ECOLOGICALLY RESPONSIVE URBAN FORMS: The Design of Human Settlements in a Technologic Age

by

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ABSTRACT

The purpose of this work is to present an optimistic view of our future environment. The stimulus to engage in this project is based upon a strong conviction that we share a responsibility to use our technologic expertise to enhance our environment and live in harmony with nature.

We are faced with growing ecological imbalance that threatens to irremediably damage our ecosystem, as a result of man's indulgence in crude, inefficient and wasteful environmental practices.

The specific objective of this study is to develop an alternative model for human settlements that is responsive to the natural environment. Ecological design concepts - soft energy sources, ecologic support systems, site design criteria and various building types are explored along with the emerging trends and innovations of our present technologic age. The design of new human Settlements relies on the influence these factors have on urban form. A scenario for the future is constructed illustrating how a successful integration of current trends and technologies with ecological principles can be realized in new communities and existing settlements.

The intent of this collection of relevant information on the design of ecologically-responsive urban forms is to create interest and promote further exploration and implementation of such Settlements patterns in a technologic age.

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ECOLOGICALLY RESPONSIVE URBAN FORMS: The Design of Human Settlements in a Technologic Age
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The purpose of this work is to present an optimistic view of our future environment. The particular stimulus to engage in this project is based upon a strong conviction that we share a responsibility to use our technological expertise to enhance our environment and live in harmony with nature.

The specific objective of this study is to develop an alternative model for human settlements that is responsive to the natural environment. This work also seeks to provide an impetus for the derivation of new models which will provide more appropriate
settlement patterns and urban forms designed with attention to ecological concerns.

While ecological concerns have centered principally on questions of animal life, plant life and pollution, this proposal goes further, by providing a concept framework of a biologically-balanced relationship between urban man and his environment.

By successfully integrating the best of our new trends and emerging technologies with ecological principles, we can establish balanced-living systems and enhance the quality of life-- creating a clean and healthy world for present and future generations.
This thesis is organized into two main parts. Part One is divided into two sections. Section One begins with the development of ecological design concepts and describes how these concepts will influence urban form and settlement patterns. Criteria for the design of new human settlements will be established. Section Two is an examination of emerging future trends and innovations and their influence on urban forms and future communities. These two sections will provide a collection of currently available systems and technologies that can be used in the design of new human settlements.
Part Two of this work uses the concepts and innovations alluded to in Part One, in order to develop a model scenario. This scenario will be developed first, on a regional level using the New England area. Ecological design concepts will be explored with the design of a prototypical community within the regional plan. The final aspect of the scenario will address existing urban settlements and offer design ideas for their redevelopment.
For the development of such a scenario, a certain number of assumptions must be made in order to proceed with a design program. The realization of the prototypical design will require a major shift in our present political and economic ideologies. The assumptions made will be based upon what I feel is the necessary direction society must take to meet the goals and needs of ecologically-responsive urban forms. Assumptions that are more specific to the design of a prototypical settlement will be mentioned accordingly.
This work is based on the premise that design can be used as a tool in the research process. The testing of the ideas set forth has been accomplished by designing a prototypical community. The research for this work was done simultaneously with the design phase. In this way, the design became part of the research and created a dialogue for the testing of ideas and stimulating new ones.

The information for this work does not pretend to be a complete or a final presentation of the issues involved. It is rather a collection of relevant information on the design of ecologically-responsive urban forms, with the intention of creating interest and promoting further exploration and implementation of such settlement patterns in a technologic age.
PART ONE:

ELEMENTS OF A NEW URBAN FORM
section one:

ecologic design concepts
The development of principles for the design of ecologically-responsive urban forms, begins with an understanding of the Earth's ecology. Ecology is the science concerned with the study of interrelationships between living organisms and their environment. An ecologic system denotes a specific area, with a distinct community of plants and animals, and considers the interrelationships among these living organisms and their environment.

The ecologic system discussed in this work, will consider a system which is comprised of the Planet Earth. It includes the factors...
which affect this planet, such as the sun, the moon, and the elements of the earth's axis and rotation around the sun. These factors are relevant in creating and controlling our weather and the seasons, which in turn, affect all smaller ecologic systems.

A primary element of the earth's ecologic system and the sustainer of life, is the sun. It is the major source of energy. The radiation from the sun heats the atmosphere, causing air movement as particles become active and move about. From this warming of air particles, a temperature differential results. Air movement, or wind is generated.
The Sun also heats the Earth's many bodies of water. Through heating, evaporation of water results, creating humid air, that together with the wind, creates our weather. This completes the hydrologic cycle. The hydrologic cycle contributes to the natural ecologic balance of the Earth.
Human settlements are a part of the Earth's overall ecosystem and must fit into its natural balance. The way to achieve ecologic balance in human settlements, is through the creation of urban forms which follow the natural regenerative cycles of the earth. Ecologically-responsive communities will incorporate this regenerative process in the development of its energy and support systems. The specific planning issues for the design of this type of community will be discussed in this section. Appropriate building types for the settlement will be shown.
1: soft energy sources

The form of ecologically-responsive settlements will be greatly influenced by the use of 'soft' energy technologies. If they are used efficiently, these systems may meet all of our energy needs.

Systems will vary from region to region, because natural energy systems must be appropriate for the specific microclimate. In addition to matching energy to location, it must be supplied at a scale and quality appropriate to the task.

Energy needs range from low-temperature space heating to high-temperature industrial uses. The following chapter takes a brief look at some of
the renewable energy technologies available for the design of sustainable communities.

These natural energy systems can be divided into four major areas -- Sun, Wind, Water and Earth.
The direct solar radiation from the sun has many various architectural applications. Once the site has been analyzed and the energy needs determined, the appropriate system can be developed. Many new solar technologies now exist along with the age-old practices for using the earth's natural energies. The area of solar energy is well documented. Here, is a brief look at available systems.

