" Testing (Benton, 1992)
Holistic Health	Integrative Systems Performance

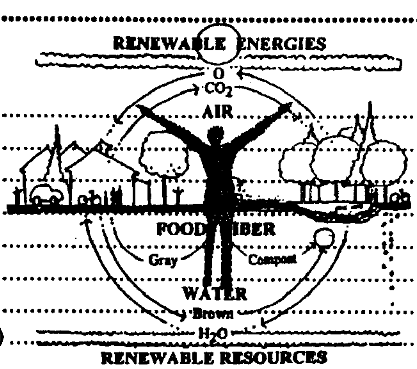

Fig. 3. Comparative array of human and environmental health characteristics.

their role in society. M^2 is unfortunately directed towards the "Me" and "MTV" generations. Currently, these M^2 attitudes are being discussed and defined as Generation X (Sacks, 1996). "Generation-Xers" are young people who are highly influenced by television and commercialism and are very personally directed, anti-science, and anti-professionalism. Apparently M^2=X. They will be a lost generation to any holistic paradigms. Shifting ones awareness to a holistic ecological paradigm must begin at early ages and then nurtured throughout our life-long education processes.

The paradigm shift is profound to the believer, but falls onto closed minds of the uninformed. We need to find ways to educate and apply this "S" paradigm which are inclusive, integrative, interdisciplinary, and effective. The author (in collaboration with others) is finding some success in comparing the traditional approach to environmental design and their visible qualities with the more invisible ecological systems of this sustainable paradigm. Successful examples can be found everywhere, in education and practice, locally and globally.

SUCCESSFUL APPLICATION OF SUSTAINABLE DESIGN THROUGHOUT THE WORLD

In general, architecture and other design fields have had a rich heritage based, in part, on sustainability or a more ecological paradigm. Vernacular architecture achieves a high level of sustainable strategies (sustainable in time as well as in its use of renewable energy, local resources, customs and crafts). Most Medieval architecture and urban developments have similar community-based evolutionary qualities, whereas the Renaissance has less of these place generative qualities. During the Modern and "Post-Modern" periods, the Cartesian, human-centered logic predominated as it does today. During these more contemporary movements, there were many professionals who have fostered a more ecologically based approach to design (designers and planners of the English Landscape and Garden City Movements and architects and landscape architects such as Frank Lloyd Wright, Walter Gropius, Alvar Aalto, Ian McHarg, Malcom Wells, Christopher Alexander, et al.). Their ideas and work have been significant, but were overshadowed by the egocentric work of most designers in the post-WWII era. The 1970s had a rebirth of energy and environmental issues and now, as we enter the twenty-first century, there exists a significant movement to shift the predominant human-centered design paradigm to an ecological concept of reality.

The contemporary movement towards sustainability is apparent throughout the world. This is evident in the number of very successful publications, programs, policies, and built projects. Considering the state of our local and global human-environmental conditions, those who are not accepting a sustainable paradigm are not keeping up with our times (not doing their homework) or are in denial or both. The following is a brief summary of some of the important developments in the western world.

Publications and Programs: In just a few short years, there is a growing number of excellent programs and references in the various aspects of sustainability (see references). National leadership and directives have had an important influence on sustainable design. There have been numerous design conferences which explore various aspects of "S^2" Design (S^2=Successful and Sustainable). In the USA, the most notable were the international conferences–"Building to Save the Earth" (BSU, 1992) and the "Building Connections" teleconferences (AIA, 1993). Both of these initiating programs were organized under the following themes which seem to be an inclusive way to clarify this complex subject:
A. Energy and Resource Management
B. Healthy Buildings and Materials
C. Land Ecology and Livable/Sustainable Cities

Policies: There is considerable advancement in building codes and rating systems which favor more humanly and environmentally sensitive buildings. Policies have a tremendous influence on redirecting society, far more than individual projects and buildings. England and Canada have developed environmental rating systems for buildings (BREEM, 1990 & BEPAC, 1993). In the USA, federal policies on air and water quality and energy codes are very influential policy developments. Building codes are important but in fact mandate just the minimum legal standard for a project. Creative designers are demonstrating the effectiveness of these policies by developing projects which exceed these minimum standards and substantially improve the appearance and performance of the built environment. Many municipalities have also developed policies and guidelines to direct developments toward a more S^2 performance.

