Global Possibilities'

Second Annual Symposium for a Solar Future

"Rethinking Design Curriculum: Integrating Solar Energy for a Sustainable Future"

Summary Report

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in conjunction with

Cooper-Hewitt, National Design Museum, Smithsonian Institution
Under The Sun: An Outdoor Exhibition Of Light

GLOBAL POSSIBILITIES

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As the millennium approaches, we are witnessing the disruptive effects of global climate change on mankind, our economies and our precious environment. Yet increasingly, leaders such as Lester Brown, President of the Worldwatch Institute, argue that we can see signs that the world community is crossing the threshold to an alternative, environmentally sustainable economy. They foresee the beginning of a new era in which the sun and other renewable energies sustain human life.

If we hope to make this transition from a fossil-fuel based economy to one using renewables, Global Possibilities and The Earth Group believe that the education of architects, landscapers, urban planners, and product designers is a key factor. Sound scientific and economic analysis shows that current building practices alone use two-thirds of the energy consumed in the United States, thus causing 25% of the carbon dioxide that produces global climate change. Consequently, we believe we can have the greatest impact in mitigating climate variability in the shortest time, if we start with those people responsible for designing the built environment. Our objective is to develop design educational strategies for a sustainable solar future.

On October 22, 1998, Global Possibilities' Second Annual Symposium for a Solar Future brought together design educators from colleges and universities throughout the United States. The purpose of the symposium was to launch an educational initiative to evaluate the current teaching of design, identify problem areas, and develop strategies for strengthening the teaching of sustainable design. This initiative includes the creation of an on-line, just-in-time, collaborative curriculum utilizing the internet.

Our long-term objectives are to give the designers of the future an understanding of the social, economic, and ecological impacts of their profession and to provide a networked context in which alternative design practices for a sustainable society can be created and disseminated.

Global Possibilities' first Symposium for a Solar Future in 1997, on the eve of the Kyoto Climate Change Conference, was optimistic about emissions reductions. However, the reality of the results of that conference are that we are dealing with less than adequate reductions in greenhouse gases, which will take years to ratify. Policy makers and economists are not paying enough attention to the impacts of how much energy we use or waste, nor are they considering visible solutions. For this reason, we are appealing to educators to educate the designers of the future to the need for resource efficiency in the built environment and the use of renewables, especially the limitless energy of the sun. Our hope is to help create a world which sustains life for us, and our children, and our children's children.

Thank you for taking the time to read this document which opens, as did the conference, with the startling assessment by Dr. Donald W. Aitken, Senior Scientist for the Union of Concerned Scientists, of the relation between climate change and architecture.

Sincerely,

Casey Coates Danson
President, Global Possibilities

Jean A. Gardner
Director, The Earth Group

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GLOBAL POSSIBILITIES' SECOND ANNUAL SYMPOSIUM FOR A SOLAR FUTURE – "Rethinking Design Curriculum: Integrationg Solar Energy for a Sustainable Future" — New York City, October 22, 1998

Keynote Speech (abridged)
Donald W. Aitken, Ph.D.
Senior Staff Scientist, The Union of Concerned Scientists

[Editor's note: this talk was supported by colored slides. The primary theses have been extracted in the following, rather than just a description of the pictures, and the topics have been somewhat abridged.]

Introduction

Buildings are incredibly important beyond the fact that they house us and shelter us and provide spaces within which we work or are entertained or are cared for. But while we appreciate these basic functions at some level, buildings are still terribly underrated. People just ignore buildings beyond seeing them as enclosures.

I was the opening speaker at the National Bioenergy Conference in Madison, Wisconsin, and we held it at the new Convention Center designed by Frank Lloyd Wright. And so, after I introduced them to bioenergy and economics and explained to them why they were there, I introduced them to the building. I had borrowed some historical drawings, and I'd taken a lot of pictures of the Center myself. So I spent about ten minutes and showed drawings and pretty pictures and told them where to go at day and night to appreciate the beauty of the building that housed their conference. And for the rest of the four-day conference, many people came up and thanked me and said, "We've never thought about the buildings we're having conferences in. They've just been rooms."

It is a major task for us to try to awaken an awareness of the importance of our built environment, to us and to what we are doing, whether it's the classrooms we're teaching in or the offices we're working in or the conference rooms we're speaking or listening in and so on.

My function in this talk in this conference is to address just some of these areas–the importance of buildings to our energy policy and our economy and to reveal the enormous potential for buildings to help us obtain a cleaner environment. I shall further focus my remarks on the integration of buildings with renewable environmental energy resources.

Climate Change, Energy and Buildings

We want to you to start convincing your students that climate change is real, incredibly dangerous, and the greatest global environmental threat that we are facing today. It's also the greatest global economic threat that we have ever faced. And then I want you to be able to explain that buildings are the most direct place to start mitigating climate change. I want you to be able to show them that **we can have our greatest impact for the least cost in the shortest time in mitigating climate change if we start with our built environment,** both the existing built environment and those buildings that we're designing and which have not yet

been built. So the rest of this talk is aimed at giving you sufficient information to support this new classroom responsibility.

A good way to put much of this in perspective is to share with you an insight that developed from my mention of my new electric car (a GM EV1) to Carolyn Ward, one of the organizers of this conference. I told her that the advertisements one sees for the EV1 state that "You can't hear it coming." And Carolyn said, "You know, that's a good metaphor for environmental problems and for the renewable energy transition. You can't hear them coming." Indeed, we realize, as we look ahead and compare the needs that society's going to have for energy with the potential exhaustion of conventional energy resources, such as oil, that sometime down the line we may face total economic collapse from a world short of energy supplies. And we can't hear it coming. Nobody's paying much attention to it. And yet it's incredibly dangerous.

It isn't a question of what we are going to do when we transition out of the fossil fuel age, but rather to adopt the perspective that the fossil fuel age <u>is</u> the transition. Most people don't realize this. The whole industrial development of the world, all the way to the middle 1800's, was done on available and renewable energy resources (primarily wood). And we can already see, not too far away, that we're going to begin to come out the other side, first without oil and gas, and then either without coal, or having stopped our use of coal much earlier for environmental reasons.

We are gifted today, however, to have an abundance of incredibly convenient energy resources, like oil and gas, which we can use to power us to and through the transition between what we might call a pre-industrial age and a post-industrial age. And if we use these valuable energy resources the way they should be used, we can accomplish this transition without physical and economic disruption. But if we just burn the stuff up in our vehicles and our buildings and our industry and then ask "What are we going to do now?", we've had it! And it is this danger that you can't really hear coming, so we do not confront it with meaningful or sensible energy policies.

Everything that we do with energy pours stuff into the environment. When we create energy, it pours stuff into the environment. When we use energy, it pours stuff into the environment. In some cases it sticks around locally, and can be seen as smog or measured as ozone. We've done a pretty good job of getting rid of the worst of that. But what we can't see continues to go into the environment, and we now do things on a human scale that's so great that our emissions into the air are altering the composition of the global atmosphere.

We're increasing the carbon dioxide content in the atmosphere. We're increasing the abundance of nitrous oxide in the atmosphere. We're increasing the abundance of methane in the atmosphere. And we're increasing the abundance of stuff that never existed in the atmosphere before, chemicals that are alien to the way that the Earth is used to working, such as CFC's. But these are still just in parts per million in an atmosphere primarily made up of nitrogen, oxygen and argon. So what's the worry?

The Earth is at a very delicate thermal balance. The amount of energy coming in from the sun equals on average the amount of energy that goes out to space by radiation. All of the energy-using and distribution mechanisms of the Earth operate within that balance–or at least until human actions began to change it. Anything that we do to disrupt the energy flow must disrupt the earth's thermal balance–that’s a straight statement of physics, not needing "research" to "prove" it.

We **are** changing the energy flow through the earth's atmosphere. We're introducing more aerosols, dust and soot, which affects the flow of solar energy coming to the

earth's surface, and we are introducing the greenhouse gases, which have a molecular interaction that reduces the ability of the earth's radiated infrared energy to flow back out from the surface. And it turns out that the impact on the earth's ability to reradiate is larger than the reduction in flow of incoming solar energy. Therefore, we are unbalancing the two sides of the earth's energy-balance equation.

Since we are changing the flow of energy through the atmosphere in an unbalanced way, it is also a straight physics statement that the Earth **must** respond. Nobody can argue that point and nobody does. So it places the whole climate change issue as a grand game of global atmospheric roulette. How will the Earth respond? Will we like it? Will it be fun? Will it be good for economies or bad? Unfortunately, everything that we look at suggests it will be devastatingly difficult for human societies and human economies and global ecological systems to accommodate to.

We have various tools to help us to try and guess how the Earth will respond to our differential reduction of the flow of energy back out to space. One way is to use ice core samples and fossil plant samples to look at the relationship of the temperature of the Earth to the carbon dioxide content in the atmosphere as far back as 160,000 years ago. And we find, over this entire period that there has been a very close correlation between carbon dioxide content in the atmosphere and the temperature of the earth's surface. Which drives which? No one really knows and it doesn't matter. But what we do know is that there is a synergistic response by the Earth's climate to the amount of carbon dioxide in the atmosphere.

We now have a carbon dioxide concentration in our atmosphere that's equal to or greater than anything we've seen for the last 160,000 years. So the first thing we might expect is that by retarding the flow of energy outward the Earth will get warmer. And, indeed, we see that there's been a monotonic increase of the temperature of the earth's surface over the last 100 years or so, and the rate of that increase appears to have picked up significantly in recent years. The hottest year on record was 1997. 1998 has been hotter than 1997. Every single month of 1998 has been hotter than every single month of 1997, so 1998 is now the hottest year on record. In fact, the hottest month on record for the last 130 years had been July of 1997, but July of 1998 was almost one half of a degree warmer.

So we are seeing evidence that's fully consistent with what we might expect, the evidence of the temperature rising abruptly and fast, faster than any time in the world's history in response to carbon dioxide rising faster than any time in the world's history. So those circumstances are scientifically consistent and also consistent with our history.

A doubling of the atmospheric content is inevitable, even with the most stringent controls and cooperation among nations. But we are heading toward the more probable goal of a **quadrupling** of the atmospheric content of carbon dioxide. That's more carbon dioxide that has been in the atmosphere for, as nearly as we can tell, at least 60 **million** years, and we could get there by the middle of the next century.

What impacts might we get from such an abrupt change to atmospheric structure and energy flow to the Earth? We're getting pretty good at global atmospheric models, even though they cannot show changes over small areas. A result of these models is that, for a doubling of

the carbon dioxide content of the atmosphere, the most likely temperature rise is around three to three-and-a-half degrees centigrade, or about five degrees Fahrenheit. But if we continue with "business as usual", we could quadruple the carbon dioxide in the atmosphere, leading to a much higher temperature rise. But again, so what?

The average daytime temperature in Washington D.C., in the summer, for example, is 85 degrees. If we quadruple the carbon dioxide, the average summer day temperature will be about 110 degrees in Washington D.C. When the air gets warmer and warmer, even though we're cleaning up the environment, we get increased chemical reactions in the lower atmosphere. And so we would have much more serious air pollution problems. The greatest killer of people in the United States right now is air pollution, and the models suggest that statistically the number of deaths from air pollution would increase greatly, in addition to deaths from heat problems.

Or consider something else. Water expands when it gets warm and, of course, we also think we already see evidence of a melting from a warming of the ice caps. And so there's a good expectation that the ocean surfaces will rise by about a meter during the next few decades. This will be enough to inundate most of the coastline of Florida as well as perhaps half of Bangladesh, and all of some of the South Sea Islands. That's what a one-meter rise of sea level can do. But a real melting of the polar ice caps would put this rise into the tens of feet. (The Netherlands is already preparing for a possible thirty-foot rise of the sea surface in its long-range plan for refurbishing and improving its dike system.)

What else? As the surface temperature becomes three degrees centigrade warmer, the snow level moves 1,500 feet vertically. For the Sierra Nevada mountains in California, that would reduce the winter snow pack accumulation by 70 percent, because what used to be snow becomes instead rain that runs off and increases the winter floods. So this three degree rise will probably reduce the ability to store water to the point where a $19 billion a year agricultural industry cannot be sustained, since the ground water is also being rapidly depleted.

Shall I go on? Ecology is balanced according to available sunlight, moisture, and temperature. So what might happen with a three-degree temperature rise? Consider the forests in the Pacific Northwest. They will have 50 to a hundred years to climb 1,500 feet up the mountain sides, in order to continue to grow in their accustomed ecological conditions. And if they can't do that, then they have to somehow travel north by 300 to 500 miles in order to remain in their accustomed ecological conditions. And if they can't do that, then they just die out to be replaced with a species variant that can make it in the new climate. That variant may not include the present commercial stands of timber, suggesting the potential death of yet another multi-billion dollar industry.

So a temperature rise of three degrees centigrade in 50 to 100 years will stress ecological systems and alter physical systems at an extraordinary rate, leading undoubtedly to enormous financial losses for industries dependent on ecological systems and on water.

We are differentially warming the northern half of the world. The models show, for example, that the United States might be expected to warm between five and ten degrees, on the average, in response to a doubling of carbon dioxide content. Now one thing that happens with a warming is a greater efficiency of evaporation. If you evaporate more efficiently, you dry out soils, and so the models suggest a reduction of 10 to 30 percent in soil moisture in the United States. So we'll want to grow even more food for an expanded population with a reduction in soil moisture, which means we've either got to irrigate more from ground water that is being depleted, or shift food growing up to Canada and export our dollars in order to import food and grain that we can now grow ourselves. And it gets worse, for if we go to four times the atmospheric content of carbon dioxide, which we will if we remain on the present path, the average temperature in the U.S. will

increase by 15 to 20 degrees, soil moisture content may be reduced by 30 to 60 percent, and we can forget about growing food in the U.S. almost altogether. We'll just have to get our food from somewhere else.

Actually, the total ability to grow food in the world may not change substantially, but rather migrate to northern lands. That could make most lands in the southern latitudes of the northern hemisphere, the equatorial latitudes, and in most of the southern latitudes, importers of food. But the countries that are expected to be the most affected, that is where we would expect to have the greatest impact on agricultural productivity, are South America, Africa, and Asia. In other words, almost all of the developing nations of the world are anticipated to have the worst time in trying to keep up with agriculture and growing food for their people, just at the time that they're trying to develop their economies and standards of living. We cannot even fathom the political pressures from these countries under such circumstances!

It has always been a bit of a mystery, at least to some people (such as critics of the concept of global warming), that with the injection of carbon dioxide so rapid, the temperature response does not follow that rapid change. The reason for that is basically, when you're just looking for temperature signals, you're looking at the wrong thing. Climate is the Earth's mechanism for distributing energy and trying to equalize the energy potential across its surface. As we increase the amount of energy remaining near the earth's surface by reducing the earth's ability to radiate it away, the Earth must try to redistribute a greater amount of surface energy, in part probably by an increase in violent atmospheric events. And so climate is the area where we really expect and anticipate and think we already see major changes.

For example, the incidence of rainstorms of two inches or more, which is a flooding rainstorm in the United States, has increased by 20 percent just this century. And the insurance industry of the world is now leading the campaign to reduce carbon dioxide injection into the atmosphere because the insurance industry of the world makes its living from risk, and they can no longer tie their future projections to past historical statistics. But the insurance companies make their business from a careful evaluation of risk. Well, so do the rest of us, although we don't usually know it.

The principal economic message I try to give to business groups and legislators is we are all making our business from risk and from managing risk and assessing future risk in determining today's policy.

I'm going to finish off this climatology thing with what, to me, has always been the most convincing example that you don't have to sit around and wait for proof that climate change is happening. It's been right under our very nose for 40 years. By grouping global rainfall in the northern hemisphere into latitude bands, we find a statistically significant migration of rainfall from the southern latitudes (5–35 degrees NL) to the northern latitudes (35–70 degrees NL), a migration that began around 1950, concurrent with the reindustrialization of the world following the end of W.W.II.

I don't know how much more research we need to have before people can be convinced that this is real stuff. It's really happening and the Earth is really responding. And 90% of the developing nations are in the region that is losing rainfall, and in which the models show a significant reduction in agricultural potential.

Responding to the Challenge

So how do we respond? And who should be the ones who respond? Well, not surprisingly, the world emissions in '95 are dominated by the developed nations, and the United States is the granddaddy of them all, contributing more greenhouse gases than any other nation of the world. So if we really want to try to help the world, or lead the world on reducing emissions into the atmosphere, the biggest opportunity and challenge is here in our own country. We've got to get our own house in order first. And in this way we can also reduce the danger to our own climate and economy from the developing nations who might otherwise follow a business as usual path, emulating us in our own global environmental mistakes.

So if we're going to get our own house in order where do we start? We start with energy. I started this talk by saying buildings are incredibly underrated. People pay no attention to buildings. I could just as well have said energy is incredibly underrated. Policy makers pay no attention to energy. They don't pay any attention to energy economics. They don't pay attention to the impacts of energy.

So let us begin by looking at U.S. energy supply and it's no particular surprise to anybody that petroleum, natural gas and coal dominate our energy supplies – the very resources that are causing the emissions into the atmosphere. But the moment we start talking about reducing it, people worry about shortages and crises. Many of us remember the gas lines in 1973-'74. We behave very badly in times of shortages. But we did respond by beginning to take efficiency seriously, and we did quite well. But we still use twice as much energy per capita in the United States. And if people feel that is just because we have a more affluent lifestyle, we should note the economically more serious circumstance that it takes twice as much energy to produce a dollar into the economy in the United States as it does in Japan, in Germany, or in other major global economic competitors.

Analysis of our energy economics reveals that we had enough energy from our own resources to power our own society and our economy until about 1970, and then we didn't have enough, so we simply started importing it. And from 1970 and 1980 we became a debtor nation, and by the time we got to 1980 we were spending around $80 billion to import energy resources. That $80 billion, if it was spent for energy resources indigenous in the U.S., multiplies itself and folds back through our own economy. This is an enormous loss of economic activity. It isn't just energy that drives the economy. It's also the way we spend our money for that energy, and whether those expenditures help our country or help other countries.

For example, we figure we spend one-quarter of the national defense fund protecting our access to the Middle East – one-quarter of $250 billion a year, something like $60 billion a year, to protect our access to oil. What does that do to the cost of oil? We import something over 2 billion barrels of oil per year. If we spend $60 billion to protect that right, we're adding two dollars from the U.S. taxpayers for every dollar they pay for oil at a world average price of $15 per barrel. Alternatively, oil to the U.S. economy is three times more expensive than it is to other economies. And if we add those costs together that are real and that we actually pay, we find that a comparison with domestically available alternative energy resources looks a lot more economically favorable!

But instead we go and look for more oil in environmentally sensitive areas and we practice what David Brower likes to call the politics of exhaustion. We'll use it until it's finished. But an alternative is to go to every house that is heated by oil and that's got single glazing and is not weatherized, and replace the windows with double-glazed windows and weatherize it. How much

oil could we save in the United States? It's about equivalent to the Alaskan pipeline, which means we have another Alaskan pipeline of oil resource presently being wasted out of our houses. If we weatherize our buildings, and reduce those losses, then the oil that was being leaked out can go back into society. It can drive vehicles. It can power industry and commerce, and all of a sudden we've got economic value from it again. That's a hugely important external economic value to weatherizing homes. It puts money back into society. It creates jobs. It supports industry and transportation.