Passive Solar Systems
These systems are used for heating and cooling. Through the use of natural means such as radiation, conduction and convection, the structures themselves become the system.

Reference 54
Mazria
Direct Gain
The actual living space is directly heated by sunlight. Storing energy for night use can be done in the actual walls and floor of the space.

Thermal Storage Wall (Trombe wall)
A storage wall works by absorbing sunlight on its outer face and then transferring this heat through the wall by conduction.
Attached Greenhouse

A greenhouse, constructed on the south side of a building with a storage wall between, makes up this system.

Convective Loop

This system uses a solar collector and a storage mass unit. Air or water heated in the collector rises by convection into the storage mass. Cool air from the bottom of the storage unit travels back to the collector and the cycle continues.

Reference 54
Mazria
Active Solar Systems
These systems use mechanical means to extract energy from the sun. The energy attained from these type systems ranges from low-temperature residential heating to high-temperature steam production/generation of electricity.

Air and Water Collector Systems
These systems heat air or water in collectors and then circulates them to a storage unit. The advantage of this type system is that one can draw heat when needed.
Parabolic Collectors

This type collector concentrates large amounts of energy on a small area. This concentration produces high temperatures needed for various industrial and large scale applications.

Reference 20
Crowther
Solar Power Tower
A field of mirrors concentrates the sun's rays onto a collector, yielding extremely high temperatures. Steam is created to generate electricity.

Reference 88
Finneran
Photovoltaic Collector System

The photovoltaic collector system uses photovoltaic cells to convert radiant energy into electricity.

Reference 20
Crowther

Reference 88
Finneran
WIND

Air movement or wind provides many forms of energy use. Passive systems include natural ventilation and cooling. The active systems provide both mechanical and electric energy. Wind driven machines can provide direct power drive. They can be used to drive water pumps for wells or for small scale industrial use.

Development of high speed wind systems turns mechanical energy into electricity through generators. The availability of high velocity wind sources suitable for electric conversion, are relative to the regional microclimate. It is therefore necessary to assess a site's

Reference 20
Crowther
ability to support a wind system, and if feasible, locate the most efficient placement for it.

The following illustrations show various wind collection, conversion and storage systems.

Reference 20
Crowther
savonius rotor starter

darrieus hoop rotor

free air stream

turbine and generator

fixed structure

prevailing wind

confined vortex wind generator

Reference 20
Crowther
There are three major sources of energy derived from water. They are defined as gravitational, tidal, and thermal gradient. The first two, draw energy through direct mechanical means. The last source draws energy through a more complex system using the temperature differential in the ocean.

Reference 20
Crowther
Gravitational Energy

This form of water energy comes from the motion of streams and rivers. The basic water wheel is the most common source, providing both mechanical power and electricity after conversion. Construction of hydroelectric dams produce large scale electricity. This is achieved by creating highly pressurized water to run through giant turbines.

Tidal Power

This system utilizes the motion of the tides to create large amounts of electric power. This is achieved by the use of turbine generators situated in dams, which provide the conversion of tidal motion into electric power.
Ocean Thermal Power

The tropical oceans collect and store large amounts of solar energy as the sun rays warm them. Energy is extracted from the ocean and converted to electricity. The OTEC power plant or Ocean Thermal Energy Conversion plant is an example of this type of system.

The concept for this system is similar to today's conventional power plant. The ocean's heated water replaces the oil heated water, while cooling done by rivers and streams in fossil fuel plants comes from the ocean depths.
Reference 85
Williams

Figure 6.2
Cutaway view of OTEC plant designed by TRW.\textsuperscript{14}
Geothermal Energy

The heat contained in the core of the earth can be drawn from to extract energy. This process is known as geothermal power. The system shown uses a heat exchanger to draw the energy from the earth directly.

Reference 20
Crowther
Methane Generation

Methane gas can be found naturally in the earth or it can be produced as a by-product of decaying organic matter. It can also be produced in a digester as shown in the illustration. Methane as a fuel can be used to power vehicles or heat buildings.

Reference 20
Crowther
2: ecologic support systems

There is a vital link between forestry, agriculture, waste recycling and water management. It parallels the natural cycles of the earth and must be utilized in turning human settlements towards ecologic balance.

The careful establishment of these systems yields an integrated, biologically-derived support system. This chapter will look at the interrelated support systems of waste treatment, water, and agriculture. Aquaculture support systems will represent a combination of these three.
WASTE TREATMENT SYSTEMS

The treatment of wastes is a major problem facing existing communities and cities. It is also a critical aspect in the design of new communities. New, more efficient and ecologically-sound waste treatment systems are being developed and need to be considered in the design of new human settlements.

The existing conventional methods for waste treatment are expensive, inefficient and cause great harm to the natural environment. In these systems, the nutrient-rich effluent, a wastewater by-product, is permitted to flow, through percolation and direct dumping into
lakes, streams, and off-shore sites. This effluent offsets the natural balance of these water sources and eventually leads to their contamination.

Another by-product of these systems is solid material, or sludge. It is presently disposed of by incineration, or by costly transportation to landfills or offshore dumping sites. These waste treatment practices take a potentially useful resource and turn it into a pollutant to be unleashed into the environment.
New innovations in the area of waste treatment have developed recycling methods for these valuable nutrients. Organic sewage contains many nutrients that act as good fertilizers. It cannot only be used to improve agriculture, but also work to restore disturbed lands such as strip mines.

A variety of ecologic waste treatment systems exist that can be utilized in the development of new communities or existing ones. The selection of which system to use, depends a great deal on the specific location and scale of development of the settlement. A well-designed community, for example, would make use of various waste treatment systems appropriate to its particular site.
An in-depth study of the site ecology would yield the systems that would work most harmoniously with the site. The size and type of treatment system selected is relative to the size of the community, or building cluster. The potential size of a community would be relatively defined by the site's ability to naturally recycle wastes.