Projects: Globally, there is a number of very successful built projects which were created in part upon a sustainable paradigm. This presentation will illustrate various state of the art projects and discuss their design performance in relationship to the selected biological indicators of air, water, land, and energy.

APPLICATIONS OF SUSTAINABLE DESIGN IN COURSES AND COMMUNITY ACTION PROGRAMS: THINKING GLOBALLY, ACTING LOCALLY

Locally, various collaborative courses and community action programs have been developed in an attempt to integrate sustainability into university and community discourse and action. Like all experiments, there have been some successes (and some with mixed reviews). These programs are briefly summarized below:

The Built Environment: The design disciplines have created an inclusive, integrated, interdisciplinary, team-taught, introductory

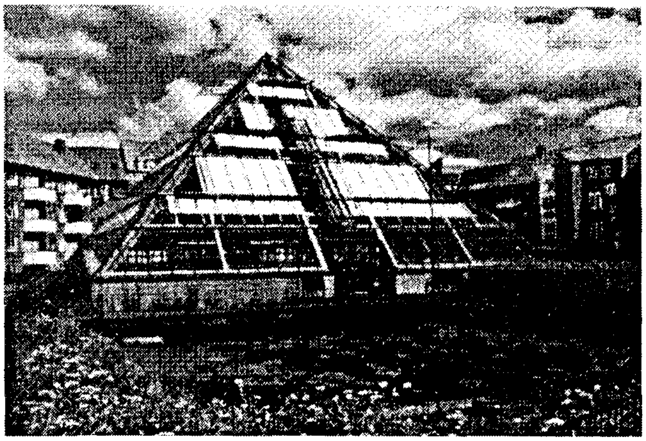

Fig. 4. Bio-digester integrated within a housing regenerative project in Central Kolding, Denmark. The Bio-digester processes human "wastes" into food for on-site landscape and agricultural produce.

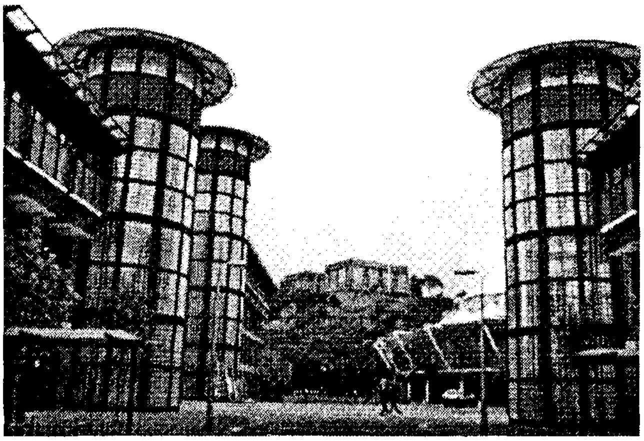

Fig. 5. Inland Revenue Complex, Nottingham, England – "S" strategies of solar shading, light selves and round stair well-ventilation shifts (solar chimneys), etc., create buildings with passive cooling and no need for mechanical air cooling systems.

course on the Built Environment for young design and general university students. The course has become quite popular, growing from some 20 to at times 250 students. It has been approved as a general university education course in humanities. The course combines design and ecology. I coordinate the course and have co-edited its textbook (a collaborative work) with a WSU Human Ecologist, Gerald Young (*The Built Environment: A Creative Inquiry Into Design and Planning*, Crisp, 1994). Ecological concepts integrate the course's diverse material. The course fosters collaboration and explores various ways each and all design levels (components and disciplines) are interdependent and "layered" together as expressed in the course logo: ProductsInteriorsStructures LandscapesCitiesRegionsEarth. The course emphasizes that human health and environmental fitness (McHarg, 1970) are fundamental to truly integrative and creative constructions. An inclusive, sustainable/ecological paradigm emerges as a central theme in this course (www.arch.wsu.edu/information /courses/arch202)