But can we actually power a growing economy with energy efficiency? We have our own history to demonstrate that. Starting with our oil shortage scare in 1973/74 we began to introduce energy efficiencies into our economy. Prior to that time if the economy grew by three percent, our energy use also grew by three percent. But after 1973/74 we went through an important 13 year to 15 year period in which the economy grew about 35%, and our energy use did not grow! We used the cost-savings from efficiency to plow back into other sectors of the economy to promote continued economic expansion. So we proved by our own experience that efficiency can power an expanding economy.

A side benefit of that is that, if we had not gone through that energy efficiency period, our energy costs today would be about $150 billion per year more than they are now—$150 billion per year for what we found to be energy waste, with no economic value! Aren't we lucky to have that $150 billion per year available for greater economic productivity today? And that was accomplished by introducing barely more than 2% per year in improvement in the efficiency of our use of energy.

We also managed to reduce our electricity use by about $50 billion a year during that same period. Buildings use two-thirds of all of the electricity in the United States. So this is already proof of some of the benefits of our energy efficiency in buildings folding right back into society. And what we have learned from experience, to do this economically, we want to look for the least expensive ways to start. And obviously we start with energy efficiency. And if it's less costly to give the same services with energy efficiency than it is with supply, we're foolish to spend the money for supply. In fact, if we squeezed the amount of energy out of each dollar that Japan and Germany do, for example, we could save another $220 billion per year, in addition to the $150 billion per year we are already saving, and still have all of the energy services that are near and dear to our hearts—and our economy.

Part of the problem with energy efficiency and with renewables, of course, is the higher first cost. But if you go out and pay more for a compact fluorescent lamp, it will outlive a whole bunch of incandescent lamps, and in the process it's probably a far better investment than anything you have got—better than any CD's, any stocks, any bonds, so investing in energy-efficient appliances is the best place you can put your money as a starting point (unless you do indeed have investments that return more than 25% to 50% per year). And in creating the same amount of light for every incandescent bulb that you replace with a compact fluorescent, 400 pounds of coal and, therefore, the emissions from 400 pounds of coal, is avoided. So, in this view, we have many opportunities to *save* our way into mitigation of climate change problems.

The Promise of Renewable Energy in Buildings

Efficiency and renewable energy go hand in hand, especially when we look at the opportunities in buildings. We can often use passive solar heating or natural ventilation cooling for our homes

and buildings. We can use daylighting. We can capture the heat of the sun falling on the surfaces of our buildings to pre-heat ventilation air. We can meet our water heating needs with solar energy. And we are beginning to be able to draw off solar-produced electricity from building components. We can also couple our mechanical heating and cooling systems to take advantage of the thermal properties of the earth.

This is what we call bioclimatic architecture. It simply means to stand on the site and look for all of the environmental resources that might naturally provide for light, comfort and efficiency, and then to design our building to capitalize on those opportunities.

Efficiency makes renewable energy affordable. There is a relationship between them. It takes less renewable energy, and hence lower costs, to supply an efficient end-use. So often the savings from efficiency can be used to offset the extra costs from renewables, and the extra costs are also less. Now that's a simple way of saying in our economic model that that's what happens on a large scale. As society undertakes efficiency seriously, we find a rapid acceleration of the application of renewables that is dragged along by diminishing these cost differences and moving the crossover point to cost-effectiveness earlier in time. The Union of Concerned Scientists' national headquarters building in Cambridge, Massachusetts, saves so much energy from its efficient thermal and daylighting design that we were able to switch over to more expensive "green" power for our electricity supply, and still spend less than if we had not undertaken any of these measures. And a simple and low-cost 2 kW photovoltaic system on the roof provides enough electricity to provide for the residual lighting needs on 10,000 square feet of office space, because of the very efficient daylighting design.

Photovoltaics, or solar-electric cells, also enable us to bring the electricity close to home and to begin to look at the opportunities for electricity production that are close, to or even directly coupled into, the end-use systems. And so we find that we begin to get an economic synergy between creating electricity with solar and providing it on the very places that we use it. And remember that buildings use two-thirds of all the electricity in the United States. (It was 66 percent last year.) All right. So you start putting them everywhere, and a few of these are from Steve Strong. They're stealing a little bit of his thunder from Saturday. We've got roofs everywhere, with opportunities for PV arrays almost everywhere. And the best place to use it, at the beginning, at least, is on schools, because it affects the kids, it affects the teachers, it affects the parents. It also returns value where public money is being used. It's really an extraordinarily advantageous starting point.

And perhaps the next step is for the utility to come out and knock on your door in a low income neighborhood and say, "We'd like to borrow some of your roof, please. Our power lines and transformers are getting overloaded, and we need to have some more power out there. But instead of rebuilding the power lines and the transformers we'd like to put our money into providing electricity where it is needed by subsidizing the cost of putting PV on your roof, and the roofs of all of the houses in this load area." When you start doing the utility economics, looking at the real benefits to the utilities in deferred infrastructure construction and maintenance, you find that the utilities really ought to be pouring a good bit of money into this stuff to help us defray the first costs of using solar.

Well, to make it easier for us, the solar industry is developing building materials that look just like your old ones, but which can also make electricity. For example, solar shingles. Or a solar electric metal roof. Or solar electric skylights, or solar-electric glass curtain walls, and soon even

solar-electric view glass. If we need shading, and are going to construct shading overhangs, they can actually be solar-electric arrays. So what we pay for is just the differential cost between putting up skylights or curtain walls or shading overhangs anyway, and making them out of solar-electric materials.

Sustainability Revisited

Well, let's now finish this off by revisiting the concept of sustainability. The Earth fortunately has a marvelous resiliency, and natural systems have a marvelous resiliency. The hope is therefore that if we reduce our impact on the Earth's systems there will be a rebound of soil fertility, a rebound of our forests, a rebound of clean water and clean air. But it's actually a rather stupid situation where we have to just hope that we're doing everything in time and we have to hope that we can recover to support up to ten billion people on Earth with good standards of living, good food, good health, good equity, good opportunities.

We are getting both hung up and misled by various definitions of "sustainability". The World Bank, for example addressed the implications of sustainability to the energy sector: "To say that a development is sustainable means, at least, that its patterns of production and consumption can be reproduced indefinitely without doing irreparable damage to essential natural ecosystems." That means we can keep doing what we're doing as long as it doesn't do "irreparable" damage to "essential" systems. But how to define these boundaries? Are lizards and frogs "essential"? Is a little dirty atmosphere with a few people dying of air pollution still within acceptable bounds since it is not "irreparable"? This sort of definition basically says you can continue to do business as usual, just do it less. But we can't continue to do business as usual. We've got to change the very foundation on which we build our economy, for ultimately the sustainability of the earth's systems is a prerequisite for the sustainability of societies and economies.

We have to take a first step, and it may appear to be a large one. The Sacramento Municipal Utility District (SMUD), for example, pledged to become the nation's leading solar energy utility within just three years. But first they had to bite the economic bullet. They turned off an expensive 800 megawatt nuclear power plant, which kept requiring money thrown after money just to keep it going. But they had five electricity rate increases the first four years afterwards to compensate for the fact they had to buy power. They came through that, though, and after introducing efficiency measures and an aggressive renewable energy policy, electricity is now less expensive for Sacramento's citizens than it was before they turned off the nuclear power plant, and SMUD is indeed the nation's leading solar utility. The first step must be taken, and it often requires courage.

The costs for renewable energy resources are coming down dramatically, and they're going to keep coming down more as we build the market. But the problem is it's a moving target, and as we bring the costs down, utilities and energy companies keep lowering their costs.

In order to make the shift, we have to equate our energy use and economics to value gain which often cannot be described in hard dollars and cents. The value difference of what we get for society from renewable energy compared to the conventional energy resources is very significant. We're just using the wrong language. Sustainability is not a matter of just telling people we've got

to equate demands for energy with resource availability, whatever its source. It's a new language of value for life and value for living in harmony with an Earth that supports us and that we are beginning to learn how to support back. So when we place our solar systems on our schools, for example, we're showing our children that it's important to us, their parents, and we want them to see elements of what it's going to be like after the renewable energy transition which they themselves will have to lead us through.

We begin to see a new relationship, revealed in the way Casey Coates Danson introduced this whole event, between the kids and future generations and the Earth and the sun, all wrapped up in a system perspective, not of technical things, but of ethics. The sun does more than just give us life support. It gives us love support.

Now, the final view I shall show in this talk is of a pregnant woman with the earth showing through the transparency of her protruding abdomen. This suggests that we must now consider just who is nurturing whom? The Earth nurtures us, but the Earth needs us now to turn our nurturing attention back on it. In essence, the Earth is now asking us to help support a rebirth of its own life and love supporting capacities, by giving birth to children who will know how to nurture and love the Earth, and who will embrace that as their own great life ethic.

Thank you very much. [APPLAUSE]

THE EARTHSCORE METHOD AND SUSTAINABLE DESIGN

Earthscore is a systemic approach to education developed by artist, teacher, and writer Paul Ryan, Professor of Communications, The New School University, New York City. Its objective is to help humankind to live in accord with the ways of the Earth. As a formal notational system, Earthscore has five components:

1. ***learning***, using the three comprehensive categories: the identification of qualities, facts, and patterns;
2. ***relating*****,** using a relational circuit that organizes these categories;
3. ***collaborating*****,** using the cooperative learning protocols based on the relational circuit;
4. ***envisioning*** a sustainable future, using creativity techniques such as working by analogy;
5. ***evaluating*** the present in relation to the vision of a sustainable future in order to identify actions to work toward that future.

For more details on the Earthscore Method, see
http://www.spiderweb.org/johnnie/paul.html

The symposium used the cooperative learning protocols to organize the conference work sessions. Component five underlies the 10 questions each participant answered prior to the conference. The intellectual architecture for the website supporting the development of sustainable design is using all five components of Earthscore to develop an interactive on-line curriculum.

The following section contains a brief summary of responses by conference participants to ten questions about the current state of sustainable design.

SUMMARY OF THE TEN QUESTIONS

Question 1 – IMAGINE POSSIBILITIES....

Forgetting all current limitations, describe the sustainable design/solar education program that you would most like to see in place?

The most desirable sustainable design/solar education program would either revamp and improve the existing curriculum or replace the existing curriculum with one founded on life as the only defensible foundation for teaching sustainable design.

Question 2 – USE WHAT WE HAVE....

Within the existing curriculum of your school, describe current courses that could be used as part of a sustainable/solar design curriculum?

This question was not discussed as it deals with specific courses already being taught at the schools of participants. See Symposium World Wide Web site for pre-symposium responses: **www.spiderweb.org/globalpossibilities/solarfuture/**

Question 3 – INVENT NEW DESIGNS OUT OF PLAYING....

What kinds of studios/classes can you imagine that would allow students and faculty to experiment with sustainable design principles? ..... classes that might allow students to invent new kinds of design?

There are four major areas that would allow students and faculty to experiment; off grid, real-world projects, collaborative learning projects, performance-based design, creation of built examples of sustainable design.

Question 4 – PREDICT RESULTS....

What kind of classes/studios would enable design students to understand sustainable design as an engineer might .... classes that would help students to formulate very specific design intentions and then develop their designs so the designs will be exactly as their students determined before beginning to design.

Studios to help students balance discovery with prediction might teach them environmental impact criteria and performance evaluating computer programs to evaluate their designs.

Question 5 – CONTEXTUALIZE SUSTAINABLE DESIGN....

What story would you create, or have you created or heard, that describes the importance of design in a sustainable society? ..... a story that replaces the description of design in industrial society?

We found that there are not yet commonly shared meta-stories. We might begin to envision a meta-industrial society, not as an alternative to or as a contradiction of, but as the logical, necessary, and desirable transformation of industrial civilization. This more sustainable, humane society would actually realize the purposes, dreams, and ideals that have moved generations by means of the Industrial Revolution. We should build this new story around the idea of interdependency and make that a motivating framework.

Question 6 – INTEGRATE SUSTAINABLE DESIGNS INTO EARTH SYSTEMS....

In the long term use of sustainable/solar design, what should we be looking for regarding issues of production of parts, maintenance, disposal, etc., so sustainable buildings and designs can best be integrated with earth systems?

There's a technological overtone to all of the participants' responses. Technology is the field today attempting to answer ecological problems and technology can complement natural systems, but today we are in an age where technology seems to be the leader and the natural systems seem to take second place. Yet, to integrate sustainable design with earth systems, the systemic, ecological frame of mind, which is how we perceive the life force of the planet, ought to be channeling creative thought in the studio and in the classroom.

Question 7 – ENGAGE SOCIAL, ECONOMIC AND POLITICAL PROBLEMS....

What social, economic, and political problems/conditions do you see sustainable design affecting?

There was very little real understanding or discussion of these three issues and how they conflict. For instance, ninety percent of the houses in this country are not designed by architects. We need to understand the forces of development. If we were to actually run two studios, one studio looking at building development under policies that exist in this country, another studio doing the same problem with the policies from Europe, then students might understand the extent to which policy structures design.

Question 8 – CREATE NEW FORMS THROUGH SUSTAINABLE DESIGN, USE OF SOLAR....

How does sustainable/solar design affect our sense perceptions? What are the aesthetic possibilities that you see in sustainable/solar design? Examples....

We actually went back and forth arguing over whether it's important to be representational and have visible forms that indicate sustainability versus whether a good environmentally responsive building was like a good structural system: it underlies what's going on in a building in a very normal way.

Question 9 – CRITICIZE CURRENT SUSTAINABLE DESIGN....

Looking carefully at the facts of the current teaching and use of sustainable/solar design, what do you think is going wrong, what is going right? Examples....

On the negative side, the U.S. Government has no centralized approach to sustainable design, in contrast to Europe. There is today, however, a main-stream concern for environmental issues even if not for sustainable practices. Another concern is that sustainable design has been very solution-driven as opposed to problem-analysis-driven. Also, we haven't done a very good job of understanding the architect's role, nor have we been rethinking the design problem itself. The nature of education is an issue, but we couldn't agree what the problem was. On the positive side, environmentally sensitive architecture has evolved from “Lean, to Clean, to Green”.

Question 10 – REASON ABOUT SUSTAINABLE DESIGN....

Based on your experience teaching sustainable/solar design, what do you think reasonably is possible in the future vis-à-vis teaching design sustainability and building a sustainable designed environment? What "if...then" patterns present themselves to you? What makes sense to you for the future of sustainable design education?

IF we build a knowledge base of examples of sustainable design, THEN possibly we, with the help of our students, alumni, and other professionals connected to our schools, can begin to shift the current architectural paradigm to one based in ethical design, of which sustainable design is a subset, and thus begin to create a common collective understanding of good design as having social value.

QUESTION No. I - IMAGINE POSSIBILITIES .....

Forgetting all current limitations, describe the sustainable design/solar education program that you would most like to see in place?

Brief Summary

The most desirable sustainable design/solar curriculum education program would either revamp and improve or replace the existing curriculum with one founded on Life as the only defensible foundation for teaching sustainable design.

Report On Responses

Group Responding - Robert Pena, Associate Professor, University of Oregon; Robin Freeman, Co-Director Environmental Studies Program, Merritt College; Walter Grondzik, Professor, Florida A & M University; Kent Hubbell, Chair, Cornell

- Reported by Robert Pena

Responses were categorized into two large groups:

1. Revamping the existing curriculum by

- creating new courses as a requirement in sustainability, i.e. studios and design theory courses;
- providing more opportunities for interdisciplinary and project-based learning;
- more hands-on interaction in projects;
- providing better access to technology and tools.

2. Replacing/Remaking existing curriculum to:

- base the curriculum on Life as the only defensible foundation for a curriculum;
- integrate the importance of environmental health and the understanding that our own health is tied to the health of the environment, which would require:

    a. a broader base understanding of the sciences (life science, biological science, physical science);
    b. a curriculum aimed at developing the whole person, within this "whole person" curriculum, first person hands-on learning;
    c. service-based, hands-on projects in compelling real places such as the campus or community.

There were a number of problems with the idea of revamping the existing curriculum. Our curriculums are already overflowing. Anything inserted comes at a cost of probably taking something out. Creating a holistic curriculum of sustainability that infuses every part of the curriculum could be seen as a threat to many of our

colleagues not only because it may be perceived as something that they don't have the knowledge base to address, but also the somewhat cynical idea that this is another fad that's passing through and will go away. In response to that, we need hooks, ways of selling, seducing, finding various avenues that will win over those detractors. One way may be a charismatic leader, i.e., Bill McDonough and Antoine Predot, who tell a good story. There have also been successful hands-on approaches such as Chris Benton's Vital Signs Initiative at UC Berkeley.

Commentary On Question No. 1

- Teach ecological design rather than environmental architecture as a whole field of its own. Skip Wenz, San Francisco Institute of Architecture

- How do you sell it? to your administration, your department? Where is the point of least and most resistance in your universities. Susan Szenasy, Metropolis

- Architecture is primarily about focus. The building is always a subsystem of a larger system. If you start with the biospheric perspective and then work your way down in scale from that to different levels, then ecological design would be the study of the biospheric scale of things and the various systems within it. Skip Wenz, San Francisco Institute of Architecture

- The advantage of a separate program for sustainable design is it allows practitioners to test out new curriculum, but I don't see that a separate program is a "sustainable" solution. It eventually needs to be in mainstream architecture. Robin Freeman, Merritt College

- The place of environmental design at the university is everywhere and it should not be seen as separate from architecture. Sustainable design should balance architecture. In fact, architects that don't practice environmental design are just bad architects. I'd like to see environmental courses as required introductory courses in physics and biology departments, and have it as a cross sectional orientation throughout the university. Colin Cathcart, Fordham University

- There is a real problem with specialization that isolates sustainable design but also some real benefits. I would like to see research institutes, faculty think tanks alongside of architectural schools. These parallel entities are where specific problems of ecological design can be advanced, allowing school curricula to teach a more generalized understanding of ecological principles. Ellen Dunham- Jones, MIT

- Challenge the fundamental values of what the school is about, create debate with issues sustained by people with a healthy bit of information. There should be a real challenge that is witnessed and engaged in by all the students because students will determine the values, not the teachers. Charles Burnette, University of the Arts

- We all admire schools where there is a John Reynolds or a Jeff Cook who are wonderful teachers with a nuclei of perception and awareness. They attract students and their popularity really gives itcredibility. If you don't have institutional support, then go ahead and be the best professor you can

  anyway and start drawing students. Strong student response can build the program. Harrison Fraker, Dean at Cal School of Architecture, is reorganizing his curriculum around the concept of sustainability. And, of course, Bill McDonough feels the same way. We need deans, who have the authority to make these changes. It is happening. We need to reach more of them! Donald W. Aitken, Union of Concerned Scientists

Additional Pre-Symposium Responses

- The possibility of teaching a holistic approach to the design of the built environment revolves around two equally important elements that are critical to the development of a student's professional judgment and design ethics.