The following waste treatment systems are adaptable to a variety of ecosystems, including farmland, forest, pond and wetland. They range from traditional land treatment systems, to aquaculture, to composting systems. A variety of scale and performance suitable for the design of new human settlements or redevelopment of existing ones is offered.
LAND TREATMENT SYSTEMS

Slow-Rate Treatment System

This system works in a way similar to conventional crop irrigation. Partially treated wastewater is applied by sprinkling, flooding, and ridge and furrow techniques onto cultivating lands. Here, the soil, plants and microorganisms purify the water, as it slowly percolates down to the groundwater. This system is presently being used to irrigate farmlands, old fields and forests. This system requires 50 to 500 acres per million gallons of wastewater per day.

Reference 9
Bastian
Rapid Infiltration Systems

In this system, partly-treated wastewater is applied in doses to sandy or highly permeable soils. The physical, chemical and biological purification occurs as the water percolates toward the groundwater. This system requires 2 to 50 acres per million gallons, per day, depending on soil characteristics.

Overland-flow Treatment System

In this system effluent is applied at the top of grassy slopes which are on top of an impervious soil layer. The liquid flows down the slope and is purified by the soil, grass and microorganisms on the surface. The runoff is collected for reuse or discharged to surface waters. This system is useful in areas with impervious soil conditions.
SMALL SCALE LAND TREATMENT SYSTEMS

Septic Tank and Soil Absorption Field

In this system sewage bacteria breaks up solid wastes in septic tanks and sinks it to the bottom as sludge. Effluent floats to the top and out to perforated pipes in gravel-lined trenches (absorption field). Many variations of this common system exist utilizing septic tanks or aeration tanks (aerobic digestion), in combination with absorption fields, seepage pits or leaching chambers, depending on the soil capabilities.

Reference 76
U.S.E.P.A.
Mound System or Evapotranspiration Bed

This system is for use in rocky or impermeable soils. Liquid is pumped into a permeable mound of soil where it evaporates. This process is enhanced by plants which draw moisture from the soil and 'breathe' it into the air.

In all of these land treatment systems the by-product sludge, must be treated through alternative methods. Through the use of new techniques sludge can be recycled for use as a soil conditioner or organic fertilizer on farms, forests, pastures, golf courses and disturbed lands.
One of the drawbacks of these systems, is the necessary handling of sludge for treatment. Even in the smaller systems sludge must be pumped out and taken to central treatment centers. Another drawback of these systems is the large amount of water used to transport wastes. Although water is eventually returned to the soil, this may cause problem in drier regions.

WATERLESS or LOW WATER SYSTEMS

These systems use little or no water, but are primarily intended for use in small-scale applications.
Recycling Toilet Systems

There are three basic types of these systems:
* **Oil-flush Systems** - This system is similar to the conventional water-flush system, however oil is the medium used. Oil and wastes go to a tank where oils rise to the top and are recycled.
* **Low-water Chemical Systems** - This system uses a combination of chemicals and water. They are both recycled.
* **Low-water System** - Small amounts of treated wastewater are recycled in this system.

All of the above systems use electricity and require maintenance.
* **Incinerating System** - In this system electricity, gas or oil burns solids and evaporates liquids. Water is not used and ash waste must be removed. Most nutrients are unfortunately lost in this process, unable to contribute to the overall ecosystem.

* **Composting System** - This system also does not use any water. It converts toilet and food wastes to compost, where, after a certain period of time it can be used as fertilizer. The **Clivus Multrum** is one such system. Each compost unit is only capable of servicing 4 or 5 persons.
NOTE: With all of the previously listed systems, the toilet wastes are being treated. Other household water, from showers and sinks, needs to be treated separately, in a manner similar to that of a land treatment system.

In a carefully and ecologically-designed system, the conservative use of water is necessary.

Attempts to collect water in roof solar stills, or in cisterns, would be helpful. The re-use of water, rather than recycling may be a better way of approaching the problem.
The solar still which formed the roof of the bathroom unit in the Ecol house at McGill University (after Ortega et al., 1972).

The Ecol water collection, purification and waste treatment system (after Ortega et al., 1972). The figures show the quantities, in litres per head, passing through the system per day.
The final waste treatment system to be discussed in this chapter is perhaps the most efficient and most ecologically-responsive of all those mentioned.

**AQUACULTURE SYSTEMS**

Most of the systems discussed previously, utilized a monoculture process which uses only bacteria to break down the elements of waste. This is also what occurs in the aerobic treatment system.

The aquaculture systems utilize a poly-culture process which contains a variety of bacteria, invertebrates, sludge-grazers, algae, plants, and in some cases, fish. These systems produce a higher quality of water which can be used for recreational purposes, in an efficient ecologically balanced process.
The advantages of this type system are the following:

- the system can be effectively applied to home or community.
- it is a low energy use system. Energy from the sun provides the necessary heat. Methane produced provides electricity. The system works on a gravity feed system and eliminates the need for pumps.
- the aquatic plants can be harvested to be used as a rich compost, mulch or as a supplemental feed for livestock.
The Solar Aquacell System

This system consists of a multicell, aerated lagoon covered with a solar heating greenhouse which provides the heat necessary for the process. The lagoon contains aquatic plants and biologically-active algaes which remove and metabolize wastewater nutrients and toxic compounds.
AGRICULTURE

An ecologically-balanced community should be able to satisfy most of its needs for food production. It should be able to grow most of its own food in its households, neighborhoods and surrounding regions.

The community's agricultural systems should include tree forestry, animal husbandry, crop cultivation, and storage and preparation. Links to the system include waste treatment residues, and aquaculture by-products as supplementary plant nutrients.