Design and Theory III: This third year fall course sequence integrates a team taught theory course (2 credit hours) with the student's first, advanced studio (5 credit hours). Sustainability is the central theme of this integrative theory and design sequence. "S" principles and processes are applied to rural and urban environments. The young students have difficulty at first with the "S", multiple variable, problem solving process but, after the series of projects are complete, most but not all, have a high level of comfort

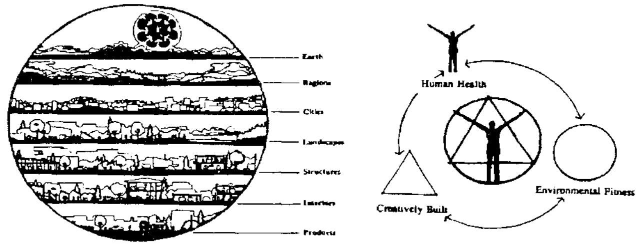

Fig 6. Built environment course logo and diagram of human-environmental interrelationships.

with this inclusive paradigm. The students who have difficulty seem to be the "generation-Xers." The integrated theory course is a critical asset to this collaborative effort.

Design and Theory IV: This fourth year spring course sequence generally deals with two complex projects—an adaptive reuse of a historic building and urban housing. Both projects imply important sustainable principles and processes. The adaptive reuse project is generally for non-profit community organizations which are interested in saving existing resources. The urban housing project explores a regeneration plan and urban village project (affordable housing) for a selected city. The parallel theory course explores urban housing which is integral to the complexities, richness and success of the urban housing project.

Sustainability by Design: A collaborative group of colleagues within the design disciplines are offering an advanced course on "Sustainability **by** Design." This interdisciplinary course emphasizes the design disciplines important contribution in creating a sustainable society and the students developed a green guide for our campus and community (www.arch.wsu.edu/~gg).

Sustainable Development Program and Institute: The university has been fortunate to gain funding from NW corporations to develop an academic, research and public service program in sustainability. Currently, an interdisciplinary, academic minor has been developed for all students. Two of the above courses are part of that program. Research, service and internships will be part of the SD Institute.

Community Action Programs: Palouse Clearwater Environmental Institute (PCEI) has sponsored a series of community workshops on "Visioning Sustainable Development." PCEI is an amazing organization, modest staff, active community and regional support with very successful programs in transportation, stream and wetland restoration, sustainable communities and agriculture.

Community Regenerative Proposals: Based upon the principles and processes of sustainability, a group of colleagues and I collaborated and developed an overall, comprehensive regenerative plan for our city illustrated below (Bartuska and Kazimee, 1994) and a new sustainable village proposal for the university. The city proposal was awarded a gold medal at the recent UN Habitat conference in Istanbul, 1996 (www.arch.wsu.edu/~sustain). More importantly, we have presented our work to numerous local groups and officials. Collectively our community is working towards a more sustainable future.

SOME CONCLUSIONS: STRATEGIES ON SUSTAINABILITY (SOS)

Sustainability is a challenging concept. It fosters greater responsibility and involvement for the environmental design professions. The "S" paradigm, once defined ecologically or biologically, mandates a new and dynamic paradigm shift for environmental design—one which can be modeled to optimize vital human-environmental support systems for sustained life on earth. Those that do not accept a sustainable paradigm are not doing their homework or are in denial of local and global issues.