- First, the curricular program should embody the traditional content areas of history/theory, the design sciences and representational methods (possibly without the traditional "walls" that classes in each seem to build). The curriculum might be formatted, from beginning to end, in a way that would require the students to constantly position themselves as stewards of the architectural environment and the local, regional and global environmental as a whole. As they progress through the program their synthetic knowledge capabilities would be enhanced by the program's progression from basic information to analytical tools and evaluation methods.

- Second, the success of the former is dependent on the expertise, sensitivity and mutual respect of faculty to be able to see, without prejudice, the value of environmentally sound reasoning. This model would benefit from the interdisciplinary inclusion of non-traditional content areas such as the physical sciences, landscape architecture, geography, and engineering technology. Each would form foundations of the curriculum from which the act of human inhabitation, in terms of its historic, social, economic, technical innovations would be elaborated, tested and new approaches sought. An example might be similar in content and style to when Bucky Fuller was at Black Mountain College in the 50's. Dale A. Brentrup, University of North Carolina at Charlotte

- The sustainable design/solar education program would emphasize:
    - Indigenous building and formal traditions (the architecture of place);
    - Renewable materials (the biology of place);
    - Psychrometric design (the thermal limits of the individual in the place);
    - Daylighting (the visual limits of place);
    - Computer "building-design-assistants" to sort out bio-climatic options;
    - Field measurements (Vital Signs) to ground the knowledge, would apply to studio problems of buildings ranging from a meditation center to office tower and in both the urban and the ex-urban context.
      Davidson Norris, Parsons School of Design

- If what one is after is truly a cultural shift in thinking about sustainability, the task is not to teach it as a discrete discipline in the design studio but rather to broaden its context, to understand solar design not simply as energy efficient in the utilitarian sense, but as efficient within an inextricably linked system of chemistry and physics of which we, as human beings, are the vital part.

- First, studies in fundamental ecology, as it pertains to natural biotic systems, should be the sine qua non of any sustainable/solar design program. What is so compelling about natural ecology is less its arguments for "environmentalism" than its description of the world as a systemic matrix that operates from top to bottom regardless of social constructions. Understanding this "relatedness" makes it relatively easy for the student to step back and see the relationship of buildings to landscapes, mechanical and structural systems, space-use conditions, etc., in a similar systemic manner which is neither mimetic nor metaphoric, but rather synthetic.

- Secondly, selected studies in philosophy and cultural theory provide a useful background for situating sustainability within the larger context of human history. This seems particularly important in a time of "post-modernist" (or post-structuralist) thought which views much of the world as primarily a social construction. The primordial (pre-human) chemistry - which we call Nature - seems to resist quite well attempts to reduce it to a problem of social language. However, its representation in language is an ongoing problem and could use more thoughtful scrutiny than that which much of present day discourse has inherited from earlier times.

- Ideally, these two areas of study would be part of required first year courses providing the foundation from which to then pursue the design, development, and implementation of specific design strategies. Peter Wheelwright, Parsons School of Design

- The ideal sustainable design/solar education program would impose a layer of responsibility upon existing curricula. Students would be required to understand and accept the effects of their designs upon the world's energy and material resources and upon the occupants who occupy their spaces. I do not believe that the necessary tools for the addition of such a layer now exist, but they are well within the reach of a concerned profession. Perhaps every design would be described in some level of detail to an interactive world wide web site that responds with projections or ratings of the project's impacts on the environment and its occupants. How one chooses to design is a personal matter. What one's designs do to others is open to public concern. Walter Grondzik, Florida A & M University

QUESTION No. 2 - USE WHAT WE HAVE .....

Within the existing curriculum of your school, describe current courses that could be usedas part of a sustainable/solar design curriculum?

Brief Summary

This question was not discussed during the October 22nd conference as it deals with specific courses already being taught at the schools of participants. Below are those pre-symposium responses that are of general interest. See Symposium World Wide Web site for more pre-symposium responses.

PRE-SYMPOSIUM RESPONSES

- What we have and what we contend with is too little, too late, mostly without rigor, and most definitely without accountability. Ironically, I just answered a question for a thesis student whose advisor sent him to me - to inform the student on how to represent "sun angles so that anyone can understand them." When the student replied that his thesis was focusing on a marine research facility he met my further query about "solar angles for what design purpose?" (meaning - are you planning for active solar collection - heating, cooling, electric generation, possibly shading to optimize daylighting? What is the balance point of the labs, etc.?) I was met with silence. My thought is that his thesis advisor doesn't know nor care either.

  The question changes then, to "Whom do we educate first?" Dale Brentrup, University of North Carolina at Charlotte

- Many, if not most, curricula probably do not now provide adequate grounding in building performance issues to permit students to comfortably address the environmental impacts of their designs. I believe that the design studios are the key to success. Students develop their design language and ethics within the studio and, if a curriculum is to become environmentally friendly, this transformation must occur in the studio. The studios are already in place. The focus or concern for sustainability is generally not. Walter Grondzik, Florida A&M

- Of growing impact are research projects which exist outside the curriculum and have separate funding as grants. These projects involve students as volunteers and/or paid research assistants. Several of the participating students, both undergraduates and graduate students, have expressed an interest in making environmentally supportive architecture their area of focus, both academically as well as professionally. Stephen Meder, University of Hawaii

- Mechanical design, if taught as a part of green curriculum, would be most critical --Roman heating system for the Thermae of Caracalla. Push "green" out into structural design - biomorphic systems

for the resolution of gravity: Calitrava, Gaudi, French and English Gothic. Study the masters: Wright, Corb, Kahn, Aalto, Ando. Study the artists: Serra, Goldsworthy, Turrell, Carpenter, Smithson, Heizer, Christo. Davidson Norris, Parsons School of Design

- The diverse science and humanities curriculum of most universities are often underutilized by design schools. The present reluctance in the Academy to loosen the classical distinction between the Arts and Sciences (further reinforced by professional specialization) makes it difficult to introduce courses, which are not viewed as professional, to the vocation of architecture. Peter Wheelwright, Parsons School of Design

- Develop ways in which studio problems could integrate solar problems, study solar access, sun angle studies, use of daylighting, passive solar. Students rarely "carry over" lessons from adjacent electives into their studios, since studios often have competing intellectual and formal agendas. Hillary Brown, Columbia
- All design studios should have this issue as a component of their syllabi within an industrial design curriculum. There should be a sustainability component in materials and manufacturing processes classes, professional practices, design theory, and history of design. Ed Dorsa, Virginia Tech

- Current courses in our curriculum include the Vital Signs electives which are offered as part of the CERES Student Scholars Program. This course engages field-based testing and evaluation of signature architecture. It has had a profound impact on each student's understanding of the variables of environmental manipulation and their connection to classic design tenets. In addition, our curriculum offers occasional seminar and/or workshop courses of an elective sort which focus on the use of computing technology in evaluation of the dynamic behavior of a building's thermal performance. The most current software appropriate to this teaching includes Climate Consultant and Energy 10. Finally, our curriculum allows for fourth year level design studios to be shaped around topical themes. Within this framework we have, for several years, offered Energy Studios which have ranged in design project assignment from neighborhood service centers to whole communities. These studios have also been platformed as CAD studio offerings, wherein the students do all their design and modeling of sustainable prototypes in a three dimensional electronic environment. Robert J. Koester, Director, CERES, Ball State University

- I would like to offer a word or caution for larger institutions which have complete engineering, architecture and planning departments. Please do not throw together a major in "ecological design" by taking little pieces of the existing curricula and throwing in a couple of ecology courses. A standard engineering department course in "waste management" has nothing whatsoever to do with waste reduction throughout the production-consumption system or the ecological disposal of waste. Even the idea of waste cleanup is, in a sense, anti-ecological. It presupposes that we will continue to generate massive amounts of waste of an ecologically dangerous nature, then spend a lot of money cleaning it up.

Similarly, most standard architecture courses, except basic subjects such as drafting, have little relevance to ecological design, in fact, most are antithetical to the concept. Ecological design is a new field and practically nothing which exists in the standard academic curricula adequately addresses its issues. Skip Wenz, San Francisco Institute of Architecture

QUESTION No. 3 - INVENT NEW DESIGNS OUT OF PLAYING .....

What kinds of studios/classes can you imagine that would allow students and faculty to experiment with sustainable design principles? ..... classes that might allow students to invent new kinds of design?

Brief Summary

There are four major areas that would allow students and faculty to experiment: off-grid, real-world projects; collaborative learning projects; performance-based design projects; creating built examples of sustainable design.

Report on Responses

Group Responding - Norbert Lechner, Professor, Auburn University; Jeff Cook, Regents' Professor, Arizona State University; Bashir Kazimee, Associate Professor, Washington State University; Charles Burnette, Professor, University of the Arts
- Reported by Norbert Lechner and Jeff Cook

Education Starts With What Is Interesting

1. Off-grid design projects, real world rather than pie in the sky projects. Frame problems so that students get more than just a form making project.

2. Collaborative learning - an interdisciplinary approach where people from all over the university come together, even a multi-national global studio and of course cross-cultural studios.

3. Performance-based design projects - form and space design that goes beyond form-based design. More than form should be considered for performance. Besides the aesthetics would be issues like the energy transformation that flows through the building, the natural systems, social systems, ecological systems and understanding their Darwinian evolution.

4. Creation of built examples of sustainable architecture to show students - we are lacking convincing paradigms for the kind of shift that represents the interests at this symposium. The best teaching device would be buildings that really perform in an educational way, for example the kind of pavilions that are here in the Cooper Hewitt "Under The Sun Exhibition". Historically, structures like wells, aqueducts and fountains were immediately descriptive of the precious value of water. They were part of a whole infrastructure so that everyone understood where the water came from. It was even sanctified and certainly understood as being vital to life. How can we come up with models that are descriptive of where our resources are coming from?

Commentary On Question No. 3

In an Architectural Tour

- How do you think we should show both good and bad examples of sustainable architecture so people learn from mistakes, made with all good intentions, rather than just seeing successful solutions? Adil Sharag-Eldin, University of Nevada at Las Vegas

- Some good examples are the molecular approach to the principles of sustainability. Energy is an indicator of sustainability that can be measured, but there are others such as land, water, air quality, and human ecology which should be studied and considered equally with measuring the energy of a total system. Using the City of Pullman, Washington, we applied the principles of sustainability based on these five indicators. We measured the air quality, water resources and how to improve air quality. A green belt can be provided to reduce the amount of pollution from car exhausts, etc. On a regional scale you could introduce bio-diversity. Then we come to the city on a smaller scale of the existing neighborhood's density and really involving the subdivision. We have a work site that you can access. (**www.arch.wsu.edu/~sustain**) Bashir Kazimee, Washington State University

Curriculum Should Stress Energy Flow

- If students can take into any design project, at any scale, the understanding that one of their goals is to optimize the flow of energy, if that notion could be planted in the school as a fundamental part of every design activity and that the affect of whatever you were doing, the ramifications of it on the surrounding energy system, should be considered so there was never an isolated energy system, then the students would begin educating themselves and not have to be instructed on what to do. Charles Burnette, University of the Arts

Assessing Performance Over Time in Examples of Sustainable Design

- Are we advocating that a sustainable building looks like a solar building? This could be made much too simplistic because even a walking tour that goes through good and bad buildings, should not be saying these are good and bad buildings just at that moment, but over time, performing throughout the day, through different seasons and different activities. Judgment should not be just a momentary assessment, which is what you tend to get with any kind of walking tour or photographic essay. So we can't reduce it down to this is a good building, this is not a good building. The issues go much deeper than that. Bill Bobenhausen, New York City College

- For 25 years I have used a sun machine where the students build models and they can see instantly how well the building performs, how well it harvests the winter sun, and how well it projects the sun. It gives immediate feedback in a way that stays with them forever. So I would recommend sun machines. Norbert Lechner, Auburn University

Framing Examples in Proper Scales

- It's important to put examples into a proper context. Sustainability really operates at the global, regional, site and building scale. As you frame an example, a building should be a solution to a series of problems. Define those problems. Point out that a building has a relationship to a larger set of problems at the community scale. This gives the opportunity for interdisciplinary collaboration between planners and landscape architects, and you can begin to see their scale, scope, values, and their concerns. The importance of using models is they clearly define the problems and the principles that those examples respond to. Larry Medlin, University of Arizona

Additional Pre-Symposium Responses

- Classes that might lead to new designs would help students to understand:
    - principles embodied in the natural laws affecting the science of building;
    - basic theories of lighting, acoustics, environmental control, building systems and energy management;
    - awareness of the principles, conventions, standards, applications, and restrictions associated with the manufacture and use of existing and re-emerging construction materials and assemblies and their effect on the renewability of the environment; and
    - problems related to the use of hazardous and toxic materials in new and existing buildings. Michael Garrison, University of Texas
- I think the "design workshop" is one of the best places to experiment and collaborate with principles - and it works better than the traditional format of the design studio where other agendas often prevent a focused approach to sustainability. It enables students to work with faculty on projects that can be rooted in real research or design projects and becomes a place for invention - sometimes in a collaborative and dynamic way that brings ideas and people together. Andrew Scott, M.I.T.

- Design a product using a waste-stream material as a resource. Redesign an existing product which uses an electrically powered motor to remain motorized but utilizing an alternative power source. Ed Dorsa, Virginia Tech.

- There is a need for extensive computer modeling with energy and solar simulation programs followed up with three dimensional simulation. Model- building to test ideas, new kits to provide small scale mechanical and electrical equipment, environmental chambers to allow weather testing and solar impacts, and instrumentation to read out and compute impacts. Charles Kibert, University of Florida
    - Living within an existing "sustainably designed" building in a familiar climate: what are the 24-hour demands upon the user? what insights about life-style impacts?
    - Living in a lower-tech, less-familiar "sustainable" culture: How does lifestyle change when contact with natural systems is most direct and least complicated?
    - Provide materials and construction/deconstruction support for experiments in simple shelters; maximum comfort with minimum energy and material use, maximum recyclability;

- Provide materials and construction/deconstruction support for selected renovations within promising conventional buildings to move them toward sustainability. John S. Reynolds, University of Oregon

QUESTION No. 4 - PREDICT RESULTS .....

What kind of classes/studios would enable design students to understand sustainable design as an engineer might .... classes that would help students to formulate very specific design intentions and then develop their designs so the designs will be exactly as the students determined before beginning to design?

Brief Summary

Studios, to help students balance discovery with prediction, might teach them environmental impact criteria and performance-evaluating computer programs that would help them evaluate their designs.

Report on Responses

Group Responding -- Colin Cathcart, Associate Professor, Fordham; Paul Lusk, Professor, University of New Mexico; Adil Sharag-Eldin, Associate Professor, University of Nevada; Vincenzo Polsinelli, Professor, New York Institute of Technology

- Reported by Colin Cathcart and Paul Lusk

- Design, as many people pointed out, is not an exact science. There is a lot of thinking that goes on outside the box to come up with a good design solution. We concentrated on that part of the question relating to the students. Teachers, have a responsibility to lay out in front of the students, course work that allows them to become skillful and make intelligent decisions. Respondents talked about providing a knowledge base prior to design through a foundation in the bio-sciences and physical sciences. They also discussed using tools that would analyze the existing built fabric as well as tools that could project into the future and analyze design work in an actual studio setting.

- The studios suggested in the responses seemed to break down into two different types, although it wasn't assumed that the studio was the only place this could happen:

    1. An "earlier" studio which would present problems and their solutions in a linear, broken down manner, where each problem would have a solution and those solutions would build to an illuminating synthesis towards the end of the studio.
    2. "Later" studios, more senior studios, that prescribed an interdisciplinary approach where the disciplines were actually represented rather than where architecture students were trying to play roles, i.e., you're the engineer and you've got to do what I tell you to do. Studios with teams of lawyers, lighting designers, engineers and architects working together on design problems seem to work well as senior studios.

3. These studios, in terms of how they could be evaluated or conducted, offered suggestions of quantitative evaluations that in our discussions were lacking a holistic emphasis and tended to distort one piece of the solution at the expense of others. The suggestion was that, perhaps, one criteria within an environmental design would be evaluated quantitatively, but the others could simply be responded to in a yes/yes-no manner. Colin Cathcart, Fordham University

- What the evaluation criteria could be comes from Malcolm Wells which I've used for a long time - a whole set of physical performance criteria that are set as guidelines for design in the studio:
    1. Looking at the building not as a box, but as a whole site that is affected by the building;
    2. Purifying water as a result of the building or building process;
    3. Enhancing the quality of the air as a result of the building - not hiring a lawyer to argue how bad it is and who pays. Paul Lusk, University of New Mexico

- Here are Malcolm Wells' words: "All site improvements should seek to create pure water, store rain water, produce its own food. These are just yes/no things you can evaluate a design with. A building should consume its own waste, maintain itself, match nature's pace, provide wildlife habitat, moderate climate and weather and be beautiful. That's a series of pass/fail evaluation criteria." Colin Cathcart, Fordham University

Commentary on Question No. 4

- Listening to this brings to mind environmental impact reports (EIRs, EISs). An EIR initial study check list is not poetic, but it can be quantified. Maybe that would be a contrary approach to the "building floating in space" concept. We could set the projected building into an environmental context in a matter of fact way. Robin Freeman, Merritt College

- Engineering is looking at the objective, and architecture is looking at the process. What's important is that the different disciplines should know where each fits into the big picture, which should be the ecological impact of a building. It Is not easy from the answers we got for an architectural student to learn the discipline of engineering. What is important is the process of finding the best solution. Adil Sharag-Eldin, University of Nevada at Las Vegas

- Being both an architect and engineer and attempting to use predictive tools in the classroom, the struggle has been while architecture students are capable of using a scale representing real dimensions, it is much more difficult when the scales are in the engineer's realm. However, the predictive tools, once the students get past some of their initial fears of working with numbers, offer a chance to look at terms that are both new for architects and engineers. The notion that it isn't learning how to do a particular mathematical calculation, but allowing the computer to do that - learning how a particular variable such as glazing area or whether it is out-gassing for a particular chemical in a building, it is learning how a particular variable changes an outcome. That aspect of looking at variables is actually new in both engineering and architecture, and it's really how

the computer, as a tool, takes mathematics and treats it as a very simple process, almost too simple. So, the struggle is really for students trying to understand what numbers mean and getting past that to how they actually represent a variable. I think we're in the midst of what the potentials are. I find that students who get past it are quite pleased to know how, as they vary designs, it affects performance as provided for them by a predictive tool. With architects, especially, there's a kind of a fear that mathematics and engineering are somehow realms that they didn't enter into in their area of professional practice." Mike Utzinger, University of Wisconsin

- Some fears seem to be associated with engineering as a process more prescriptive than anything else. Engineering seems a contradiction in the design process in terms of discovery and trying to find out what it is we're doing when we resolve a design problem. One respondent suggested that rather than an engineer, perhaps a CEO would be a better model to look towards. Vincenzo Polsinelli, New York Institute of Technology

- I spend a lot of time around engineers. I gave one of the responses that said design is not the same as predictive engineering. The best engineers are extremely innovative and they are not just doing lab experiments where they already know what the predictable result is. What I often ask my students to do is to put themselves in the role of the urban planner and articulate what they are trying to maximize or minimize. In my studios, the problem usually has to do with parking and driving issues so that students can be very specific about goals. It is not about predicting, but setting some criteria where it's not just the student trying to come up with a form of self expression that's going to be the end-all of design. Ellen Dunham-Jones, MIT