Food production in an ecologically-balanced community includes both indoor (i.e. greenhouse),

Reference 73
Todd
and outdoor home-scale production, as well as, larger-scale neighborhood production. The growing of food would consist primarily of fruit trees and vegetable and herb plots. Larger-scale production would yield grains, dairy products and meats.

A combination of passive energy technologies are utilized in the formation of urban block farms. The following diagrams present the intricacies of such a system.
Reference 7
Britz
3: site design criteria

In planning ecologically-responsive human settlements, many site considerations must be made. Water and air quality, soil, earth, hydrogeology, and topography cannot be considered separately. By implementing plans that consider the full range of the ecologic system, most environmental injury can be prevented and quality of life can be maximized.

The most commonly recognized site characteristic for the development of ecologically-responsive design, is the orientation of built forms with respect to the sun.
Because the sun is an everchanging source of heat and light, it is a source that we can tap only to the degree in which we take account of its dynamic character. The solar envelope is a concept devised to allow each site in a plan, access to the sun during critical daytime periods.

The construction of such a three-dimensional envelope is made through the extrapolation of solar arcs representing the path of the sun. These extrapolations are then transferred to the corners of the land parcel.

Depending on the duration of desired solar access, the land parcel configuration, and surrounding conditions, the size and shape
of the envelope will vary. The solar envelope's size, shape and orientation are greatly dependent on the patterns of urban settlement.

Development within this container will not shadow its surround during critical periods of the day. The envelope is therefore defined by the passage of time as well as by the constraints of property. It is modeled on straightforward zoning regulations, and its intent is to assure future rights of access for its respective site.
of the envelope will vary. The solar envelope's size, shape, and orientation are greatly dependent on the patterns of urban settlement.

STREET ORIENTATION

The streets in many human settlements for example, typically run in a north-south direction. In order to maximize solar access, streets should be planned with the concept of solar access in mind. The optimal orientation is to situate the street grid at a 45-degree angle from the north-south axis. Streets are then lighted and warmed during the midday and are consequently more pleasant during the busy noontime shopping period.
Varied topography of a site results in areas of increased and decreased exposure to the sun.

In cool regions, building on south- and south-east facing slopes is the primary pattern that should be followed in site selection and placement of urban forms. Higher ridges and hilltops are undesirable, not only because they are exposed to winter winds, but also because they are characterized by lower temperatures created by cold air setting in the valleys.

North-facing slopes are usually inappropriate because they are exposed to the wind and receive
less solar radiation than south-facing slopes. Structures set into the earth on a south-facing slope are particularly effective in providing protection from winds.

South-facing slopes have higher ground temperature due to increased solar radiation, creating a more favorable microclimate in winter, an earlier spring and a later fall than is the case of a north slope. While there is no doubt that siting on south-facing slopes reduces energy consumption in cool climates, the quantitative effect will vary depending on local climate, exact site conditions and other site features.
Relative humidity increases with altitude because the temperature falls although the amount of water vapour in the air remains the same. As the air is forced higher the temperature drops until the water vapour condenses as cloud and rain.

Wind speeds are increased with altitude. Wind at sea-level is approximately \( \frac{1}{3} \) speed of wind at 610 m (2000 ft).

When wind is blowing over an obstruction, it accelerates up the windward slope.

On flat ground the angle of incidence of insolation is less than on a S-facing slope.

Cloud base can be 185/230 m (600/750 ft) above sea level so an upland site may often be in the clouds. This results in more damp, misty conditions, and a greater risk of condensation.

The air gets clearer with altitude.

More rain and higher wind speeds give a higher driving rain index. Higher wind speeds and lower temperatures give greater wind chill.

The nearer the angle of incidence is to 90°, the greater the insolation.

Temperature decreases with altitude on mountain sides at a rate of 1.8/2.0°C (3/3.3°F) per 305 m (1000 ft). (Dry adiabatic lapse rate.)

Because the temperature is lower it is below freezing point more often than in lowland areas; therefore there is more snow and it remains longer. Because of the strong winds, there is more drifting.

Reference 1
Abbott
SITE ELEMENTS FOR SHADE

We can best provide shade from the sun through the use of trees in our human settlement. Shrubs, walls and fences also work to reduce the summer cooling load of our urban forms. Siting for shade, requires the selection of an area with trees that are without dense branch patterns which would interfere with solar gain in the winter. Typically deciduous trees are located on the south side of the built form in order to provide summer shade.

Reference 78
Univ. of Minn.
SITE ELEMENTS FOR WIND PROTECTION

Wind protection can be adequately provided for by solid barriers such as earth berms or fences as well as existing and new vegetation. These barriers significantly affect a built forms energy needs. Energy savings from reduced heat loss can be offered at little or no cost. Windbreaks such as clusters of built form or individual units can be effective in wind protection in entire settlement designs.
SITE ELEMENTS FOR NATURAL VENTILATION

In the same manner that vegetation, earth berms, fences, and walls can be used to reduce cold winter winds, these same elements can be used to channel and even accelerate summer breezes.

In cooler regions, trees, shrubs, fences, walls and earth berms on the southern side of a built form can be located to channel prevailing breezes from the southeast and the southwest through the window openings of the house. Site elements on the north side of a built form have little effect on summer breezes unless they obstruct the openings or outlets for cross-ventilation. Winter windbreaks should therefore

Reference 78
Univ. of Minn.
be placed far enough away from the house to allow some air flow in the summer.

Clustered buildings should be staggered to take advantage of natural ventilation. Locating housing near bodies also enhances natural ventilation, in addition to moderating temperatures and providing evaporative cooling in dry areas.

Natural ventilation is maximized simply by proper orientation of the built unit, window placement and elimination of any obstructions on-site. Site elements for natural ventilation therefore, may be unnecessary in many cases.
It will however, be particularly desirable in situations where it can correct for poor orientation, or to help accelerate air flow.