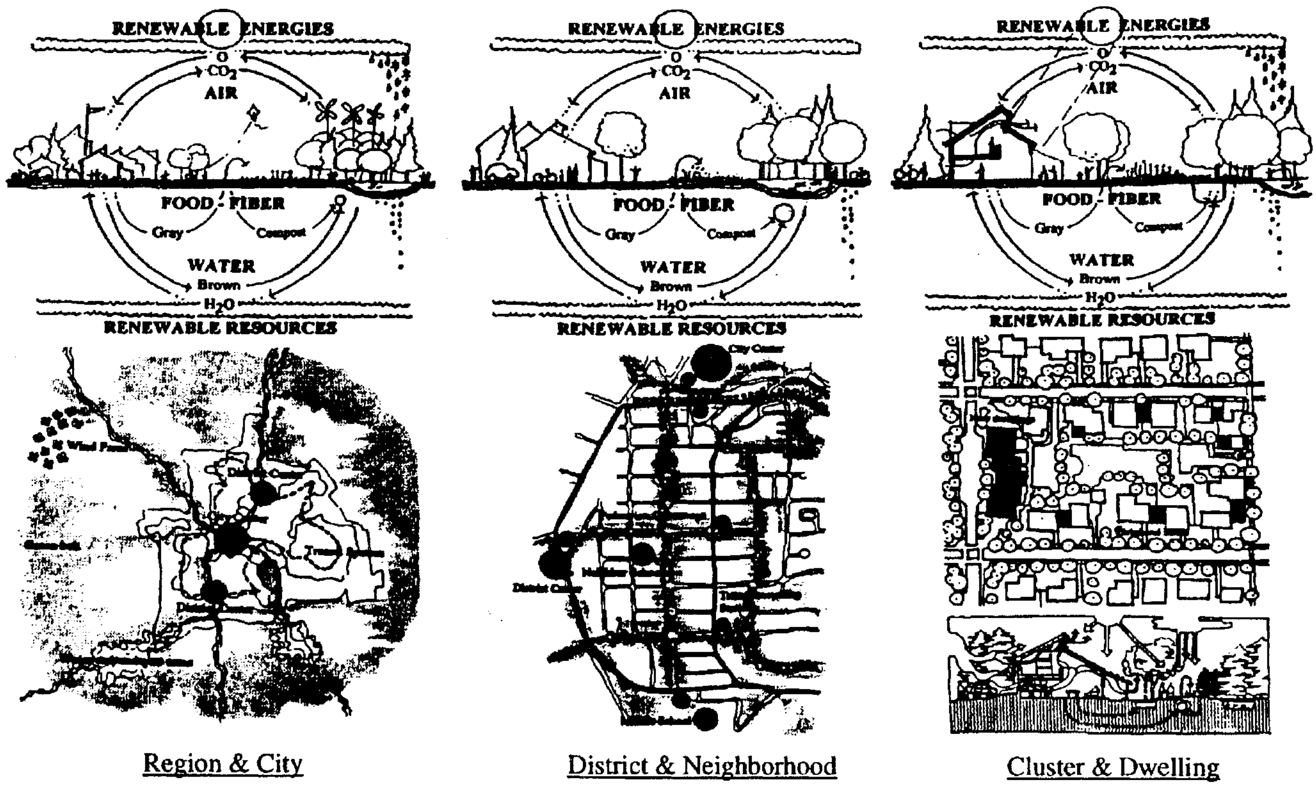

Fig 7. Conceptual diagrams and collage of images of the Sustainable City Plan (Kazimee, Bartuska & Owen).

Teaching the "S" concept in architecture is a challenge. Its inclusive, integrated and interdisciplinary approach is not easily assimilated into the minds-eye of the young students nor the traditional mind-sets of the faculty (young and old). Approximately 1/3 of our faculty embrace sustainable issues in their teaching, research and/or public service (this seems to be the norm across the country). This proportion is amazingly high in comparison to the newness of the concept. National and international leadership and grass roots community dialogue are important signs of progress. Success is not achieved by competition among factions with contrasting philosophies or paradigms but by inclusiveness and collaboration.

Sustainable development (personal and environmental) is an evolving life-cycle process. It must begin in early ages, grow and be enriched in our educational and professional studies and continue throughout life. Incremental additive changes are occurring. There are more excellent "S" projects being built, comprehensive and interactive information systems established, user friendly computer modeling programs created and significant conferences which address this new paradigm of thought and action. Sustainable design offers exciting opportunities to clarify our public and professional mission in education, research and service as well as recreating a quality built environment, locally and globally.