Establish a Balance Between Prediction and Discovery

- I don't think predictive tools are inherently good or bad, but one of the difficulties is that the Generation X student often just asks you to "give me a way to solve a problem and I'll do it" without stepping back and understanding fundamental principles. Students who will learn leap immediately into that and let their entire design follow rather than stepping back and asking a more general question or having the ability because they've had experience to ask, "Is the output of that program really meaningful or not?" Optimizing the energy performance of a building affects the very beginning conceptual level. That tends in young students to not allow them to ask the questions about what it means to design a home or a school, what's the quality of environment that you want to create for living or dwelling, and does that need to be a building or does it need to be some combination of indoor/outdoor space. I think it's important to establish a balance between those dimensions. Larry Medlin, University of Arizona

- I want to tie this together. The situation in architecture is not unlike in medicine. Doctors don't know how the body works really, but in some cases they do know precisely how to improve health. But mostly doctors try to avoid ill health in public medicine and public health. If students have a check list to begin with, it can be an environmental impact statement check list or the check list that a teacher made out, then students will try to minimize the ill effects and maximize the other effects. There are some things which can be measured precisely, certainly energy can be measured quite precisely. We don't know what the ultimate effect is. We don't even know what the accumulative effect of energy use is. So I think you can get both. You can get the very precise engineering and you can get this general condition that you're just trying to maximize the health as we understand it

now and minimize the damage that architecture can do and maybe even have architecture improve some things that we've damaged like water quality or air quality at the site. Robin Freeman, Merritt College

Performance Tools As Design Tools

- I want to come out strong in defense of performance estimation and performance tools. A performance tool is a design tool that will really help guide your design. One of the chief architects of the new Energy10 design tools, Bill Bobenhausen, is sitting here, and I'm one of the instructors in that program. One of the benefits of that tool, aside from presenting 16 different coupled design strategies, is that when you're in the early phases of your design and you change any strategy, the computer couples your change in all the other 15. So you instantly see how, as you're thinking about one design area, it is affecting your whole design and it can do it a whole lot faster than you can. Using this tool becomes incredibly educational and revealing. The Lawrence Berkeley Lab work, especially on the DOE 2.1(a) all the way through (e), has been a critically important design tool for producing excellent buildings that do deliver as design. I think the numerical part of this is too hard for people to do on paper now. I think performance design tools are very important. And you might think of them as engineering tools, but they're tools for architects. So I really see through building science, I see a coupling of engineering and architecture. And again, I want to put a very strong defense of this. What the Lawrence Berkeley Lab is doing right now is coupling CAD with DOE 2.1 so that you will then have your CAD drawings on your screen and the computer will calculate the performance off your drawings. You will not enter anything else except your climate and where you are, and maybe possibly patterns of use. I think this is important. Donald Aitken, Union of Concerned Scientists

Additional Pre-Symposium Responses

- A course in Geo Science to give a general foundation of the planet's energy systems, how they work, their process of transformation over time, and specifically tracking the transformation of our planet in the last two hundred years - this course should include scientific data and calculations which are known and tangible as in engineering;

- A design studio in which a design project is formulated using the above criteria as a major design tool;

- I would not try to set up a design course where predictions about design outcomes need to be met. This severely limits creative thinking about any kind of problem. Design process should lead to a new place, a new solution. The constant should be the knowledge about energy systems and how they really work, so that they are being incorporated into the design and carefully considered so they perform well. Karen Van Lengen, Parsons School of Design

- Our fall classes at the University of Hawaii School of Architecture, under the Environmental Systems heading such as Lighting, Acoustics and Mechanical Systems, help students quantify lighting levels, energy demand and efficiency, heating, cooling and passive design methods. The special research topic classes and the research projects also introduce students to quantifying environmental impacts of buildings. Software programs to assist design and case studies,

especially field visits, help students broaden their understanding of balanced building practices. These lessons can, and are at times, reinforced in the design studios. Stephen Meder, University of Hawaii

- Designs should not be exactly predetermined like a computer program. Design should be allowed to develop and alter throughout the design process prior to finalization. Prediction tools should focus on estimating the costs of sustainability, both societally and in architecture (life cycle assessment techniques). Development of regional centers, i.e., lighting laboratories, where students can test the performance of particular designs. Martin Davis, Clemson University

QUESTION No. 5 - CONTEXTUALIZE SUSTAINABLE DESIGN .....

What story would you create, or have you created or heard, that describes the importance of design in a sustainable society? .... a story that replaces the description of design in industrial society?

Brief Summary

We found that there are not yet commonly shared meta-stories. We might begin to envision a meta-industrial society, not as an alternative to, or as a contradiction of, but as the logical, necessary and desirable transformation of industrial civilization. This more sustainable, humane society would actually realize the purposes, dreams, and ideals that have moved generations by means of the Industrial Revolution. We should build this new story around the idea of interdependency and make that a motivating framework.

Report on Responses

Group Responding - Gary J. Coates, Professor, Kansas State University; Ed Dorsa, Associate Professor, Virginia Tech; Hillary Brown, Adjunct Professor, Columbia; John Reynolds, Professor, University of Oregon

- Reported by Gary J. Coates

- We found that there are not yet commonly shared meta-stories. We have no common vision of a desirable future direction within the context of which stories about a particular building or a metaphor to think about sustainability, or even reading lists that have a tactical, instrumental place for different audiences or for different purposes, can exist.

- We are in a kind of interregnum between worlds - between the industrial world, which hoped to create the greatest good for the greatest number, but the results of which are somewhat negative, and the future for which we do not have a compelling positive vision.

- We might begin to envision a meta-industrial society, not as an alternative to or as a contradiction of, but as the logical, necessary and desirable transformation of industrial civilization into a more sustainable, humane society that would actually realize the purposes, dreams, and ideals that have moved generations by means of the Industrial Revolution, and all of its consequences and products.

- First of all, when envisioning the meta-industrial society, we should not make people feel guilty. This is not going to play, people are not going to be motivated. The tactical measures we've taken so far will continue to prove inadequate. Many of us have spent decades trying every possible strategy from writing books to teaching courses to doing conferences. Name a strategy, and probably it was represented in this group. Yet we are still marginal characters within our own schools and within the larger culture of the design professions, and everything we have tried is largely not working because the strategies we have been using all beg the question.

- The fundamental question is "why change?" You have to be motivated to change. What motivates our students in architecture and design schools is they want to make a compelling, beautiful, better world. Yet, however they envision that world, they still like to make sexy objects, buildings that are just totally cool. They are influenced by the larger culture of the design professions communicated through schools, academic journals, publications, the different media by which we have created a system of "style stars" - architects who seem to be producing things that strike a resonant chord, that give an outer image of an inner condition of our time. These architects become very fashionable and, both faculty and students tend to be profoundly influenced by these style-star trends and movements. If you want to change the culture of architecture education, you have to change at that level. You have to find people who are producing buildings that are fantastic architecture. We're at a very different place now than we were in the 70's when we were inventing solar chicken coops. Take Frank Gehry, who is very appealing to many students and, for example, his building in Bad Oeynhausen, Germany, where he hooked up with a utility company to demonstrate daylighting, passive solar and photovoltaic-powered design strategies as a model for building the headquarters of an energy utility. In this building, Gehry became a good architect because he had a discipline and a purpose. Suddenly all his different form gestures, i.e. the wall leans out, the skylight grabs the sky for more light, and the cool form on the outside with the titanium, are also a perfect strategy to get a three-story lighting of a corridor. You look at that building and say, "This has discipline, whimsy, grace and a certain design flare to it. This is cool!" When I show my students Gehry's building and others like the Commerce Bank and the IMG Bank, the exemplars of so-called high design, the hook is first that here is an attractive, appealing building.

- If you want to change the culture of design education, you have to start at the top perhaps learning from the downside of the original. You're going to have to start with a series of conferences or venues with leading design architects like Norman Foster and Renzo Piano, together with the leading technical people for engineering and ecological design, public policy, etc. Get them together for some very intensive mutual education sessions in which we begin to articulate the parameters for the new architecture for the meta-industrial era. The intention would be to come out with videos, websites, books, magazines, a whole range of communications. In these documents, we would feature the larger paradigm of a sustainable society as the framework for presenting good design as sustainable design.

Commentary on Question No. 5

- This question got us to think beyond architecture to the idea that one could use a story to intrigue students that gets at different learning styles of students, social issues and aesthetics, in addition to the technical issues that bring us together. So we really valued the idea of the story as this way to reach out beyond the more traditional limits. John Reynolds, University of Oregon

- Simply ask the students what's valuable to them, what do they value, and let them build the story from there. Robin Freeman, Merritt College

Policy

- One of the reasons that some of the best sustainable design work that star architects have done is in Europe is that their work there is driven by policy and legislation. The stars all have design ability. When they're forced to bring in factors having to do with sustainability, it really changes their work. Ed Dorsa, Virginia Tech

- I think the invitation to meet with us should not be directed toward the star architect, but people like the chairmen of major corporations, the people who really make policy. Because I think architects are responding to problems defined by other professionals. My example is the Commerce Bank. The policy, there and in Europe, is that you only have a certain distance between the exterior wall, the skin of the building to the elevator core. In the United States, that distance is nearly double. Therefore, in Europe you don't have offices without natural light or natural ventilation because of that requirement. That's a fundamental design decision which results from government policy. Vincent Polsinelli, New York Institute of Technology

- This country has been made upon the idea that resources are limitless. Until we get over the hurdle that this country does not have unlimited resources, we are going to continue to build unsustainably. We have to send a message that resources are limited and that grandeur is also limited. Vincenzo Polsinelli, Professor, New York Institute of Technology

Interdependency/Team Teaching

Many conference participants said that design educators need to get away from the heroic concept of architecture and the poster boys. Robin Freeman, Merritt College

It's very clear that the global economy has taught us that Adam Smith's economic man doesn't work anymore and that the theme is interdependency in every way. We should build a story around the idea of interdependency and make that a motivating framework within multidisciplinary courses. Charles Burnette, University of the Arts

I'm troubled with the idea of going to stars and trying to get them to do good. I think it's an extension of the economic man. I think the root problem is studios that are still taught by the master and emulate the master's game and approvals. Team teaching should be a requirement in studio and having students of different disciplines in the studio, not just architecture students trying to play the role of these different characters -

rather, to have students from engineering, students from law and so forth in the group dealing with the problem. And, have the studio team taught so the students don't focus on getting approval from the master, but will deal with these issues as a group. Because you know in your practice that no one is, even the Frank Gehrys, the sole source of a building design. Stars are part of a team, and the fact that they've been idolized is because of the process of approval and reinforcement of the Hero Architect role in schools. Change that process and you'll change the outcome. Paul Lusk, University of New Mexico

Additional Pre-Symposium Responses

- The best narrative description explaining the distinction between sustainable design versus conventional design is one which compares a sailboat and a motor boat. The motor boat can essentially be any shape, the larger it gets, the larger the motor you just stick on the back to force the boat through the water. (This is much the dynamic of the design profession in the construction industry today. Engineers are called upon to react to problems that architects' create. They just accommodate by sticking on bigger mechanical devises.) A sailboat in distinction, of course, uses no motor. It is hard to separate the notion of the mass and shape and materials from the mechanics of how it is propelled. It is seamlessly integrated, a single continuum. That is the meaning of integrated design. This for me is the distinction of design in solar society versus Industrial society. Another good narrative is David Orr's Reflections on Water and Oil (water as signifier and underpinning of life, oil as toxic, or in service to things that eventually are toxic to life). Hillary Brown, Columbia University

- A metropolitan area produces 1 used automobile tire per year per person. (2.5 million people = 2.5 million tires). This results in about as many discarded tires in the U.S. as there are trees. An alien observer wouldn't necessarily be able to tell which was the resource and which was the waste product. Ed Dorsa, Virginia Tech

- "Given that humanity is now in charge of most of the land surface and responsible for it, what designs of the terrestrial landscape are best for the rest of life and, therefore, for us? The answers cannot come wholly from unaided esthetic intuition or short-term econometrics. They must come also from a science that adds the living world effectively to a larger picture" Edward O. Wilson. Michael Garrison, University of Texas, Austin

- Here's a quote and a story:

- "In fact, careful records of human time budgets show that not only New Yorkers and Indians, but also Californians, reputed nature enthusiasts, average only about one-and-a-half hours per day outside." *Jesse Ausubel, Program for the Human Environment at The Rockefeller Center*

- "The woman making the coat has no interest in making a coat, per se, but in making someone warm. She could do this by putting her arms around a shivering person, but instead she

accomplishes her goal by indirection - by making the object which then remakes the human site that is her actual object .... the coat-maker is working not to make the artifact (which is just the midpoint in the total action), but to remake human sentience." *Elaine Scarry, The Body in Pain*
Chris Jarrett, Georgia institute of Technology

QUESTION No. 6 - INTEGRATE SUSTAINABLE DESIGNS INTO EARTH SYSTEMS .....

In the long term use of sustainable/solar design, what should we be looking for regarding issues of production of parts, maintenance, disposal, etc., so sustainable buildings and designs can best be integrated with earth systems?

Brief Summary

There is a technological overtone to all of the participants' responses. Technology is the field today attempting to answer ecological problems and technology can complement natural systems, but today we are in an age where technology seems to be the leader and the natural systems seem to take second place. Yet, to integrate sustainable design with earth systems, the systemic, ecological frame of mind, which is how we perceive the life force of the planet, ought to be channeling creative thought in the studio and in the classroom.

Report on Responses

Group Responding - Chris Jarrett, Assistant Professor, Georgia Institute of Technology; Skip Wenz, Director of Ecological Design Program, San Francisco Institute of Architecture; Andrew Scott, Professor, MIT

- Reported by Chris Jarrett, Andrew Scott and Skip Wenz

Technology

- One-third of the respondents had no idea what to do with the question of how to integrate architecture with earth systems, and the other two-thirds basically said yes, integration is good, and left it at that. One of the issues that we, the team summarizing Question 6, had regarding building systems and approaches to integration with earth systems, was whether you take low-tech design strategies, a la sort of adobe and more traditional and vernacular approaches, versus more high-tech resolutions. Technology is the field today attempting to answer ecological problems and technology can complement natural systems, but we are in a day and age where technology seems to be the leader and the natural systems seem to take second to that. Chris Jarrett, Georgia Institute of Technology

- There is a technological overtone to all of the participants' responses. I think what's missing is the interpretation of sustainability as being much more culturally and socially orientated. How do we know ideas work, how do we know they relate to the big picture? Andrew Scott, MIT

One System

- There aren't really two systems on the planet, there is just one system, and as long as we think of it in terms of two systems, we're heading on a course of self-destruction. The planet will go on. If we don't sustain ourselves, we'll be gone, and that'll be OK because the planet, the bacteria will continue to evolve. Sustainability is really a human issue. Our task is to figure out how we can get with the ecological paradigms that we're living among right now and not destroy our own campground. We need to think about fundamental issues such as food, water, the supplies thereof, and integrate those into one system at all different scales.

- Should we be building new buildings? Is it a good idea to build new buildings when we have thousands of empty buildings in cities? I challenge the idea of having a road that goes out into the country to a new ecological house in some pastoral setting because, I think, in building that house, we've destroyed some of the ecology and we don't have a lot left to destroy, no matter how ecological the house. The energy flow of the house is part of the whole earth system. The solution is to have increased energy flow through more solar, conservation of materials in eco-systemic models, and increase all levels of bio-diversity, species diversity, genetic diversity, intellectual diversity, and cultural diversity. But we're going in the opposite direction in those areas. We're decreasing energy flow by using oil. We're obviously not recycling very well, and we are decreasing diversity. Skip Wenz, San Francisco Institute of Architecture

Commentary on Question No. 6

Framing Design Problems as Earth Systems Problems

- For us to affect the sustainability of the human presence on the planet, we have to look at the systems making it possible for us to live here. We need to start thinking of architecture, from building roads to building chairs, as having an absolute relationship to those earth systems. What if we framed design problems so students, working in teams, investigate the material and the energy sources of their projected buildings as part of the process of designing it? What if we have them chart and map each of the elements involved in the final building as a factor in the design process? In other words, what if we have students investigate the whole process in which a building is involved as integral to its design? For instance, after the building is built, it has a life span that has effects on the planet. If the building is renovated or parts are replaced, what happens to the discarded materials? What about introducing to students the idea of buying services rather than products that is practiced by the rug tile manufacturer, Interface. You don't buy a rug tile from them, you get a service for a rug tile that recycles and replaces the tile when it wears out. We could frame design problems so our students rethink every relationship in a building, including when the initial function is no longer operative, is the building then a "dead object"? Is there any way in which the flexibility of response over time of a building can actually be part of the design? In other words, the systemic, ecological frame of mind, which is how we perceive the life force of the planet, is the frame of mind that ought to be channeling the creative thought in the studio and in the classroom." Jean Gardner, The Earth Group, Co-organizer of Conference

- I have developed principles of ecological design as a guide for industrial designers that are relevant here. (See footnote at the end of this section.) I am advocating looking at the issues in a very simple frame. How can I do the most with the least? You know, Bucky Fuller. How can I do it in a way that will not have adverse effects? We get so wrapped up in the bigger questions that we forget what it's like to be in the studio, making those decisions, coming to grips with the whole problem that is confronting students, and learning how to deal with complexity. In industrial design, you can look at the processes and see what it costs to do them in much better ways than in architecture because there are more of them in architecture. Nevertheless, even when you're detailing a tile on a roof of a house, if you're thinking of the best way to optimize the flow of energy and work in this particular detail, you're thinking the right way. It's the same way industrial designers think. Charles Burnette, University of the Arts

- Someone mentioned that a good idea for a studio problem would be an off-grid building, a zero-energy building. Well, to some extent in the real world, if you look at the whole onion, that's ridiculous, that's really not a good problem at all. But in terms of allowing students to see what all the inputs and outputs are, how to balance them within a problem, that would actually inculcate certain positive habits of mind. I think we can make a distinction in the problems we send our students, between the knowledge we want to give students, and the habits of mind or skills we want to give students. Colin Cathcart, Fordham University

- There is a rich narrative within environmental science into which we can place architecture for our students. For instance the textbook, G. Tyler Miller, "Living In The Environment", Wadsworth, San Francisco (and many other cities, new edition every couple of years), provides a well written story of environmental science. The cultural part of the environmental story is, of course, that until recently, people were all indigenous, living within the natural cycles very closely, and the cultures were all linked to nature. I think we're culturally and genetically hard-wired to really like these stories. When you come up with them for students, the light really goes on. Robin Freeman, Merritt College

Additional Pre-Symposium Responses

- Five ecological concepts pertinent to full understanding of sustainability should be presented: stability, biodiversity, adaptability, carrying capacity, and biological productivity:
    - stability or the capability of a system to absorb trauma and recover its characteristic of stability;
    - biodiversity: stability is enhanced by the presence of many different species in the landscape;
    - adaptability is the capability of a system to successfully change to a modified form while maintaining its primary ecological functions;
    - carry capacity: each biological, institutional, or physical entity or system appears to be subject to the idea of limits;
    - biological productivity: a near-natural level of biological productivity indicates a level not too far from that which would prevail if the whole landscape had native ecosystems. Quantifying near-natural more precisely is an important challenge in sustainability. Michael Garrison, University Texas at Austin

- No waste, no emissions, function off the sun and natural forces, be designed for disassembly and subsequent recycling or reuse, be beautiful as well as functional, be durable and adaptable. Charles Kibert, University Of Florida

- Have the students design for non-earth systems, say a moon module, or for extreme earth conditions, say a redesign of William Perry's ill fated underground Antarctic hut where he soloed for a winter and nearly died of asphyxiation because air changes per hour were inadequate and ice built up to a 2" thickness on all surfaces. Connect the idea of design and survival. Leave the rest up to the students' fervid imaginations. Davidson Norris, Parsons School of Design

- On-site systems: develop awareness of what systems are disrupted, and in what ways, by the activity of building and its occupancy; how disruptions might be minimized; how existing system performance might be enhanced (like retention of rainwater).