Placement of trees to enhance natural ventilation must be coordinated with tree placement for shading and wind protection. For urban forms with a substantial amount of earth contact, which produces cooler temperatures, natural ventilation may not be as necessary to maintain comfort.
WATER AVAILABILITY AND QUALITY CONSIDERATION

Water availability is a basic requirement for human settlements. Consideration should be given toward the ability of nearby streams to assimilate wastes from proposed development or the cost of the required level of work.

In planning human settlements, one must look at surrounding bodies of water and identify the uses they are capable of—water supply, recreation, protection of aquatic life, waste water disposal systems, and agriculture.

Discharging, even the most highly treated wastes into surrounding lakes, reservoirs
or estuaries, is detrimental because such bodies have limited self-purification capacity, and sewage effluents stimulate aquatic growth (i.e. bacteria).

HYDROGEOLOGY AND FLOOD HAZARDS

Good soil level and ground water conditions are essential in building a human settlement. Flood plain management is a good investment and its costs are a fraction of the cost of the damages that may be incurred without it. Poor soil areas can be used for other non-conflicting uses. Flood plains and fragile wetlands can be uses for parks and agriculture.

Reference 28
Golany
4: building types

This chapter illustrates the variety of building types available for the design of ecologically-responsive communities in a technologic age.
Stepped Terraced Housing

Reference 1
Abbott
THE ARK TWO

ARK SPACES - greenhouses used as living spaces

Reference 73
Todd

THE CAPE COD ARK
BESS-Greenhouse

This is an example of an organic recycling center for neighborhood use.
SOLAR ENVELOPE APPLICATIONS

These diagrams are examples of solar envelope application to the design of built forms.

A view of the east-facing envelope shows the high south ridge and the long slope down to the site's north edge.

A design seen from the same direction gains south exposure for a northern row of units by admitting low winter rays between tower-like shapes on the south. In this way, much of the envelope's large bulk can be used to achieve a density of 45 dwelling units per acre, fifteen more than on the other site.
For example, the additional width on a north-facing site provides a very long, high envelope ridge. Instead of facing all units to the south, this design fills the envelope's high ridge, thus exposing broad building faces to the east and west. While sun control problems are thus increased, more units can be added for a density of 43 dwelling units per acre rather than the 30 units on a 100-ft. site with the same ridge orientation.

Reference 42
Knowles
Multiple-Unit Earth Sheltered Housing Project

This project effectively illustrates the use of attached earth sheltered units on steep south-facing slopes.

Reference 78
Univ. of Minn.
Earth Sheltered Community Design
Reference 78
Univ. of Minn.
Solar Housing Cluster

Reference 66
Safdie
This living space demonstrates how computer technology might influence the form of future dwellings.

Reference 86
Wolf
Solar Townhouses

Urban Forms, California
section two:
emerging trends
and innovations
EMERGING TRENDS AND THEIR INFLUENCE ON URBAN FORM

This section will explore innovative trends and technologies and their influence on urban forms and settlement patterns. This information, while speculative, will be valuable in establishing new design concepts for human settlements of the future.

The work is based on current information and predictions of the innovative ideas moving into all aspects of American culture. The impact of these new trends affects so many factors of society that I will only be addressing those that specifically influence the form of our built environment.
There is now more than at any time in history, a societal preoccupation to predict the trends of the future. Rapid advances in science and technology are moving society into a new age of development at a wildfire rate. The effects of this move have yet to be fully realized.

Daily, one may find reports in the newspapers, magazines and on television regarding present possible alternatives for our future. Alvin Toffler in his latest work, describes the history of civilization as characterized by three major eras or waves.

Reference 75
Toffler
The first wave represents the agricultural age of development. The first human settlements were made possible through the invention of farming tools and techniques. Cultivation of the land encouraged the once roaming nomadic tribes to establish more permanent dwelling units. During this era, land became the main social measure of power and status.

The second wave is known as the industrial age. The basis of the economy shifted from agriculture to industry. The social measure of power moved from those who owned land to those who controlled and owned cheap energy and resources. Rapid urban growth and the development of the automobile led to the urban sprawl that now exists. A major characteristic of this age was the evolution of a highly mobile society.
TELECOMMUNICATIONS

Toffler asserts that civilization is now entering The third wave-- an age of technology and information, where information is power. This age is marked by rapid development of the computer, which has found its way into just about every aspect of life.

Its uses range from aiding corporate decision-making to biochemical research to doing one's taxes. Working couples are shopping by home computer to save time and money. Adults and children alike use the same device, to broaden their knowledge of everything from hobbies to language and mathematics. The personal computer and home television are becoming the tools for bringing families an increased variety of goods.

Reference 51
Maloney
and services. Databanks and videotext services give individuals access to informational systems of their choice.

Various computer-based recreational, educational, and control services will appear in many homes in the next ten years. The "electronic cottage" is a prime example of the influence of emerging trends in our technologic age. It is a proposal to trade transportation for telecommunication, that is, working at home using a computer terminal.

Underlying this notion, is the belief that many employees, especially those in white-collar jobs, could stay at home, one or two days a week and still perform, via the network, essentially the
same duties that they now do. About ten million
workers who deal in information--writers,
educators, accountants, lawyers--are ideally suited
for "telecommuting". Jack Nilles, director of
information technology at the University of
Southern California's Center for Future Research,
predicts that the number of people working at home
with computers is going to double each year.
This system would demand close coupling of the
office in the home, with the conventional office.

It is difficult to imagine how such a concept would
affect one's interactions with colleagues and other
members of the family unit. As the automobile
played a key role in the development of urban form
and pattern, telecommunications will alter present
day form. With an increased portion of our business,
domestic and recreational activities performed at
home, there is less dependence on physical transport systems. With less travel, consumers can look forward to energy savings. Central cities will be faced with less congestion and pollution in high density areas. Individuals will enjoy more leisure and less demands on their time.