ADDENDUM: THE FIVE "INVISIBLE" ECOLOGICAL VARIABLES FOR MODELING SUSTAINABILITY

As introduced earlier, sustainability is critical to the design professions role in recreating truly livable environments. The following five "invisible" variables of a site system (air, water, land, energy, and human ecology) have been found useful in defining and modeling the inclusive nature of sustainability.

Air (one can only live 2-3 minutes without oxygen): Air quality is an often overlooked, yet a vital resource to human and planetary health. Multiple Chemical Sensitivity (MCS), caused by airborne toxic chemicals in the home and work place is a 60 billion dollar problem in the USA (AIA, 1993). At the global scale, ozone depletion and global warming are extremely critical issues to resolve. **Although air quality is a complex issue, modeling the carbon dioxide to oxygen (CO_2–O) cycle can become a useful technique or indicator for sustainability. Society, locally and globally, must reduce the burning of carbons and place CO_2 in balance with the oxygen-producing photosynthesis.** Modeling CO_2–O exchanges mandate a truly green world and creates fundamental sustainable design relationships between plants, animals and human habitat. It is significant to note that internationally, the two leading environmental rating systems for architecture (BEPAC, 1993 and BREEM, 1990) and the AIA's *Environmental Resource Guide* use air exchanges and embodied energies as their primary assessment methods.

Water (one can only live 2-3 days without water): Humans require only approximately 1-2 gallons of water per day, yet in the USA, we consume approximately 100-150 gallons per day. Many believe that water is fast becoming a critical resource and the competitive human-environmental demands will require careful management and conservation in the next decade. **Modeling the input and output of water resources of a site provides a useful indicator for a sustainable system. This modeling mandates the need for water conservation to place the H_2O exchange in balance with the amount of precipitation that falls on a site.**

Land-Food and Fiber (one can only live 2-3 weeks without food): Land, of course, is not invisible but the ecological systems which define a site are not central to ones surface vision. The food, fiber and other material resource requirements of a site are very complex and the author is searching for ways to model these diverse variables. **The three R's (reduce, reuse, recycle) seem to be a simplified way of modeling sustainability. The percent of resources that are reduced and recycled is a useful indicator of sustainability. Sustainability would require 100% reuse and/or**

recycling.. A communities "ecological footprint" (Wackernagel, 1996) is another holistic way to model a community, region, or country's need for land. Locally or globally, a society's ecological foot print must be equal to its defined land base.

Energy (the primary exchange agent in ecological systems): Energy exchanges are fundamental in modeling sustainability and energy use is highly related to air, water and land use. Renewable energies are, for the most part, sustainable whereas non-renewable systems are not. **Therefore, the percentage of renewables used in any system is another useful indicator of sustainability. Sustainability would require 100% use of renewable energies.** Fortunately, energy conservation is a well-accepted goal of the design professions. Renewable energy systems (photovoltaic, wind and water power) are becoming cost effective alternatives to non-renewable sources. Designing with climate, computer-aided modeling of energy performance, and the use of daylight and renewable energy are critical architectural and energy conservation issues.

Ecology: Human-Environmental Interactions (a critical and dominant indicator of society's abilities to achieve sustainability): Ecology, or more specifically **human ecology**, defines the final, but most challenging variable to this proposed set. It, of course, includes the other four more basic environmental variables (air, water, land and energy). **The author has separated them out for clarity, to minimize human centeredness and to emphasize that these natural, invisible variables are more biologically and ecologically fundamental to society's ability to define, model and measure sustainable development.** How society defines and manages its human-environmental interactions is probably the central defining issue to this all-inclusive variable. Literally hundreds of communities across the United States (Corson, 1992) and many times more around the globe are actively pursuing sustainable planning by defining and modeling "indicators" of human-environmental interrelationships.

REFERENCES

ACSA: Association of Collegiate Schools of Architecture

ACSA/AIA. 1994. "Educating Architects for a Sustainable Environment," AIA/ACSA Recommendations, Rosenman, Director, Ball State University.

AIA. 1992. "Building Connections," a three-part national teleconference and accompanying resource booklets. Washington, DC: American Institute of Architects.