- Off-site systems: develop awareness of the inter-connections of supply networks; what is an optimum level of reliance upon off-site systems; how might a new project contribute to, not merely take from, such networks (a huge promise of both photovoltaic and wind power, for example)? John S. Reynolds, University of Oregon

- Many practitioners of explicitly directed sustainable architectural design are better equipped to address this question than I. There are many examples of "breathing" and/or absorptive wall skins, differential circulation systems for water, passive and active solar and wind engagement, etc., as well as a range of re-cycled material uses in the production of building material. These efforts, while remaining far from mainstream, gain currency daily and, as a result, technological innovation in these areas will only increase. When I think of an affective architecture, I imagine a mutable architecture which physically adapts itself to natural conditions as they occur. Examples of this range from Paul Virilio's description of the cybernetic transference of wind data reforming the wing configuration of advanced military jets to the U. S. Army Corps of Engineer's manuals on mechanical diverter systems for public buildings allowing flood water to flow through them without damage. Peter Wheelwright, Parsons School of Design

Footnote: Charles Burnette, University of the Arts, Principles of Ecological Design for Industrial Designers:
These principles should not distort the goals of design, which are to improve the function, manufacture and appropriateness of industrial products while raising them to the level of art. The principles are intended to help make what we do more meaningful and to help us to become more sensitive and responsible designers.
When designing we should all:

1. Reduce the use of natural resources.
   Reduce the use of natural materials and energy in products and services in order to reduce the potential for environmental damage, depletion, unnecessary work, waste and the need for waste management.
   Implications: Reduce the size of products and the amount of material needed and used. Reduce the need for power. Utilize waste energy when possible. Design for the maximum useful value of all materials. Use renewable, reconstituted and waste materials when possible.
2. Choose ecologically appropriate materials.
   Know the performance of your materials throughout their lives, both regarding the uses and reuses that you intend and can anticipate; and the effects, hazards and failures in the product or the environment that may effect the material.
   Implications: Develop or obtain environmental/health impact information over a full range of performance conditions and extremes for every material and combination of materials that you specify. Develop scenarios and guidelines during conceptual design to guide design and the potential uses and reuses of the intended product and its components. Use the fewest and most easily reconstituted materials possible.

3. Choose environmentally safe processes.
   Understand the side effects of the manufacturing processes you employ and design to prevent or minimize harm or discomfort to the worker and to reduce energy consumption, sound pollution, harmful emissions, precipitation of particulate matter, and material waste.
   Implications: Understand the demands of the process and equipment to be used. Design to minimize the required operations, harmful side effects, unusable by-products, and maintenance impacts of the process employed. Avoid finishes, plating, adhesives and coatings that release harmful solvents when applied, require toxic agents or become harmful or ineffective with use or age.
4. Design for the lives of the product.
   Design environmental problems out of the product by designing for customer satisfaction, ease of use and safety, optimum quality, operation and durability, easy/minimum maintenance, the reuse/replacement of components, and the recycling or reconstitution of all materials.
   Implications: Understand the customer, the potential uses and the contexts of potential use for your design. Design to assure that everything is made and used well. Understand how the product can fail or be abused. Design it to be longer lasting, cleaner, more efficient, easy on the user and easy on the environment of use. Make the product sense and respond to conditions of use. Simplify, integrate and standardize the fit and interface of reusable components. Provide standardized, easy identification for all materials. Design for easy separation, handling, cleaning, reuse and recycling of product components.

QUESTION No. 7 - ENGAGE SOCIAL, ECONOMIC AND POLITICAL PROBLEMS.....

What social, economic, and political problems/conditions do you see sustainable design affecting?

Brief Summary

There was very little real understanding or discussion of these three issues and how they conflict. For instance, ninety percent of the houses in this country are not designed by architects. We need to understand the forces of development. If we were to run two studios, one looking at building development under policies that exist in this country, another studio doing the same problem with the policies from Europe, then students might understand the extent to which policy structures design.

Report On Responses

Group Responding - Ellen Dunham-Jones, Professor, MIT; David Fox, Professor, University of Tennessee; Stephen Meder, Professor, University of Hawaii; Davidson Norris, Professor, Lighting, Design Architecture Department, Parsons School of Design
- Reported by Ellen Dunham-Jones

- The majority of the responses basically said yes, of course, sustainability should include social, political and economic sustainability. But there was very little real understanding or discussion of these three issues and how they conflict, nor any real discussion of the sustainability of cities. This is an area where we, the summarizers of Question 7, feel there needs to be more research. Is Sir Norman Foster's CommerZBank in Frankfurt the best example for integrating daylight or other sustainable design techniques into a high-rise? We felt the discussions of transit and transportation need to be part of the discussion. There needs to be more education, and we hoped that schools would be doing more to research the thinking involved in the better examples.

- The importance of economic incentives at all scales cannot be understated. Whether at the scale of appealing to the individual consumer, telling them that they can lower their heating bill, that's one scale of the much larger scales of the economic issues. These all obviously need to be understood in different ways. We need more innovative ideas. Some really interesting innovative ideas occur when you get multi-disciplinary approaches to look at and really understand the economics. We talked about innovative mortgage programs, innovative financing which could expand how we think of architecture and design.

Development

- Ninety percent of houses in this country are not designed by architects. They are designed by production builders. If you want to deal with that building type, get the big national home builders involved in this. The architects have essentially abandoned that market. Does that mean we shouldn't talk about design of individual buildings? Certainly not, but we do need to really understand the forces of development - where it's really occurring. We need to look at the scale of the individual building and the scale of the city, how it interacts, as well as the scale of the planet. Often the discussion of sustainability goes from the individual living a survivalist lifestyle, telecommuting from Aspen, and then jumps to the planet and global pollution issues, but missing the realm of the city.

How Change Occurs

- Will change occur principally through the free market and capitalist development of new products, or does it occur really through government intervention? Low E glass, for example, was initially developed through government grants and the D.O.E. and research that developed low E films, and then it was taken to market and mass produced. There are a lot of models that are working in different countries. Some understanding is needed of the role of the architect here. Which of these markets are we trying to work? Are we trying to play to the market or are we trying to play to policy makers?

NAAB Criteria

- We did talk about how the NAAB criteria for architecture schools' accreditation addresses issues related to economic, social, and political concerns. Students are expected to be able to "do", certain things; they're expected to "understand" certain things, and then others they need to be "aware of". These social, economic and political issues should, at the very least, be in the "aware of" category.

Commentary On Question 7

- This is a precautionary tale. Back in the 80s, the Philadelphia Solar Planning Project attempted to address the types of problems we are discussing here. A complete survey of housing stock, 500,000 two-story flat-roofed houses with solar orientation. I mean, the whole bit was done - utilities, economics, incentives, conservation programs within communities, the gas works, distributed conservation guides endorsed by eleven organizations. What killed it was pure economics. The price of oil didn't do what everyone said it was going to do and I've never seen anything die so fast in my life. So the point here is that to really tackle something as big as we're talking about, there needs to be a degree of sustained effort that is very difficult. But it doesn't mean it's not worth doing and some dents were made, but the issue of sustainability has to be a sustained drive. Charles Burnette, University of the Arts

- An area that really never seems to be addressed in these types of discussions is the other realm where many people live - middle density settlements, that is to say suburbs. But the issue is a deep one. Many people choose to live in a place where they have some access to what it is that's called outdoors or land. And then you have dispersed systems of utilities and other kinds of support, transportation, structures, and so on. The question: Is it possible to develop the suburban pattern so it is sustainable on a large scale or not? It's easy to imagine that the city offers certain advantages with one surface of the six in the box of the apartments exposed. What about the suburbs? This is an area that has to be addressed, especially since more and more people tend to live in that kind of pattern than any other. Jonathan Friedman, New York Institute of Technology

- The suburbs outside the cities are even a tougher nut to crack, and probably needs even more research. One example that we talked a little bit about is the work that the congressmen of the new urbanism have done on this topic. New urbanism is a lot more than just pastel porches. It's actually attacking the regulation by which the suburbs are developed, the laws by which financing for affordability is developed, both in the suburbs and in the cities. It's putting forward a model of more compact, yet still suburban density, transit-oriented sustainable development. Ellen Dunham-Jones, MIT

- If we were to actually run two studios, maybe not initially perceived as being connected, but one looking at building development under policies that exist in this country, which includes zoning laws such as providing a certain number of automobile parking spaces per net square foot of office space, and another studio doing the same problem with the policies from Europe, possibly with bicycle spaces instead of cars, or whatever, but with the two different requirements, then at the end, instead of simply critiquing a student's work, critique the policies in the built environment, and raise the issues amongst students within the classroom. Really set up a different discussion of form and sustainability, then students might understand the extent to which policy structures design. Mike Utzinger, University of Wisconsin

Additional Pre-Symposium Responses

- There are few social, economic and political problems that sustainable design does not touch: environmental equity, scarcity of resources, undervaluing of ecological resources, political control over resources. Sustainable design offers the prospect of evolving synergistic solutions which have positive social, political and economic benefits. Hillary Brown, Columbia University

- A better question might be: What social, economic, and political forces are working against sustainable/solar design? I think people are unaccustomed to getting something for nothing. They can't believe that merely good design can cut energy needs of buildings by more than 50%. This is why I believe the "Sun Emulator" can show the general public, as well as the professionals and politicians, how informed design can harvest the winter sun, reject the summer sun, and collect high-quality daylighting all year. Because children should grow up understanding these basic principles, I would like to see a "Sun Emulator" type of machine in every science museum. The next generation might then be convinced of the great potential of solar design and demand it from their builders. Norbert M. Lechner, Auburn University

- Sustainability creates jobs: deconstruction, recycling and reusing instead of landfilling creates 10 jobs for every landfill job. Renewable energy systems create 10 jobs for every job associated with central fossil or nuclear power production. Switching to products of service can create a vast new infrastructure of businesses that maintain, remanufacture, and recycle our goods. Sustainability also creates healthy human environments and communities, all beneficial to humankind. Charles Kibert, University of Florida

- Sustainable design touches on everything from religion to politics, economics, education and design. At root - the environmental crisis is merely the outward sign of an inner condition. The crisis of sustainability is a spiritual problem and will not be addressed, let alone solved, unless it is dealt with at this level. This idea was also developed at great length in Resettling America. Gary J. Coates, Kansas State University

- Sustainable design is a repatriation of primitivism. Meaning that we acknowledge, individually, our share in "the commons." To the extent that our current industrial society could "become primitive," i.e., mimicking tribal cultures in which highly integrated individual and communal life erases boundaries between art, economy, and environment, we could readily (re)claim a culture of stewardship. Robert J. Koester, Ball State University

- Social conditions: we must improve global conservation of resources for future generations. Economic conditions: long term loss must be factored into all understandings of short term gains. Political conditions: the populist dependency of democratic government systems definitely mitigates against long term planning and thinking. David Fox, University of Tennessee, Knoxville

- Sustainable design will affect all of these conditions/problems. Fundamentally, commerce must be re-oriented from a process of continuing growth, without limits, to an ecologically centered approach. This is comprehensively discussed by Paul Hawken in his book, The Ecology of Commerce. As an expanded response to this and the previous question, Paul Hawken, Chair of the U.S. Division of the Natural Step points out four tenets they consider to be fundamental rules of a sustainable society. They are listed in the July, 1998 issue of Metropolis :

    1. "Substances used from the earth's crust must not be allowed to systematically increase in nature." That is, we can't go on depleting resources as we have been.
    2. "Substances produced by society must not systematically increase in nature." That is, we can't keep matter that will not decay or biodegrade.
    3. "The physical basis for the productivity and diversity of nature must not be systematically diminished." That is, we cannot continue to chop down the rainforest or fish the seas faster than nature can restore them.
    4. "Human needs must be met by a fair and efficient use of natural resources." That is, we have to be concerned about the just distribution of resources.

    Richard Larry Medlin, University of Arizona

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- Essentially, a sustainable planet would be one which evolves toward greater, not lesser, diversity. Bioregionally based economies make the most sense in this regard. Currently, goods are over produced. Most of us have way more stuff than we know what to do with or how to get rid of. Usable materials are getting in shorter supply, and there is liable to be a great deal of warfare in the

next century over potable water, food, etc., even though our productive capacity could easily exceed demand.

- I see the post industrial world society as based on a sustainable agriculture and information exchange. Agriculture is the most direct and efficient use of solar energy. Taken in its broadest sense, agriculture can mean the growth of managed forests, etc. Agriculture would be based on building, rather than depleting, soil, water and mineral resources, and tuned to bioregional priorities and potentialities.

- Obviously the equitable distribution of goods will be needed to make such a system work. In terms of consumption, the average American consumes something like 37 times as much as the average East Indian. Their actual population is about twelve times that of ours, yet there is plenty to go around, if it goes around. If the flow is unidirectional then the system breaks down. We are currently witnessing the breakdown of the world-wide economic system, accelerated by the recent "boom" in third world labor production and excessive consumption in the industrialized countries.

- It is in the West that we need to learn how to live sustainably. Bali, for example, has or had, until we disrupted their culture with cash crop demands and "improved" water technology - an ancient, highly evolved, well tested water distribution system which ensured that the crops matured in sequence, thus creating a steady food supply. We need to understand and revive such systems to put ourselves on a sustainable track. Skip Wenz, San Francisco Institute of Architecture

QUESTION No. 8 - CREATE NEW FORMS THROUGH SUSTAINABLE DESIGN, USE OF SOLAR .....

How does sustainable/solar design affect our sense perceptions? What are the aesthetic possibilities that you see in sustainable/solar design? Examples....

Brief Summary

We actually went back and forth arguing over whether it's important to be representational and have visible forms that indicate sustainability, versus whether a good environmentally responsive building was like a good structural system: it underlies what is going on in a building in a very normal way.

Report On Responses

Group Responding - Neil Denari, Dean, Southern California Institute of Architecture; Michael Utzinger, Chair, University of Wisconsin; Karen Van Lengen, Dean, Parsons School of Design

- Reported by Neil Denari and Michael Utzinger

- New formal languages are not really the issue. If performance is the main way to analyze sustainable design, then paying attention to the phenomenological aspect of a design, to the aspect that is not measured on what you see, but on what your body feels, to the hypersensual aspects of the work, might make the building operate within conventional architecture. But let's think about this question from the point of view of representation. There's a new high-rise going up by Fox and Fowle in midtown New York City, which is touted as the first green high-rise, at least in New York. But there's no iconography or rhetoric or sign form on the building which suggests or calls out to the public that this is doing something different than any other corporate envelope. It is a lost potential for it not to represent what it is. The obsession, on the one hand, with a formal language is somewhat troublesome, but the issue of what is the appropriate structure for this work, is certainly very much open ended. For instance, take form which comes out of incredibly large formal gestures of very large sloping surfaces, as opposed to curtain walls which take that surface and sawtooth it into a particular way to talk about dramatic forms and projects and scales, contrasted to the deployment of those surfaces in smaller ways to generate other types of less definitive sorts of iconic surfaces. There is a building by Gunnar Berkerts, from the mid-70s for IBM, a block in the middle of the landscape with four different performing facades, from a flat skinned black facade on the north to a sawtooth skin on the south. This building does not attempt to generate wild form but actually performative sorts of envelopes. Neil Denari, SCI-Arc

- There were a couple of responses that looked at the issue of process more than form, but at the same time somehow related to form the idea of architecture as something that was dynamic, and described buildings that began to dynamically respond to the natural environment in terms of mediating with the environment.

- As a group we actually went back and forth arguing over whether it's important to be representational, and have visible forms, versus whether a good environmentally responsive building was like a good structural system. It underlies what's going on in a building in a very normal way - that one can have well thought out structural systems and then form other issues that may be visually more important. One can be a structural expressionist and the same should be possible with environmental and sustainable design. That is, there probably are forms that are very iconographic and reflective of what's happening. There are probably very good buildings that don't have to be iconographic. There was some feeling that environmental issues are more than formal issues. It can be used as a means of organizing a building in form. But to predispose architecture to a particular set of forms that then make them sustainable didn't seem to be the way that we saw it. Michael Utzinger, University of Wisconsin

Commentary On Question No. 8

- When I read that question, I immediately thought of Ralph Knowles who really explored this in an urban context. I think it's a very exciting humane type of architecture that can come out of responding to the solar needs. Norbert Lechner, Auburn University

Additional Pre-Symposium Responses

- Of course, for an architect of my generation trained in the 60's and 70's, deriving new forms from sustainability and solar design is what it is all about. I believe that these important new considerations will yield an incredibly beautiful architecture and urbanism, but it will not come quickly. Success will require the dedication and career achievements of many designers to evolve an architecture with these elements as an integral part. Kent Hubbell, Cornell

- Understanding "balanced building" allows us to improve our ability to see both the obvious as well as the subtle. The obvious, and often overlooked, patterns of sun, wind and seasons escape our notice, profoundly impact our lives and provide wonderful opportunities as form generators for the built environment. The subtler aspects lie in the process. A building's resource and energy demand and the life cycle of building materials are frequently unevaluated. The origins of the material, the means by which it was processed, the healthfulness of its performance and the method of its final disposition, are values inherent in any given material. Comprehending this gives clarity and purpose to design and construction. From site selection and development through building orientation, design, and material selection, the building's form and performance can represent these principles. We have available to us today, the ability to develop buildings that are resource efficient and for the first time in human history, we can create buildings that are not simply large energy consumers, but are structures that are energy generators. Stephen Meder, University of Hawaii

- Sustainable design offers the clarity of natural systems, of things working in accordance with natural principles, not working upstream against them. There is a pragmatic integrity in "right-sizing" - getting balance, eliminating excess. The aesthetic satisfaction can be derived in part from this. There is a resonance, to getting the optimal ends through an economy of means. We should optimize, when our culture and economy pressures us to maximize.

- Sustainable or green building doesn't have a formal agenda. Moreover, it defies the emphasis given in most design curricula in which the visual dimension prevails. An effective green ideology reasserts the primacy of human factors - measurable physical comfort and well-being - engaging all the faculties and providing supportive ambient conditions. As we "live on the leash of our senses" according to Diane Ackerman, so may we be spiritually limited or expanded by them. Here architecture traditionally under-performs! Beyond the purely visual, all other sensory experiences can be enriched to produce higher quality environments. We need to understand the consequential benefits of air quality, thermal comfort, use of varied textures and finishes (such as one would find in the natural world) and acoustically benign environments, and how such features support our quality of life. Hillary Brown, Columbia

- Many designers want to be creative and unique in their design appearance and create new forms without thinking about the performance of the building and the environment in a holistic way. Integrating sustainable design strategies and natural processes into their design can have a meaningful and profound aesthetic quality and long-term multiple benefits. Bashir A. Kazimee, Washington State University

QUESTION No. 9 - CRITICIZE CURRENT SUSTAINABLE DESIGN .....