Teleconferencing will allow important meetings to take place over long distances without necessary travel. Neighborhood-based systems will emerge, with provisions for community based work stations and neighborhood health centers. This framework will promote decentralization of commercial and industrial activity. We will witness the rebirth of local community life and the formation of economically-sustainable satellite communities.

Reference 28
Golany
Current changes in American lifestyle exert an important influence on urban form. These factors exist as a major element in re-thinking the design of future household spatial requirements.

The typical American family of wage-earning husband, homemaker wife and two children, now represents only 7% of our household units. By 1990, according to the Harvard-MIT Joint Center For Urban Studies, the number of households headed by a single person will increase. The married couple, although not exactly threatened with extinction, demographically, are barely surviving as an institution. Out of 20 million new households established in the next decade, only about 3 million will contain a married couple with children at home.
The remainder, will consist of single-parent households, "single" people, couples and the elderly.

The proliferation of other kinds of family units is partly due to a 50% hike in divorced parents with dependent children. The increased cost of adequate housing has also contributed to the most startling statistic in the growth of non-family households. The number of individuals living alone and non-related persons dwelling together (communal living), has leaped 71% since the 1970 U.S. Census. For the first in this nation's history, fully half of all households consist of only one or two persons.
The design of housing in the decade will reflect these new factors of social habits and economic reality. Single family houses are expected to shrink in size, contain compact floor plans, and sprout energy-efficient appliances.

Smaller size households may share kitchens and living areas often under the roof of one townhouse or modified single-family structure. Houses may also be clustered for more efficient use of land and community resources.

Renovation of existing homes should occur in order to render them more ecologically/energy efficient. The house of the future will be much smaller. Instead of rooms with specific and singular uses, multi-purpose rooms will be created.
INNOVATIVE TRANSPORTATION SYSTEMS

Because the functional systems within a city are highly interactive, the demand for transport will depend on the locations of residential areas, work stations, and shopping and recreation sites. Lifestyle variables and expenditures of residents will depend on transport systems available. Size of the settlement, the demand for freight transport, the amount of congestion and the means for regulating congestion, need to be analyzed in order to design a good system.

The basic objectives of a good transportation service are to provide better transportation than the automobile affords; to reduce the
impact of highways and automobiles on the 
community; and to avoid the introduction of 
ew objectionable features such as unsightly guideway structures, ramps, cloverleafs, and 
large station parking areas.

To have a significant impact on the urban problems created by the present overwhelming public preference for automobiles, it is clear that any new system must offer superior local area service. Matching the auto's 'door-to-door' time implies, a short walk, immediate boarding, a direct route to the destination, and a high average speed. Certain other amenities as pleasant design, comfort, and relaxation during travel, could also be added.

There are many transportation innovations that can be usefully employed in conjunction with the design of new human settlements. Two
categories to be presented are those providing access to a new settlement, and transport systems and vehicles employable within a new settlement.

Reference 28
Golany

INTRACITY TRAVEL

The transportation system for new ecologically-responsive communities would rely mainly upon systems for pedestrians, cyclists, and small-scale vehicles.

The City Bicycle
The Electric Witkar

Each Witkar station includes a parking strip for 10 cars, a current rail for automatic contact with a vehicle, an electric charging system and a selection pole. The choice pole is in communication with a processor that regulates the distribution of Witkars over different stations.
INTERCITY TRAVEL

Needs for intercity travel will be met through various forms of mass transit. These include buses, aircraft, watercraft, railways, electric cars (automated guideway system).

Aircraft

Helicopters and existing aircraft provide a wide range of fast and long-range air travel. The helicopter provides the advantage of flexible landing and takeoff.

Watercraft

Hovercrafts, air-cushioned boats and hydrofoils are a few of the various water transport devices for commuting between shore to shore cities.
**Railways**

Metroliners, tube and turbo-trains provide direct high-speed (80 to 130 mph) rail access between communities and cities.

**Electric Cars**

Electric cars can be used for short distances or on automated guideway systems that provide electricity and controlled routes.

Transport of goods and services is available through the means of Intermodal Freight Centers. These centers collect freight from various places and sources, where it is transferred to other modes or accumulated for final shipment to other destinations. Freight would move during the inactive periods of transit use.

Reference 32
Hanson
In larger scale cities, these and other mass transportation systems will be used. These include buses and monocab systems, traditional subway-type systems and surface systems.
10-PASSENGER VEHICLE

MANUAL CONTROL OFF GUIDEWAY
COMPUTER CONTROL ON GUIDEWAY

Reference 32
Hanson
PART TWO:

TOWARD AN ECOLOGICALLY-RESPONSIVE FUTURE
section one:
constructing a future scenario
1: developing a regional plan

This regional plan is an attempt to develop a new morphology for human settlements. The concept is based on developing an optimal efficiency and ecology of land use. It utilizes principles for attaining ecologic balance and energy efficiency. The regional plan aims to create a satisfactory hierarchy of lifestyle and opportunity levels available to all citizens of the region.

Present urban development has limited the amount of land currently available for human use. Large expanses of paved surfaces and cleared land have deteriorated the watershed and increased runoff.
The automobile has been the most influential factor in creating the urban sprawl we evidence today. Its flexibility and convenience has led to its present domination as a means of transportation and shaper of urban form.

One of the primary concerns in the development of a regional plan is to provide an alternative to this means of transportation. By providing an alternative to this conventional, yet wasteful means of transport, we can hope to influence urban settlement patterns toward a more efficient and rewarding use of urban space.