AIA. 1992-95. *The Environmental Resource Guide*. Washington, DC: American Institute of Architects.

AIA & UIA. 1993. "A Call for Sustainable Community Solutions." Washington, DC: American Institute of Architects.

AIAS. 1992. "Declaration on Sustainability," American Institute of Architecture Students, Resolution Passed at National Forum, November.

ASLA. 1993. "ASLA Declaration on Environment and Development." Washington, DC: American Society of Landscape Architects.

Barnett, D. and Browning, W. 1994. *A Primer on Sustainable Buildings*. Rocky Mountain Institute.

Bartuska, T. and Kazimee, B. 1994. "Modeling Sustainability: Theory and Design." Association of Collegiate Schools of Architecture, Technology Conference and Proceedings, University of Michigan, January.

Bartuska, T. and Young, G. (eds.). 1994. *The Built Environment: A Creative Inquiry Into Design and Planning*." Crisp.

Benton, C. 1993. "Vital Signs." University of California, Berkeley.

BEPAC. 1993. *Building Environmental Performance Assessment Criteria*. Environmental Research Group, School of Architecture, University of British Columbia.

Boyer, E. and Mitgang, L. 1996. *Building Community: A New Future for Architecture Education and Practice*. The Carnegie Foundation.

BREEM. 1990. "Building Research Establishments Environmental Assessment Method." Watford, UK: Building Research Establishment.

BSU. 1992. "Building to Save the Earth," a national conference on sustainability. Ball State University.

Capra, T. 1982. *The Turning Point: Science, Society and the Rising Culture*. Bantam Books.

CEM. 1993. "The Secretariat of University Leaders for a Sustainable Future" (International). Medford, MA: Center for Environmental Management, Tuffs University.

Corson, W. 1993. "Measuring Urban Sustainability." Washington, DC: Global Tomorrow Coalition.

Gershon, D. & Gilman, R. 1992. *Household Ecoteam Workbook*. Woodstock, NY: Global Action Plan for the Earth.

Hall, C. 1994. "Moving to an Age of Synthesis" in *The Built Environment: A Creative Inquiry Into Design and Planning*, T. Bartuska and G. Young, eds.. Crisp Publications.

Krizek, K. and Power, J. 1996. *A Planner's Guide to Sustainable Development*. American Planning Association

McHarg. I. 1970. "Values, Process and Form" in *The Ecological Conscience-Values for Survival*, Disch (ed). Prentice Hall.

NSTC. 1995. *Bridge to a Sustainable Future* and *Technology for a Sustainable future*. Washington, DC: (President's) National Science and Technology Council.

Robert, K. 1997. "The Natural Step," a Swedish program presented at the Sustainable Development: Managing the Transition Conference, Rice University, March.

Rosenbaum. 1993. "Sustainable Design Strategies," *Solar Today*, March/April.

Sacks, P. 1996. *Generation X Goes to College*. Open Court.

SBSE: Society of Building Science Educators

Steele, J. 1997. *Sustainable Architecture: Principles, Paradigms, and Case Studies*. McGraw-Hill.

UDSDN. 1994. *La Carta di Megaride 94*, Corrado Beguinot, et al. Departimento di Pianificazione, Università degli Studi di Napoli, Italy.

Vale, B and R. 1991. *Green Architecture: Design for an Energy-Conscious Future*. Thames and Hudson Ltd.

Van Der Ryn, S. and Cowan, S., 1996. *Ecological Design*. Island Press.

Vieria. 1993. "A Checklist for Sustainable Developments" in a resource guide for "Building Connections: Livable, Sustainable Communities." Washington, DC: American Institute of Architects.

Wackernagel, M and Rees, W. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society.

Wann, D. 1996. *Deep Design: Pathways to a Livable Future*. Island Press.

Wann, D. 1992. *Biologic: Environmental Protection by Design*. Johnson Books.

WCED. 1987. *Our Common Future*, World Commission on Environment and Development, United Nations. Oxford University Press.

Zelov, C. and Cousineau, P. (eds.). 1997. *Design Outlaws on the Ecological Frontier*. Knossus Publishing.