Looking carefully at the facts of the current teaching and use of sustainable/solar design, what do you think is going wrong, what is going right? Examples....

Brief Summary

On the negative side, the U.S. Government has no centralized approach to sustainable design in contrast to Europe. There is today, however, a main- stream concern for environmental issues even if not for sustainable practices. Another concern is that sustainable design has been very solution-driven as opposed to problem-analysis driven. Also, we haven't done a very good job of understanding the architect's role, nor have we been rethinking the design problem itself. The nature of education is an issue, but we could not agree what the problem was. On the positive side, environmentally sensitive architecture has evolved from "Lean, to Clean, to Green".

Report On Responses

Group Responding - Michelle Addington, Professor, Harvard University; Bill Bobenhausen, Professor, City College of New York and New Jersey Institute of Technology; Dale Brentrup, Director of Laboratory Research, Lighting and Building Energy Technology Laboratory, University of North Carolina - Charlotte; Peter Wheelwright, Professor, Architecture Department, Parsons School of Design

- Reported by Michelle Addington and Bill Bobenhausen

- There's a large gap in policy leadership in the United States. The European model comes up, as far as government groups go, because it has full levels of response educationally, institutionally, and organizationally, as well as integrating into practice from that standpoint. As a counter to that, even though we recognize that the U.S. has no centralized approach or inclusion of sustainable design within mainstream practices, it doesn't mean that there is not a mainstream concern for environmental issues. Even though sustainable design or sustainable initiatives have not fully integrated themselves through all practices, something's very different now than it was twenty years ago when many of the initiatives were thought of as being reactionary, idiosyncratic, and unnecessary. There is fairly widespread belief that we do need to do something, and it's shared by our students, (is probably well shared by most of the residents), certainly in this country and perhaps throughout the world. Which means that doomsday types of strategies that politicize this

as being part of certain kinds of movements is not necessary and may be counterproductive to speaking to the mainstream. The mainstream already believes that there is a problem, and they don't need to be convinced, scared or cajoled into thinking that there is a problem. This notion of educating the mainstream is probably not one that we have to deal with, but getting sustainable practices into the mainstream **is** something that we're concerned about.

- The next concern was that sustainable design has been very solution driven as opposed to problem analysis driven, and the solutions have been very narrow. The focus has been on appearance, add-ons, ready mades like solar panels - on objects. This romantic notion of an individual building where everything is self-contained, that there's an envelope for the building, and that all things are balanced within that single envelope doesn't take into account the sort of multi-modal, multi-dimensional aspect of sustainable design. For instance, so many performance measures are indeed stochastic measures, which means it's quite difficult to parametrically relate them back to their initial cause. When we realize that, of course, the causes themselves are quite multi-dimensional and interrelate in many different ways, then the thought of basing something on performance, when indeed we don't know that the performance is quite the right thing to be looking at, becomes questionable. Take, for example, the weatherizing of buildings. Trying to reduce the rate of heat transfer through a building envelope has produced a whole series of negative consequences. Think about the latest studies that show that 20% American children have asthma. Asthma was an extremely rare disease in the 50's. Asthma has come about because of the increasing problems with indoor air quality. There are concerns about many other aspects of weatherizing with some choices of materials. There's a whole life cycle issue as well. The full series of ramifications from choosing a measure or privileging one measure without understanding its complete interrelationship with all the other measures is problematic.

- If indeed sustainable design is about performance - that is, taking that performance and measuring back from that performance - then it's simple, the problem is solved. We have marvelous computational tools, so in a matter of just minutes, any student or architect can analyze their design and determine what to do with it so if it really is only about a performance measure, material specifications and choosing the correct equipment, that's done. It's obviously much more than that.

- What we haven't done a very good job of so far is trying to understand the architect's role other than as a material specifier or as a specifier of certain types of properties. What other roles should an architect be playing besides this?

- We haven't been rethinking the problem, in terms of what else it might affect. We haven't questioned the nature of the building envelope. We haven't questioned the nature of what the heat transfer through the building envelope is trying to deal with. Ultimately, all we're trying to deal with is the comfort level of the human body. Yet we have made the boundary of the human body this huge other boundary, as well, but we've accepted that and are trying only to work marginally within that. We haven't begun to look at different kinds of huge problems. One of the things that didn't show up as we talked about electricity use and improvements in efficiency, is the fact that a 386 computer

had 2 watts heat dissipation. Pentium II was up to 50 watts. I just got my new 500 MHz computer last month. It's an 80 watt dissipation and the typical computer of the year 2000 is expected to be a 200 watt dissipation. So all of a sudden we have unprecedented types of heat loads coming into buildings, and so many of our initiatives have dealt with the heating of buildings. Very few of our initiatives have dealt with understanding the cooling of buildings, and the real problem that's going to be introduced as developing countries try to pick up on information technology.

- The nature of education was something that we could agree was an issue, but we couldn't agree what the problem was. Is an architect's education too general to begin to really effectively deal with these issues, other than in more simplistic fashion or a very direct fashion? Should we be dealing with increasing specialization and increasing technology? Another standpoint looks at architects dealing with even more interdisciplinary problems, but this may not be a possibility, of course, as each of these become vastly more complex. Even though my doctorate is in heat transfer, I feel as though I can only talk about one percent of the research that's happening in heat transfer very effectively. And I certainly can't expect an architectural student to be aware of the issues in heat transfer. The question becomes, at what level do you still teach and deal with an interdisciplinary type of education in accepting how one works in a much more interdisciplinary field, when the specialists are perhaps dealing with topics that are much more specific. There is less and less congruence between the types of specialists. At what point do you start to ask the architect or architectural education to start defining levels of specialization? Michelle Addington, Harvard University

- I'm a big optimist these days, because I think there's almost an undercurrent in this discussion that we have a serious problem, and I think the problem is solving itself. Many of us who have been influenced by events of the 70's, the energy crisis, the year I graduated, had certain things that got us out there learning and talking about issues to other students. Now there's a whole new generation that's come along and they're getting powerful. One of my students that I'm proud of is Sandy Mendler, who's head of sustainable design for HOK. There's a small army of people out there who are gaining influence and power in the architectural community that a lot of us have influenced. Believe me, everyone above them, whether they like it or not has been influenced by Love Canal, Chernobyl, and Three Mile Island, and solutions of a very profound environmental nature and they look at the world differently. If I teach a class on building performance, it might have a fairly narrow course description, but I ask in the first class, "What about sustainable design", and 30% to 40% of the class says, "yeah, we want to talk a lot about that in this class." So the curriculums are expanding. We hear what's going on at Berkeley and other places, and it's going to be spreading. It has no choice. It is much more mature than what happened in the 70's though. There are incredible things going on here in New York City. So let's not be pessimistic at all, but be amazed at how quickly things have moved. Whenever people do ask me to talk about green, I really insist I want to talk about from lean, to clean, to green, the evolution of environmentally sensitive architecture, because it's not a trend. It's a process and we've gone past the point of return. To me, the genie is out of the bottle. The young generation of architects are not going to fall

victim to you're a great architect if you don't know where the sun rises and where it sets. You have to know that, too, then manipulate the form and then do a good job, and then make it beautiful, and then bring it in on budget. Bill Bobenhausen, City College of New York

Commentary On Question 9

No time for commentary

Additional Pre-Symposium Responses

- Current teaching of sustainable issues focuses primarily on technical aspects of sustainable design, i.e., complex curtain wall design or the composition, lifespan and disposal of materials. It does not look to the ethics of intention and aesthetics. Why build a 5,000 sq. ft. house when one can easily live in half of this space? Why complicate a design for the sake of an image with reason, etc.? These are critical issues in any design program. Karen Van Lengen, Parsons School of Design

- Student interest in sustainable issues exists. Administrative interest in sustainable issues is generally not noticeable. **We need administrators to help convince faculty of the importance of the topic.** Research monies are difficult to ascertain with regards to sustainability. A source, either public or private, needs to be established to fund research in sustainability and design. Additional sources for publication need to develop, since the means to publish research is limited in this field. Computer tools are improving but they still require simplification to be integrated thoroughly. Martin Davis, Clemson

- This question depends on where you are talking about. In Europe there is a body of work emerging that gives rise to hope that sustainable design is entering the mainstream of construction and development. In the UK, at least 8 universities offer advanced degrees in sustainability. Corporations and developers understand that environmentally responsive low-energy design makes sense and produces better places and cities in which to work and live. Environmental assessment has become common place in the design process. As a consequence, one can see how CO2 targets can be met in the long term. In the U.S., I see the architectural community focused upon the "relics" of the solar movement - the health and ecological aspects of construction and materials technology at one end, and the new urbanism movement at the other. Admirable as these are, I feel there is a vacuum at the center of the mainstream, where there is a marked lack of work being produced in the vast majority of practice that has an agenda related to the environment. Andrew Scott, MIT

- It's still viewed as an adjunct to design rather than a primary consideration in all design problems. Ed Dorsa, Virginia Tech

- Beware of the project or product that proclaims itself sustainable based on a single tenet. We must ask ourselves, is an extravagantly sized single-family home with five bathrooms and an Olympic-sized swimming pool worthy of a sustainable label simply because it has a solar water heater and 1.6 gallon per flush toilets? No matter how efficient, it may not be sustainable unless it considers an

alternative to commuting that does not require individuals to use their private automobiles to commute long distances to work since 72% of the average Texas household's energy budget is for transportation, that is, the automobile.

- We must consider more compact and integrated communities without the long commutes necessitated by sprawl development. We need more emphasis on Urban Design. Michael Garrison, University of Texas at Austin

- In many places there is a fear of appearing too different; the designer's object seems to be to visually minimize a building's sustainable features, to appear as conventional as possible while maintaining at least some sustainable performance. This denial of the fundamentally different approach of sustainability might enhance current "market appeal", but we need leaders as well as followers. Looking conventional is simply following. John S. Reynolds, University of Oregon

QUESTION No. 10 - REASON ABOUT SUSTAINABLE DESIGN .....

Based on your experience teaching sustainable/solar design, what do you think reasonably is possible in the future vis-à-vis teaching design sustainability and building a sustainable designed environment? What "if...then" patterns present themselves to you? What makes sense to you for the future of sustainable design education?

Brief Summary

If we build a knowledge base of examples of sustainable design, THEN possibly, we, with the help of our students, alumni, and other professionals connected to our schools, can begin to shift the current architectural paradigm to one based in ethical design, of which sustainable design is a subset, and thus begin to create a common collective understanding of good design as having social value.

Report On Responses

Group Responding - Jonathan Friedman, Dean, New York Institute of Technology; Michael Garrison, Professor, University of Texas at Austin; Charles Kibert, Professor and Director, University of Florida; Richard Larry Medlin, Professor, University of Arizona.

- Reported by Jonathan Friedman

Paradigm Shift

- A paradigm shift is needed and that shift will occur when people understand that ethical design is the issue, and that sustainability is a subset of ethical design, and that ethics is not a design style, just as responsibility is not a question of political correctness.

Star System

- It may be possible to transcend the heroic style of architecture, the star system, with an interdisciplinary non-ego teamwork concept of design. On the other hand, it's also possible that there will be a new heroic period of architecture. We are in an eclectic phase where many things are being tried, but there's not yet clarity on what makes a viable and typical solution, both stylistically, formally, and plastically, as well as programmatically. But because there is a convergence of new technologies and new social issues, perhaps we will begin to see some inevitability to the new forms that might arise.

Documenting Examples of Sustainable Design

- We as architects, and our students, can render the vision of what this paradigm shift is by making public the preferred examples, not of sustainable design per se, but just design. The issue is design, and design is second nature. If things are made well, then they will be well-designed, and they should be by definition now that we understand that sustainability is an issue. If we begin to collect the evidence of sustainable design, then there will be a knowledge base that's available to students. We should also make the knowledge base available and interactive with the alumni of schools, as well as the professionals who are associated with the schools. What we need to be looking at is how to document the examples of sustainable design and how to spread the word. This raises questions of how can we measure what is good, aside from taste, by using such things as life cycle, cost benefit, post-occupancy analysis. What about the signals that we want to send about rewarding and punishing? Can we tax waste and pollution? Can we give credit to the avoidance of those kinds of things? It was mentioned that the Iroquois measured their concerns in the light of seven generations, which is something that we haven't yet really built into our computer modeling and evaluations of things.

What Does This Mean For Schools?

- If we look at ideas like performance-based contracts for design services, that would help to motivate students. If we talk about how solutions have occurred, both in developing and developed countries, then what emerges is a comprehensive design science. We're looking at whole systems, we're looking at the traditional means and valuation of architecture and an economy of means. When you have an economy of means, there's an intrinsic elegance and, therefore, an intrinsic beauty. The suggestions were that perhaps there should be more design/build courses, more discussions of how developers can be experiencing and learning about sustainability, courses in theories of environment and sustainability, exercises in holistic thinking in which planning and interiors and structures were all brought together. Reconfigure the studio so that the students are given both the contents and the principles to make designs that measure sustainability. Offer co-requisite courses in life cycle, reuse, ecology, natural systems, etc. And, of course, the inevitable recommendation about the NAAB criteria - should there be more, should there be less?

What Does This Mean For Students?

- Once students learn about sustainability, they can tell people in the rest of the world what's good, what's bad, and how do we go from there. However, if you go into the public school systems, not only high school, but junior high school and earlier, and into the corporations, then you'll see that they're way ahead of the universities and that they have a lot to teach us. Maybe the issue here is not only that the students are the missionaries, but that the students are the gatherers of the information and bring it back and change the institutions. In addition to that, there was the thought that the studio itself is an exemplar for this thinking about integration that doesn't happen in the rest of the university, and this has a lot of overtones to it. The studio is the place where everything has to come together. The real strength of the studio is measured in the output rather than the talking about the output.

Problems Within the University System

- There are some problems in the university. The tenure system and the notion of separate disciplines drives everyone into a territoriality that undermines any idea that we could make these holistic propositions. The idea of putting a design course where sustainability is a primary issue, or other subjects that had to deal with sustainability, ecology, and so on, early in the curriculum, comes up against the fact that many of our students are under-prepared in math and English and the basic cultural understanding of the world that they live in.

The Bigger the House, The More Successful You Are

- An ethical issue came up which is the question that a student might ask of a professor these days, do you live in a solar house and do you commute? And if you don't live in a solar house and if you do commute, does that mean that you haven't chosen to sacrifice a lifestyle that buys into the economic successes of the apparent times? This ethical issue raised other questions, because it touches on a very big issue, which is that the image of success that we have to deal with in the world is that the corporate executive is at the top of the heap, and a measure of his success is the 40,000 square foot house or larger. This raises another very interesting question, which is that the public does buy into this measure of the success of people by using buildings in a certain way. The bigger the house, the more successful you are. Doesn't matter how much energy it uses, it's not a question at this time. The fact is that in the beginning, there's food, clothing and shelter, and many people believe that when you're rich, there's cuisine, fashion and architecture. We might recall that there was a time when good design was equated with a kind of social value, even in this country. What comes to mind are things like PVA and the WPA and CCC and the national parks. There was a collective public understanding of the fact that we could do things together, and that a common minimum standard was as valuable as a few individuals who were successful. Conspicuous consumption is now the measure of taste and success. The more expensive things you have, the more successful you are. So we have a whole problem as a profession, and as educators, to educate not only our own students and the public against this habit, but to provide them with something else that can rescue the society.

Commentary On Question No. 10

No time for commentary

Additional Pre-Symposium Responses

- if required then...
  if funded then...
  if educated then...
  if responsible then...
  if there was just one more person who looked at the problem.
  Dale Brentrup, University of North Carolina at Charlotte

- I think almost anything is reasonably possible within an individual program. Great things are possible within 2, 6, a dozen programs. What is difficult is making change within 50% of the accredited programs in North America. But .... what if this meeting can generate or lead to direction

tools, and a rationale for development of sustainability programs within architectural curricula? What if those results are then championed by enough educators of sufficient "stature" to get the attention of mainstream architectural education? Then we might be able to change priorities and change studios and change design. That makes sense to me. Walter Grondzik, Florida A&M

- I think, in the future, sustainable design will not be thought of as a style, but as second nature. We should drop the notion of sustainable design as a style and just use the term design. Sustainability will simply become a part of any design thinking. Michael Garrison, University of Texas at Austin

- Economic forces are arrayed against these new design ideas. I have had personal experience with ASHRAE, who are bent on protecting their turf which is the sale of large quantities and sizes of HVAC equipment. Solar design provides an entirely different perspective and this is not being inculcated in Colleges of Architecture or Engineering. It suggests we can do with less, the antithesis of consumption. We all need to be better educated about win-win economic situations where everyone benefits from the result. The transition will have to be gradual. We lack real world successful, functioning examples. They are beginning to appear slowly. If the economics can be demonstrated, then the shift will take place. The implication is that students and professionals will need a broader education because they must influence both clients and policymakers. The playing field is not level at present, and a shift in taxation to waste and inefficiency is badly needed to accelerate the pace of change. We also need to help put performance-based contracts for design services into place to provide the professional incentives to change. Charles Kibert, University of Florida

Summary Remarks by Donald W. Aitken, Ph.D.

As we started on Question No.1, the curriculum, we asked if we can revamp what we have or start over and create new material. Then people started working with the idea that we certainly need more hands-on learning, more models, more real examples, more opportunities for students to experience what it is they're talking about, and what it is they're designing.

In this discussion we are finding an underlying basic demand**: re-thinking of curriculum based upon life, the relationship of that to our health and to the health of the environment, and to the development of the whole person**.

I recently submitted a report to the Department of Energy published by the Renewable Energy Policy Project entitled *Putting it Together: Whole Buildings and a Whole Buildings Policy (REPP Research Report No. 5, September, 1998)* which seeks to redefine all federal research on buildings around a single systems concept of whole buildings. Our discussion here relates to the concept of whole buildings, but we went far beyond that. Now we're speaking of starting from the biosphere and working back down to buildings as an interactive subsystem. Instead of saying that "Here we have a building, now how does it fit into the environment?", we start by first asking how the environment works, and then seeing how our building design can conform to those principles.

I mentioned earlier an organization called *The Natural Step* (TNS) which has had some great success overseas and is gaining recognition in this country. By introducing simple principles of sustainability to corporations, TNS starts out by giving a two or three hour introduction to corporate executives on how the world works, because "we want you to understand that." For example, the world is accustomed to utilizing a certain amount of its own substances and then recycling those same naturally occurring substances. If you increase the rate at which even natural substances are introduced into the world to beyond the earth's capacity to absorb them by natural means, such as mercury, there's going to be problems. Or, if you introduce compounds that are alien to the Earth's natural substances and unfamiliar to the Earth's natural systems, you can expect that there will be problems. If you try to work outside the "solar budget" of the Earth, there will be problems. And if you use the Earth's resources wastefully, and do not distribute them equitably, there will be problems, since the quest for survival will force societies to violate the first three principles.