As is true of any ecologically-derived system, a network of varied and diverse transportation options are provided.
DEVELOPMENT OF 'CONURBATION' ALONG HIGHWAYS

AND THE ALTERNATIVE SOLUTION

Satellite communities provide natural & productive landscape between dense urban settlements
Satellite Cities

A satellite settlement concept is formulated. A central city for our future scenario serves as the nucleus of this concept. For our plan it will be Boston. The central city is the region of planning agencies, business and cultural centers, concentration of government and central educational institutions. Connected to the central city are a number of satellite mini-cities--Lowell, Framingham, Worcester, Lexington and Peabody. Surrounding them, is a series of small sustainable villages.
This plan is realized through a poly-centric pattern of urban centers, each of which would be related in differing ways to a nucleated and partly self-contained unit of development. A new community created within this framework would offer its citizens a good choice of localized work and social opportunities. By being mobile in an urbanized area, they have a choice to seek satisfaction within the central of the urban complex.

The regional approach satellite concept creates urban environments closely attuned to natural environment. It is a system based on the natural cycles of the sun, wind, water and soil. It provides its inhabitants with a desired interactive
urban life, while satisfying essential needs for greenspace and countryside. This regional alternative disperses urban growth through self-contained, efficient satellite communities separated by agricultural and natural woodlands. The agricultural development of each satellite limits the need for mass transport of most goods (i.e. foodstuffs).

Such a regional plan establishes satellite communities and "mini-cities" with detailed mass transit networks excluding the use of the automobile as we know it. The many new innovations in the area of transportation mentioned earlier in section two of Part One of this work, give us the materials to create a system of this caliber.

Reference 32
Hanson
While the concept of the private car may exist, the use would be primarily for recreational purposes. Its features will be similar to electric or hovercraft type vehicles. They would not however be available for use within the community.

Computer-controlled predefined transit paths or lanes existing outside the settlement would be available for these vehicles to visit other "mini-cities" or the central city, Boston. Switching to a manual mode would make possible travel to more varied destinations. Spontaneous jaunts to specific areas would also utilize this idea of public "private" cars. Conservative use of this vehicle is encouraged.

Bicycle and electric car network, and pedestrian pathways exist within the settlement. The new
MASS TRANSIT NETWORK
and links to mini-cities and Boston
form of settlement patterns will respond according to this transport system.

The central city itself, must utilize energy-efficient and environmentally sound practices to become as sustainable as possible. Urban block farms can be created to better utilize land plots situated between urban blocks. The amount of paved area is greatly reduced yielding more land for purposes of cooperative agribusiness and recreation. Special zoning requirements are established restricting the construction of built forms which obstruct solar access. The city is fueled by a series of decentralized energy support systems--biomass, biofuel, wind energy, photovoltaics, and solar heating and cooling.
TRANSPORT
SYSTEM

use of existing infrastructure in the development of mass transit system.

site of prototypical community
Work Force

In response to basic ecologic principles and available technological innovations, redevelopment of the work force will occur. The effects upon type of employment available, work hours, and wage payment will be relative to each respective settlement.

Some adjustment in the trades system will be made. Many new jobs will be created that benefit the collective settlement. Reforestation teams, operators of biomass facilities, wastesystems and energy services, and transportational services. System maintenance must have trained personnel, in addition to the collection of contributors from all segments of the settlement.

Reference 75
Toffler
Agricultural concerns will grow and barter systems will thrive in this cooperative.

The need for a centralized work force will be reduced by the advancements of telecommunications. Large corporations will easily establish neighborhood work stations, utilizing the communications network outlined in section two of Part One. Many people will be able to work from their ecologically-responsive homes via a telecommunications network. They may opt to travel to nearby community work-stations. The development of a shorter work week, more varied time schedules and curtailed work hours at peak efficiency will mean more jobs and more leisure time for community tasks and enjoyment.
The regional plan disperses the urban growth and density of the central city (Boston), to "mini-cities", in this case Lowell, Massachusetts. Agricultural and natural woodland areas act as physical boundaries. These satellite cities will have the potential of sustaining themselves through renewable energy systems, neighborhood health centers, energy-efficiency, food production and and a viable economic base. Major medical centers, cultural events, recreational shopping and dining will be located in the central city.

It is the regional plan's goal to forge a pattern that retains the best of the high technological, urban, information-oriented/telecommunications culture, while renewing people's sense of place and their connection to the basic rituals involved in an active participation in the natural cycles of life.
2: designing a prototypical community

Satellite Community

A modern community designed to sustain a high quality life based on ecological balance and efficient energy use.

Location: south of mini-city Lowell, Massachusetts

Feasibility: combines sensible land planning and proven technologies in a commitment to a secure future based on renewable energy sources

Site Information:

Topography ** Hilly densely forested
Deciduous and Coniferous Trees and Shrubs
Suitable variety of wildlife
Sites for urban forms on south-facing slopes.

Climate ** North Temperate Zone
In summer, S-W wind
winter, N-W wind

Site Design Relates to Climate
Zoning: Zoning for solar access, utilization of solar envelopes

Density Workable Toward Ecological Balance of Site

Bio-Regional Plan-- map determines area of development and preservation, as well as industrial and commercial use

Allows for diversity of design

Housing: Variety of adequate designs

Clustered for more efficient use of land and community resources --rebirth of community life, shared public space

Semi-Cooperative Living / Density 5-15 units/ acre

Compact Floor Plans, Multi-Purpose Rooms

Neighborhood Center:

Day Care, Health Care
Seniors, Pre-School Toddlers

Industrial, Cultural and Recreational Centers also exist.