Those four statements introduce the four TNS "system conditions", conceptually and simply, but they can serve as predictors of potential problem areas arising from our own actions. Negative environmental impacts are not ad hoc societal problems or even simple design issues. They result from violations of the fundamental ways the world works.

More and more I think we're finding here in this discussion that students need to understand how the world works first. And then they must know how to come on down to how we fit with it, what we're doing or designing into that grand scheme — is it consistent with basic principles or not?

A number of attendees here have talked about teaching "outside the box." With regard to viewing energy "outside of the box" I made reference at one point to a building as an energy generator, and to Amory Lovins' concept that eventually you'll have no power plants because vehicles and buildings will together and collectively become the *distributed energy system* that powers everything else — using the building as a mechanism to improve environmental quality, deliver energy, and to clean the water. Instead of having the building solve a design problem, have the building itself be a means to help solve societal problems. An example could be the design goals for the new *Environmental Studies Building for Oberlin College*. (David Orr)

But then Paul Lusk got up and gave his whole list of criteria that went considerably beyond that. And I like the fact that his list of all the things that a building can do to improve the environment included being beautiful. And I thought to myself, yes, it will be beautiful, because what we're finding out is that buildings designed according to these sustainability principles are beautiful. Daylighting is, of course, an incredibly important tool for sustainable design, and it produces incredibly beautiful buildings. We don't even have to say, "Oh, and they are beautiful" or "they need to be beautiful." We're finding more and more that they just turn out to be, because conforming our designs to nature's principles builds nature's beauty into them.
That's a wonderful synergy.

In our discussion on performance tools, I think the problem where we got hung up was on the use of the word "predictive". Performance tools are not predictive tools. When I stand up in front of a workshop for architects, I will say I'm going to teach you how to use *Energy 10* as a design tool, but *Energy 10* is not going to predict the performance of the building you're designing with it, because that would require absolutely all of the exact conditions that are assumed in the *Energy 10* inputs. Instead, it will help you assess the potential performance of the building, help you see and quantify the interacting relationships between variables that affect the performance, etc. I think that discussion got hung up because we were thinking a little bit too narrowly. We tell ourselves to get out of the box, and then we got into an engineering box and narrowed our own perspective.

I had a wonderful time with the story I told this morning because that's what I like to do. The story first was, indeed, that this is the way the world works and then this is what we're doing to the world that doesn't fit with that and, therefore, these are the negative results we can expect and the impacts that we're seeing today. But then I continued the story to show a positive way out, and showed that we're really on the way, that we know how to do things right, and that the right way is practical and realistic. There is a vision out there of a society powered by renewable energy. It's going to be a fabulous society, it can work, it can be done. People can go away from my story, not just with a vision, but with a positive sense that that vision can pull them along.

So the story is incredibly important. But I even mentioned in my own talk that sustainability doesn't give a vision. Going back to what the architect Bill McDonough has said and written, sustainability is only a bridge between destruction and regeneration, so it is not an end in itself.

And when I showed the image of the woman with the Earth in her womb and the picture of the child hugging a tree, it was to go beyond sustainability to say that we have a responsibility for regeneration. Isn't that a wonderful challenge? It's a great opportunity. Of course, sustainability is one of the criteria that must be met in order to provide for regeneration. But regeneration captures the spirit and draws on our ethics.

I liked the basis for the story told by other attendees here that the industrial world is coming to an end, and they therefore asked what should the positive, compelling vision be, and how are our designs expressions of that vision? (You're going to see I'm quoting many of you here.) I agree that we need exemplary building examples. It's really very important for people to be able to see them and to experience them. And if an architect does really good work, I think it's wonderful for students to listen to that architect talk about it. And if they admire the work of that architect, I think that too is fine. For a while I felt in the discussion today that it was somehow negative for an architect who does good work to be seen as a "star", and that if you're a star then maybe you shouldn't talk to students. I disagree. I think there's a lot to be learned from listening to each other.

I believe that buildings tell their own story, and the moment I say that, I think it's incredibly important to be talking about historical architecture and vernacular architecture, about bioregional architecture and bioclimatic architecture. The buildings that we've been building for centuries and even for thousands of years tell their own story about how to do bioclimatic design. For example, the Anasazi Indians liked to be comfortable. The pioneering work that Professor Ralph Knowles did in his analyses of the cliff dwellings showed that they were designed to deliver interior temperatures of around 20 degrees Centigrade for most of the year, summer and winter, because the designers and inhabitants found this to be a comfortable temperature, as we do. There's a whole lot to be learned from those kinds of examples.

Bill McDonough gave a talk recently that I attended, and he reminded us that we're seeking "sustaining" design. Maybe we ought to use the word "sustaining" instead of sustainable. And when he talked about our obligation to the future, he suggested that we enact a "Declaration of *Interdependence* — life, liberty and the pursuit of happiness, free from *intergenerational* tyranny." When you pass bad buildings, nuclear power plants and toxic waste to future generations, that's intergenerational tyranny. And then Bill reminded us that we are the seventh generation from Jefferson's time when the Declaration of Independence was written. This is a significant time for us.

David Morris of the *Institute for Self Reliance* gave a luncheon talk at the National Bioenergy Conference just a week ago, and he quoted Bertrand Russell. I was looking at my transcription of that quote at the very moment that Jean Gardner mentioned David Morris here. Bertrand Russell noted the distinction between change and progress. He said, "Change is inevitable, while progress is problematic. Change is scientific, while progress is ethical. Change will come about whether we will it or not. Progress will be achieved only if we make rules that channel scientific genius and entrepreneurial energy and investment capital in directions compatible with our values. So everything subserves our values." And I tried to put that in this morning, too, and to

say that's how we need to start viewing even energy use, too. That was my primary focus when I was talking from the standpoint of the value of the energy service we're getting, rather than of the amount of energy that we use.

There was a question here today of integrating with the Earth's systems. I was thinking at that time that we used to talk about taking responsibility for resources from cradle to grave. Now we say from cradle to cradle, and just at that moment Jean mentioned that to everyone. That concept is really important. We're talking about designing buildings these days that are durable. And we're talking about designing buildings into which we specifically build in ways to dismantle them – not to demolish them but to easily dismantle them. So first we try to make them adaptable to changing user needs, but eventually we can dismantle them so that all the building materials can be used to make new buildings. This is a cradle to cradle concept.

You're first concerned about the materials you use for the building, but then you're concerned about those materials lasting beyond the useful life of the building, but not beyond their own useful lives and therefore being available for reuse, so demolition and throwing away should no longer be part of the design assumptions. This places an additional responsibility on the designer, of course, but it is necessary for both sustainable and "sustaining" buildings.

I liked the general question posed in the discussion here of who is the audience. The students or the teachers of students? But who are we really addressing in our classes, and here? I like the suggestion made here that we have to be up front and realistic about the inherent conflicts between the social, economic and political implications of our designs. You could see that what I was doing in my talk this morning was really trying to show these relationships.

In particular, my assigned task was to show the relationship between climate change and the social, political and economic consequences, and then specifically to introduce solar energy into today's discussions, to bring solar energy for architects into this discussion, as well. That immediately narrowed my focus. Therefore, I didn't show off-grid homes or country homes. I did show a suburban subdivision designed by a production builder. And to show some of the kinds of solar opportunities in cities, there were parking lots with solar electric shading canopies and high rise buildings with surface-integrated photovoltaics. I realize there's a whole lot left out. Nevertheless that doesn't diminish the importance of the topics I can't cover here in the allotted time.

We're getting important experience out in the field now of how fundamentally and economically important sensory response to buildings is. We have four case examples that I'll just briefly mention here. In daylighting, we know the sensory perceptions are profoundly part of our experience. We are now finding that when you daylight stores and commercial establishments, you sell more products. (Now don't get on my case at this moment about encouraging a consumer-oriented society. That's not the issue for this particular point I want to make.) The point is that people respond to daylit buildings by doing more of what they were supposed to be doing in those buildings, or doing it better.

For example, Wal-Mart divided their Kansas store into two parts, and daylit one half and not the other half, and got 15% more in sales of anything that was in the daylit half. So they're now

designing what they call their Eco-Wal-Mart stores purely for their own commercial benefit. They typically get a one-year payback on increased construction costs just from increased sales, not even accounting for the added economic benefit of saved energy. That shows the type of practical impact from architecture that supports pleasurable sensory perception.

Another example that I've talked about often is daylighting and beauty, and that was the example of the Lockheed Missiles and Space Building 157 in Mountain View, California. Leo Daly Associates designed the building for them, and Lockheed moved 3,000 people into it. After a year there was a 15% reduction in absenteeism because people liked being and working in the building. It was daylit and it was beautiful. Lockheed had predicted a five-year simple payback on added first costs from energy savings, but they got a one-year payback because of the productivity benefit. The energy savings were an economic bonus to the real economic benefits. Those are tangible and measurable economic valuations related to architectural support for sensory perception.

The North Carolina architectural firm, Innovative Design, did an extraordinary analysis of 20 daylit schools in North Carolina, and published papers showing measured improvement in performance by students in daylit schools that they had designed compared to 160 baseline schools which were in culturally and economically similar districts. Our designs don't just house people, they really affect people. You're in a school to learn, in a building to work, in a store to buy. Whatever it is you do, people seem to do it better when the building is compatible with your sensory needs and enjoyment.

My final example is the use of passive solar in low-cost houses. The Nevada builder Paul Neuffer has built over 500 variations of passive solar homes in various tracts near Reno. He had no sign outside saying this is a solar home. People would walk in and say, "Oh wow, it's bright, it's sunny, I really like this, I want to buy this home." And then he'd say, "Congratulations, this is a good choice because it's also going to save you energy, money, be quieter and more comfortable." He estimates that sales increased by about 30% because people just enjoyed the experience of his solar models. So we really should not underrate the huge economic and social benefits we get from the sensory rewards that are integral to buildings designed according to environmental and "sustaining" principles. I couldn't agree more with the thought/question posed to this group telling us not to politicize this as a problem, but just to get this stuff into the mainstream, as the builder Neuffer is doing so successfully.

Another concept that came out in our discussions here is that we're designing for the human body rather than designing an enclosure for the human body. All architects realize that at some level, but often tend to forget that in the design development. When I'm teaching my own design workshops, I start with a picture of a person sitting on a chair, and show the mechanisms of body energy transfers with the world, and I say, "This is what's going on to keep you comfortable, and this is how it's affected by the things around you." So when you design enclosing surfaces to go around you, you must understand how everything around you affects your comfort.

For example, as you're sitting in this room, 70% of your energy loss is by radiation and only 30% of your body heat transfers directly to the air. So what do we do to make you comfortable? We

heat or cool the air, which is about the most energy-inefficient method we can choose. Whenever we can figure a way to control our body radiation losses or gains, it's obviously much more efficient and comfortable. Now, isn't it wonderful that solar energy entering a living space tends to warm masses, like walls and floors, which reduce our radiative losses to surrounding surfaces and help us keep some of our body heat to ourselves? We don't heat the body, we just use architectural design and natural energy resources to help it keep some of its own biologically produced heat. These provide different perspectives that are incredibly useful. You are designing for the body, so your design should be based upon the same principles with which the body interacts with its environment.

Bill Bobenhausen referred here to sustainable architectural design as being a process from “lean to clean to green.” I like that line. And we can we really pull it off! On the paradigm shift, the ethical design is the issue and sustainability is a subset of that. Again I'm quoting what you just heard from yourselves, but I think that's extremely important. This should just be "design." Once society adopts sustainability as a societal goal, and even better than that, adopts regeneration and sustaining design as a societal goal, then the mechanisms to achieve that become mainstream. In this context, what you call sustainable design becomes just "design", or what you call passive solar design becomes just "design", because the concept of design will have been expanded to be all-inclusive.

Back to the question – "Are we educating the teachers or the politicians or the people or the students?" The answer is "Yes." But it makes it rather difficult figuring out how much of this you can or should cover in an architectural school. I was very sympathetic to those of you who are wondering how far can we go in teaching environmental science and political science and so on in architectural schools. We must teach studio. And students have to go out and know how to respond to a program, design a building, stay within the economic limitations and do the engineering. So you can't expect everything to be done in the architectural school, but it's wonderful if you can infiltrate into other departments, and certainly get support from the other departments. Design will follow society's evolving sensitivities – I hope."

(APPLAUSE)

NEXT STEPS

1. Use our world wide web site created for this symposium as a coordinating tool for our continuing efforts *(www.spiderweb.org/globalpossibilities/solarfuture/)*.

2. There are many design schools in the United States that don't have access to any education on solar or any aspect of sustainability. As a group, we represent many years of experience that we could bring to these schools on-line or in person. Through our world wide web site we can coordinate regional efforts to bring sustainability information to these schools rather than flying people all over the United States.

3. Gather knowledge about regional practices and materials based on the ability of materials to conserve energy as well as their local availability in order to cut down on energy used in transporting building materials from one region to another. Jean Gardner, Director, The Earth Group, Co-organizer of Conference

4. Global Possibilities' (GP) will host regional conferences throughout the U.S. to address: *The Impact of Design Practices on Climate Variability – How Can Design Education Help Mitigate Climate Change?* GP will select conference sites as designated by the U.S. Global Change Research Program's (USGCRP) climate change regions. Our first will be the Southeastern Region to be held at the Smithsonian Institution in Washington DC on June 25, 1999. Deans, chairs and professors of Schools of Architecture, Landscape, Urban Planning, Engineering and Industrial Design from 14 states will be included. Casey Coates Danson, President, Global Possibilities, Co-organizer of Conference

- The linking of CAD with energy evaluation is a very important step. In the context of one of the ultimate goals for this group being to reach the necessary audience with information that is measurable, we should establish a set of values and criteria measurements for success in the areas of sustainable design and transform them into a Nintendo game. When the game reaches the eleven year olds and they understand how to win in the game, then you will have communicated to the society what they need to understand, and that's sustainability. Jonathan Friedman, New York Institute of Technology

- My suggestion comes from working with four students to actually construct a house in an urban environment at a site that nobody else wants to work on. This adds a solution to many of the problems of sustainable design: put a hammer in the hands of students and let them go out and start building. The issues of passive solar are fairly easy to teach. They're very difficult to implement in an urban condition, but the rewards are very high. David Fox, University of Tennessee.

- The new generation of young people have been doing CAD and Energy 10 on the computer. When they shape their models guided by an accurate sun dial for the site, you witness the magic of young students seeing their paper model that they're not afraid to play with and tear up and put back together, shaping their models in the sunlight guided by their little sun dial and its peg. The new thing we're doing is very carefully videotaping the results for our

growing international student body, some of whom don't speak English. We're in our sixth year of summers going to Peru to look at how the Incas used the sun. What we're doing is Ralph Knowles type stuff with the Inca sites and it's very rewarding. I recommend these activities. Brent Porter, Professor of Architecture, Pratt Institute

- I would like to suggest a kind of peer review and the possibility of developing a voluntary certifying criteria for a sustainable or sustaining architecture program within many of our schools. If we don't do this, someone else will be regulating us. Leading to that we might try some peer review. The document that comes out of this meeting could be disseminated to us for review and sent back so we have a peer review system going, and maintain the network between us and bring others in. Also, a newsletter, certainly would help tenure if you could publish in the Journal of Sustainable Design which we could invent right now. Look at funding for projects. Look also at curriculum. Robin Freeman, Merritt College

- I'd like to recommend using sun machines. One of the problems is getting a hold on the assumption because there's no place you can buy one right now that I know of. At Auburn we have developed a sun machine which is conceptually very clear that we're trying to make available to all the schools and all the science museums and need funding for. Norbert Lechner, Auburn University

- I suggest that any curriculum we develop also be directed at post professional education. There is a need for this. When architectural firms express an interest in practicing new technology, they don't have a place to go to learn it. Whatever becomes of the proposed curriculum, should also be considered for post professional use. Hillary Brown, Columbia University

- I have my students do an ecological redesign of their own living space. Often they say, I don't own the space or it's an apartment building and apartment buildings are ugly, you can't do anything. But I found that it's very successful. By the time the semester is over and they've done the redesign, it brings it home to them literally. They start to realize where their water is coming from, etc. People might want to consider doing a similar personal space project with their students. Skip Wenz, San Francisco Institute of Architecture

- Engineering through the National Science Foundation funding over the last five or seven years has essentially reinvented itself in many ways. Mechanical engineering, of course, has had a history of design, although it's more about optimization than anything else. But at Cornell, a group of mechanical engineering faculty created the Engineering Design Studio of the Future. They invited the Department of Architecture to help in a variety of ways. Architecture faculty actually designed the space and then taught as guest lecturers on design. This process has broadened the engineering faculty's view of design. The most recent development is that the architecture faculty is now teaching engineering students in civil, environmental and mechanical engineering, as a first year studio which will become a major in design within the college of engineering. My suggestion is that architectural faculty in other schools get together with engineering faculty and see what happens. Kent Hubbell, Cornell University

- I teach a field course on forestry and forest products with a colleague who is an ecologist with ecology and design students. We actually go out and look at the forest, mills, and

construction sites, look at where they sell the forest products and buildings where they use forest products. We work with engineers and environmental engineers. We've tried to set up a consortium of environmental studies programs in the San Francisco bay area. Cross fertilizations like San Jose State and ours have worked out very well because people really get a kick out of working with each other in a professional model, where they've got landscape architects, every kind of science involved and lawyers and designers. Sadly, there aren't architects involved so we need to have architects in that. Robin Freeman, Merritt College

- I suggest that the next time this happens, there should be some landscape architects here. Carol Franklin probably has a better understanding of site than most of the architects in the world. Ed Dorsa, Virginia Tech

- How about interior designers and industrial designers? Susan Szenasy, *Metropolis*

- Two points. One, have debates between people of different disciplines that do not agree about what is the best solution. On one hand, obviously, collaboration is a great thing, but on the other, setting up a constructive, but confrontational debate between people of different disciplines is actually an incredible experience. Two, as far as getting architects to reach out beyond their usual boundaries, some very interesting possibilities are the legislation, Model Inter-Surface Transportation Efficiency Act. It's just been renewed as TEA-21.