Transportation: Combining Work and Living Space

Bicycle Paths, Pedestrian Aids, Small Electric Vehicles for Automated Guideway Heliocopters

All Destinations Are Within A Short Walk

Private Cars (present day auto) is banned Within Site
WORK: People Working on Site and Neighborhood

Work Stations due to Telecommunications-System Network

High Technology Industry and Information Services

Manufacturer of Solar-Related Products

New Work Styles/Job Titles

ENERGY: Solar-Photovoltaics, Solar Ponds
Biomass as a supplemental heat source
Biofuels—from methane
Wind

AGRICULTURE: Prime foodstuffs from local area
Household, Neighborhood and Community Farming
Increased Use of Land for Urban Farming

HEALTHY ENVIRONMENT: Marsh and Pond for Wildlife and Birds
Recreation, Fish Farming
Natural Trails and Open Space for Hiking and Biking.
SITE DEVELOPMENT CONCEPTS

SUSTAINABLE COMMUNITIES

north winds

... A SECTION

- preserve agricultural land, utilize best geographic location / soil
- locate urban settlement on less desirable landscape - high lands - south facing
- locate support services - in respect diminishing factor
- integrate land uses
  (work, play, live)

forest or rural order.
TRANSPORTATION DETAILS

WALKING DISTANCES...
from home to community activities.

- improved levels of transport tend
to shorten times/distances cited
- again for shortened work week
- major transport demand times
- increased leisure time needs closer
  proximity to recreation and nature.

- Home
  - 5 miles
  - 1/4 mile

- 15 min
- 1/2 mile

- 20 min
- 1 mile

- 30 min

- pre-k
- daycare
- school
- convenience
- shopping
- open space
- recreation
- middle school
- health clinic
- religious
- day-care
- indoor entertainment

- high school
- major cultural
- activities
- major transport
- facilities

- regional
- services
- adult care
- employment
SITE ANALYSIS

- Shaded north side of slopes - non-buildable
- Wind mill - therapeutic
- South facing slopes most suited for housing development
- Fragile wetland areas to be preserved - recreational use
Community Center
Safdie
Solar Industrial Center
Table Mountain
Neighborhood Center and Housing Cluster
Goody, Clancy & Associates
Cluster Housing Prototype
Safdie
Lakeside Recreation Center
Taylor & Williams
3: reshaping existing settlements

This chapter looks at the existing urban environment and the changes it will undergo as part of the regional scenario.

The existing cities, having replaced the automobile with a highly-efficient mass transit network will become pedestrianized promoting an enhanced quality of life.

The suburbs will also benefit from the replacement of the automobile. Vast paved surfaces will be converted to valuable recreational and food producing areas.

The following examples show how urban environments and suburban communities can evolve into more ecologically-responsive human settlements.
The existing situation ...
...the alternative

Reference 25
Franzen
Pedestrianized Urban Streets

Reference 90
Hosken
The City Transportation Network and Enclosed Street Mall

Reference 25
Franzen
The Evolution of a Suburban Block

Watch this space!

Reference 7
Britz
phase one
The Development of an Ecologically-Responsive Neighborhood

Reference 7
Britz

* form homeowner's association
* buy commons and farmhouse
* renovate + sell farmhouse
* maintain ownership of commons
* reduce cash outflow
  for example: grow as much food as possible, cancel garbage pickup,
  build temporary plastic greenhouses for vegetable starts.
phase two

* Homeowners association expands to include 19 homes.

* Permanent renovations occur for solar heating, food growing, home improvement.

* Permanent plantings of fruit trees, shade trees, berry crops, herbs.

* Provision for recreation in commons.

* Refinement of public/private edges.

* Conversion of streets to food growing & recreation.
phase three

* Complete on-site waste utilization
* Near-complete production of electricity for black through photovoltaic collectors
* Creation of on-site employment for residents
CONCLUSION

This work has provided a collection of ideas and examples that present an optimistic view of our future environment. The examples chosen in this last section are, but a few of the many alternatives available today, and of the many yet to be explored as we move into an age of high technologic innovation.

The conclusion to this work does not bring this topic to an end. It is, on the contrary, a place for the ideas espoused, to begin to create the impetus for their implementation.
An ecologically-responsive urban will not emerge without a commitment to, and a conscious effort for its creation. The move towards an energy-efficient, balanced urban environment will require a restructuring of our established settlement patterns.

New zoning ordinances need to be delineated which provide for solar access and efficient site orientation. Building codes must be altered to optimize the efficiency and energy use of built forms. An overall national policy must be reached that recognizes the needs and desires of the public to shape our political, economic and social ideologies so that it may ensure a future which uses technologic innovation to produce an ecological balance in our environments and maximizes the quality of our lives and those of future generations.
Some towns and cities have begun to implement new ideas and alternative solutions in planning their communities. They serve as good examples of specific ways of achieving high quality urban environments.

When Davis, California was threatened by suburban sprawl and multiple traffic demands, the city council made a decision to limit the city's growth. A decision to conserve energy resulted in an ordinance approved by the city council and aimed at achieving conservation by establishing a set of performance standards for the construction of buildings.

Reference 65
In Seattle, Washington, the use of nuclear power to meet energy needs was rejected. Energy conservation was the chosen alternative. This approach developed new building codes aimed at achieving efficient construction and higher densities. It also rethought existing transportation policies. Seattle is currently considering a free bus system for its downtown areas in order to cut down on automobile use in its cities. Much publicity has been sponsored to promote the use of conservation measures in the home.

The city council has expanded its efforts to conserve energy by encouraging the use of bicycles. It has provided a complex of special paths and bike lanes on public roads to direct this change. Davis' City Hall maintains its own fleet of bicycles for employees who need to travel about on the job.
Other cities throughout the nation are experimenting with alternative energy sources. In Clayton, New Mexico they are using wind power to produce a substantial amount of electricity. In Burlington, Vermont they are experimenting with wood power, and in Ames, Iowa they have pioneered a system for producing energy from refuse.

The benefits of such environmental programming schemes are clear. Continual exploration and future developments can only add to our expertise in designing ecologically-responsive urban forms for human settlements in our future. It is my hope that this work will promote the interest and provide the direction for the achievement of urban environments built in harmony with nature and providing an enhanced quality of life.
BIBLIOGRAPHY