  Specifically, it allotted a percentage of all transportation funding for local enhancement funds to be locally determined, not determined by Washington DOT. It's been an area where architects, landscape architects, and artists have become involved in not allowing the infrastructure systems of water and waste only be designed by engineers. Now other people besides engineers can be involved in making public places out of the systems of waste, water treatment, etc. This is a very fertile area, one that students can get really excited about when you pose these responsibilities. Ellen Dunham-Jones, MIT

- I would like to ask Michelle Addington to write and publish on the web a guide that a student could use to really do design thinking in terms of energy transformations so that they could take it into any problem they had and think clearly about how to evaluate the energy transfer. Charles Burnette, University of the Arts

- I teach in the University of Oregon's School of Architecture and Allied Arts which includes planning, fine arts, and landscape architecture. Our students, inspired by a really successful regional law conference called Land, Air and Water have started their own Eco Design Arts Conference which has gone on for four years. It's become a very successful regional gathering that focuses on how the whole design arts community can address issues of sustainability. It brings in people both regionally and nationally. It's all been student initiated and very successful. Rob Pena, University of Oregon

- One of the things we have done is gone into the high schools, both inner city schools and private schools. Because design literacy is not taught in any U.S. high school that I know of, you can't get into the high schools through the principal's office. We found that biology

teachers and science teachers love learning about sustainable design. These teachers and high school students, especially members of ecology clubs, come on our field classes. Getting them interested in sustainable design is working like a charm so far, especially because we take them out on boats and stuff. As long as it's a life threatening situation they'll pay attention. Robin Freeman, Merritt College

- I have a suggestion that we put everybody's picture on the web site. Two years from now when we reconvene we can recognize each other. Also, I just wanted to mention that Martin Luther King Jr. High School in Berkeley has a very successful gardening program and the students there are building structures and doing an organic garden led by a couple of community people. You see kids eating vegetables in this program and you know how hard it is to get kids to eat vegetables. Skip Wenz, San Francisco Institute of Architecture

- My suggestion is that we make this face-to-face meeting resonant to and reverberate over the internet so that we can take what we know and have struggled with for so many years and actually make it available to other schools. We will be sending around a transcript of today's discussion for comment, clarification, and editing in order to develop, as a group, a statement on the current state of sustainable design education in the United States. This statement could also be a way of approaching schools not represented here with practical suggestions about how to support sustainable design in their school. For instance, we could develop courses about sustainability on line through the symposium web site. We could establish regional groups to identify local teachers in sustainable design who could be guests in schools that don't have faculty knowledgeable in this area. We could develop educational materials on sustainable design that we can all use. The European Union supported the development of such materials that were given free to 300 schools of architecture in the member nations. Perhaps, the U.S. Department of Energy, who helped fund The Cooper-Hewitt "Under the Sun" exhibition could support this effort. Also, The Natural Step (TNS) is an organization that is of interest to our efforts. TNS grew out of the efforts of Swedish scientists to take what they knew about how the Earth works and condense this information into what ended up to be, in effect, basic scientific principles for survival. They arrived at their agreement through many iterations of their ideas. Perhaps we can put together something similar, a "disjunctive synthesis" of criteria for sustainable design and procedures for its assessment because as Casey Coates Danson said earlier, this is what we owe to the seventh generation beyond our own. The statement would be the *declaration of the design profession for a sustainable future*. Jean Gardner, Director, The Earth Group, Co-organizer of Conference

SUGGESTED RESOURCES: TEACHING SUSTAINABLE DESIGN

Note: *There are many resource lists available on the subject of sustainable design. This list has been edited to avoid redundancy and for immediate relevance to teaching sustainable design in the context of climate variability. World Wide Web addresses subject to change: If a web address doesn't take you where you want, use the search engines to find what you are looking for.*

Academic Programs/Curriculum

Architecture & Urban Design
UCLA School of the Arts and Architecture
Contact: Murray Milne, Professor, UCLA
http://www.aud.ucla.edu

Center for Construction and Environment, University of Florida
CSR Rinker Professor/Center Director
Contact: Charles J. Kibert, Ph.D., P.E., University of Florida
http://www.bcn.ufl.edu/sustainable

Center for Regenerative Studies
California State Polytechnic University, Pomona, California
A shared vision of designers, scientists, and educators dedicated to restoring and preserving the planet. The Center for Regenerative Studies is a university-based setting for education, demonstration and research in regenerative technologies – the collective means of using solar energy, reusing water, maintaining the fertility of soils, growing a variety of foods without pesticides or chemical fertilizers, recycling wastes, and providing shelter compatible with existing environments.
http://www.csupomona.edu/~crs/

CERES – Center for Energy Research/Education/Service
Ball State University
The Clustered Academic Minors in Sustainable Practices is an interdepartmental program built around discipline-specific electives and anchoring courses followed by a shared educational experience using a closing course entitled "Creating a Sustainable Future."
Contact: Robert J. Koester, Professor of Architecture, Director CERES
http://www.bsu.edu/provost/ceres

Design Education in the Age of Sustainability
World Wide Web site for Global Possibilities' Educational Initiative for Sustainable Design Education
Casey Coates Danson, President, Global Possibilities
310–656–1970 fx: 310–656–1959
casey@globalpossibilities.org
http://www.spiderweb.org/globalpossibilities/solarfuture/

EASE – Educating Architects for a Sustainable Environment
The EASE Project website features dozens of recommendations and implementation strategies, as well as model curricula for sustainably oriented approaches to architectural education, as well as numerous links to related issues.
Contact: Marvin Rosenman, Ball State University
http://www.ease.bsu.edu

The Michael Kalil Center for Smart deSign
Department of Architecture, Parsons School of Design
The New School University, New York, NY 10011
Contact: Jean Gardner
212–662–8516
gardnerj@newschool.edu
http://www.spiderweb.org

SUSTAINABILITY IS AN ARCHITECTURE
This essay has been used as part of introductory course materials distributed in a fourth year design sustainability studio which has been taught for several years and the presentation is framed by the NAAB accreditation criteria.
Contact: Robert J. Koester, Professor of Architecture, Director CERES
Ball State University
http://www.saed.kent.edu/~archeds/rkoester.html

Vital Signs
This Curriculum Materials Project addresses a secret life of buildings, one related to physical performance. Think of a building that has been a source of architectural inspiration for you. How much do you know about the physical environment it creates? Its amenities as viewed from an occupant's perspective? The energy it consumes?
http://www-archfp.ced.berkeley.edu/vitalsigns

Note: See www.spiderweb.org/globalpossibilities/solarfuture/ for specific courses and syllabi.

Climate Variability

Cities for Climate Protection
We are a campaign of the International Council for Local Environmental Initiatives (ICLEI), which encourages cities to reduce local emissions of carbon dioxide, other greenhouse gases which contribute to global warming (climate change), and related air pollutants. Over 295 municipalities have joined the campaign and their number is growing. This website gives you a tour of the climate issues as it affects urban areas, and illustrates actions you can take as a citizen or local elected official. ICLEI is an association of local governments dedicated to the prevention and solution of local, regional, and global environmental problems through local action.
http://www.iclei.org/co2.html

Global Warming and Human Health
Global warming may have grave consequences for the future control of disease. The current warming trend is likely to increase the exposure of millions of people to new diseases and health risks. Droughts, floods, storms and fires directly cause death and injury. Floods also create breeding grounds for insects carrying diseases and can contribute to the contamination of drinking water. Heat waves and winter storms can cause cardiac and respiratory deaths. Current models project that by 2050, many major cities around the world could be experiencing up to several thousand extra heat-related deaths annually, independent of

any increases due to population growth. Children, the elderly and the poor will be most vulnerable to the human
health effects from global warming.
http://www.essential.org/orgs/Ozone_Action/gwhh.html

Intergovernmental Panel on Climate Change
U.S. Coordination Office
Vulnerability to Climate Change – The Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to asses scientific information about climate change relevant for international and national policy formulation.
Richard Moss, Head
400 Virginia Avenue, SW, Suite 750
Washington, DC 20024
202–314–2225 fx: 202–488–8678
ipcc@usgcrp.gov
http://www.usgcrp.gov/ipcc

Regional Climate Centers
The National Climatic Data Center's Regional Climate Centers Program was developed to meet local and regional needs for climate data, research-based information, and expertise. A nationwide network of six regional centers provides convenient and timely access to accurate and reliable climate information. These centers also monitor and report current climate conditions in the regions they serve. The expertise and data resources of the Regional Climate Centers are available to assist in interpreting present conditions, quantifying climate variability, and assessing the likelihood of extreme weather events that often produce major social, economic and environmental impacts in a region.
http://met-www.cit.cornell.edu/other_rcc.html

1. Southern Regional Climate Center
Texas, Louisiana, Mississippi, Arkansas, Tennessee, Oklahoma
http://www.srcc.lsu.edu/

2. Northeast Regional Climate Center
Serves the 12-state region that includes: Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia.
http://met-www.cit.cornell.edu/nrcc_home.html

3. Midwestern Climate Center
Kentucky, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri
http://mcc.sws.uiuc.edu/

4. Southeast Regional Climate Center
Alabama, Georgia, Florida, South Carolina, North Carolina, Virginia
http://water.dnr.state.sc.us/climate/sercc/

5. High Plains Climate Center
Kansas, Colorado, Nebraska, South Dakota, North Dakota, Wyoming
http://hpccsun.unl.edu/

6. Western Regional Climate Center: Alaska, Hawaii, California, Oregon, Washington, Idaho, Montana, New Mexico, Arizona, Utah, Wyoming, Nevada
http://www.wrcc.sage.dri.edu/

State by State Impacts of Global Warming
http://www.epa.gov/globalwarming/impacts/stateimp/index.html

U.S. National Assessment
The Potential Consequences of Climate Variability and Change
Michael MacCracken, Executive Director
400 Virginia Avenue, SW, Suite 750
Washington, DC 20022
202–488–8630 fx: 202–488–8681
mmaccrac@usgcrp.gov
http://www.usgcrp.gov/

U.S. Global Change Research Program Coordination Office (USGCRP)
USGCRP research is organized around a framework of observing, documenting, understanding, and predicting global change; assessing the consequences of these changes and the vulnerability of human and ecological systems to their potentially adverse impacts; and developing the tools and capabilities to conduct integrated assessments to synthesize and communicate this body of knowledge.
David Goodrich, Executive Director
400 Virginia Avenue, SW, Suite 750
Washington, DC 20024
202–488–8630 fx: 202–488–8681
goodrich@usgcrp.gov
http://www.gcdis.usgcrp.gov/

For additional USGCRP activities,
Global Change Research Information Office (GCRIO)
1747 Pennsylvania Avenue, NW, Suite 200
Washington, DC 20006
202–775–6607 fx: 202–775–6622
help@gcrio.org
http://www.gcrio.org/

Washington, DC: Global Warming: Our Nation's Capital at Risk (report)
By Dr. Janine Bloomfield and Sherry Showell – May 1997
http://www.edf.org/pubs/reports/dcwarm.html

News and Reports

e design online and the **Florida Sustainable Communities Center**
Larry Peterson, Florida A & M
http://edesign.state.fl.us/fdi/newlook/index.html

e-EFFICIENCY NEWS
The latest inside news on energy-efficiency research, policy, and events, an electronic newsletter published by the Alliance to Save Energy, a Washington, DC-based nonprofit. e-FFICIENCY NEWS will alert you to newly published reports, invaluable web sites, and eye-opening facts about energy efficiency and beltway happenings. Take a look at the debut issue, and if you like what you see, you can sign up to receive the bimonthly newsletter via e-mail free of charge.
www.ase.org/e-FFICIENCY

Global Change Electronic Edition:
Select Newspaper Citations Related to Global Change
http://www.globalchange.org/infoall

GreenClips
GreenClips is a summary of news on sustainable building design and related government and business issues published every two weeks by email.
Architectural researcher and environmental consultant, Chris Hammer of Sustainable Design Resources, publishes *GreenClips* in San Francisco. Ms. Hammer helps planners, developers, building owners, designers, builders, and facility managers practice sustainable planning, development, building design, construction, and operation.
http://www.greendesign.net/greenclips/index.html

Green Design Network
A searchable database of green building resources, newsletters and publications on green building from sources including Rocky Mountain Institute and Lawrence Berkeley Laboratory, regional resource guides for California, the Yellowstone Region and more**.**
http://www.greendesign.net

Land Use: Instability in Earth and Human Systems
Understanding Land-Use Change: Cutting Edge Research and Application
One of the most pervasive aspects of human induced change involves the widespread transformation of land through efforts to provide food, shelter, and products for our use. Land-use change is perhaps the most profound result of human actions because it affects so many of the planet's physical and biological systems. Organized by Richard Haeuber, Ecological Society of America
American Association for the Advancement of Science
202–326–6450
confinfo@aaas.org
http://www.aaas.org/meetings/Scope/99/program/inssyn.html

Our Changing Planet: FY99 Edition (abstract)
A report to Congress supplementing the President's FY99 budget, pursuant to the Global Change Research Act of 1990. The report describes the U.S. Global Change Research Program (USGCRP); presents highlights of recent and ongoing scientific research on key global change issues; presents highlights of current developments in integrating activities supported by the USGCRP; outlines a National Assessment of the Consequences of Climate Change for the United States, initiated as a core USGCRP activity; and provides a detailed view of the FY99 USGCRP budget,
including FY99 program components and program highlights by agency.
http://www.gcrio.org/ocp99/toc.html
For Additional Publications and Resources:

U.S. Global Change Research Information Office
User Services
2250 Pierce Road
University Center, MI 48710
517–797–2730 fx: 517–797–2622
help@gcrio.org
http://www.gcrio.org/

"A Powerful Opportunity: Making Renewable Electricity the Standard" Union of Concerned Scientists (UCS) has just released this new energy report, that finds that the US could increase the amount of electricity from renewable energy sources to about 10 times current levels over the next 20 years, and still see a 13 percent decrease in electricity prices. This and other energy reports are available at *http://www.ucsusa.org/energy/*

"The Sad State of Architecture in America"
Walter Grondzik, Florida A & M University
http://www.state.fl.us/fdi/edesign/news/9711/pwf.htm

Smart Growth: $mart Growth Press
$mart Growth Network in partnership with the Sustainable Communities Network (SCN)
http://www.smartgrowth.org/

Organizations

Center for Maximum Potential Building Systems
Mission – a non-profit education, demonstration, and research organization with over 70 years combined experience in the application of appropriate technologies and sustainable design practices to meet the needs of a broad range of users, from individual home builders to regional planning and natural resource agencies.
Contact: Pliny Fisk, III, Co-Director
http://www.cmpbs.org

Development Center for Appropriate Technology (DCAT)
Mission – for the purpose of supporting the development and use of sustainable approaches to meeting human needs through the appropriate use of technology. We know that today's complex problems cannot be solved by using technology independent of its context. To be appropriate, technology must be connected to the place, resources, economics, culture, and impacts of its use. We carry out our work in that larger context through a variety of interrelated projects based on principles of education, leadership, leverage, and synergy.
Contact: David Eisenberg and Joelee Joyce, Co-Directors
P.O. Box 27513, Tucson, AZ, 85726–7513
520–624–6628
http://www.azstarnet.com/~dcat/

The Natural Step (TNS)
Mission – to train business, government, educational and community leaders in natural systems thinking and planning so that our collective daily actions support the emergence of a sustainable economy in America and throughout the world.
Contact: Catherine Gray, Executive Director
4000 Bridgeway, Suite 102, Sausalito, CA 94965
415–561–3344
http://www.naturalstep.org/

The President's Council on Sustainable Development (PCSD)
Vision – of a life-sustaining Earth, committed to the achievement of a dignified, peaceful, and equitable existence. A sustainable U.S. will have a growing economy that provides equitable opportunities for satisfying livelihoods and a safe, healthy, high quality of life for current and future generations. Our nation will protect its environment, its natural resource base, and the functions and viability of natural systems on which all life depends.
Contact: Marty Spitzer, Executive Director
730 Jackson Place, NW, Washington, DC 20503
202–408–5296
http://www.whitehouse.gov/PCSD

Physicians for Social Responsibility's Environment & Health Program *Purpose* – building a national Environment & Health Network of physicians, public health professionals and supporters working to promote a safe and healthy environment and ensure a sustainable future for all.
http://www.psrus.org

Rocky Mountain Institute (RMI)
Mission – to foster the efficient and sustainable use of resources as a path to global security. RMI focuses on energy, transportation, green development, water and agriculture, economic renewal, corporate sustainability, security, and communications.
Contact : Amory and L. Hunter Lovins
1739 Snowmass Creek Road, Snowmass, CO 81654
970–927–3851
http://www.rmi.org

Second Nature
Mission – a nonprofit organization providing education professionals resources to make the integration of environment sustainability thinking "second nature" to higher education.
http://www.2nature.org

Society of Building Science Educators (SBSE)
Purpose – an association of university educators and practitioners in architecture and related disciplines who support excellence in the teaching of environmental science and building technologies. SBSE recognizes that the fields that comprise environmental technology are evolving rapidly and such changes fuel a need for constant renewal among teachers of environmental technology.
Contact: Walter Grondzik, President-Elect, Florida A&M University
gzik@polaris.net
http://www.polaris.net/~sbse/web/

Solar Design Associates (SDA)
Description – SDA is an interdisciplinary group of dedicated professionals working to create a sustainably built environment. SDA offers services in environmentally responsive building design, the engineering and integration of renewable energy systems and product and technology development to private, commercial, utility, and research clients worldwide.
Contact: Steve Strong, President
Solar Design Associates, Inc., Harvard, MA 01451–0242
978–456–6855
SDA@solardesign.com
http://www.solardesign.com

Union of Concerned Scientists (UCS)
Mission – to advance responsible public policy in areas where science and technology play a critical role. UCS conducts technical studies and public education, and seeks to influence government policy at the local, state, federal, and international levels.
Contact: Michelle Robinson, Senior Advocate
2 Brattle Square, Cambridge, MA 02238–9105
617–547–5552
http://www.ucsusa.org

University Leaders for a Sustainable Future (ULSF)
Leadership for Global Environmental Literacy
One of ULSF's primary focus areas is higher education reform and interdisciplinary curriculum that teaches values, knowledge and skills for environmental literacy and sustainability. ULSF educational services are available for administrators, faculty, staff and students.
http://www.ulsf.org

Worldwatch Institute
Mission – to analyze and focus attention on global problems. Worldwatch is a research organization that draws from a network created through 20 years of global information-gathering. Worldwatch creates many publications including the annual State of the World.
Contact : Christopher Flavin, Senior Vice President
1776 Massachusetts Avenue, NW, Washington, DC 20036–1904
202–296–7365
http://www.worldwatch.org

Energy Design Tools

Energy-10
Passive Solar Industries Council (PSIC)
1331 H Street, NW, Suite 1000
Washington, DC 20005 USA
202–628–7400 fx: 202–393–5043
http://www.psic.org

SUGGESTED READING

Books

Achieving Our Country by Richard Rorty (Cambridge, MA: Harvard University Press, 1998)
Drawing on figures such as Walt Whitman, John Dewey, Abraham Lincoln, Irving Howe, Herbert Croly, and Harold Bloom, Rorty conjures an inspiring vision of a left that reconciles economic and cultural progressivism and becomes once again a participatory, progressive, and relevant force in American politics.

Anasazi Architecture and American Design contributor Paul Lusk, “Anasazi – Pueblo Site Design: Application to Contemporary Urban Development" (Albuquerque, NM: Morrow, Baker 11, and V.B., Price, editors. UNM Press,1997)
The learning process must be based on long term well-being of all life and multiple variations fitting different contexts.

Beyond the Limits D. Medows, et. al. (White River Junction, VT: Chelsea Green, 1992)

Dimensions of Sustainability by Andrew Scott (E & F N Spon, Routledge Inc.,1998)
Sets out to broaden the base of our understanding of the issue in architecture.

Earth in Mind by David Orr (Covelo, CA: Island Press, 1994)
Orr (environmental studies, Oberlin College) describes the problems of education from an ecological perspective and presents principles for re-creating education. He argues that much of what is wrong with the world is the result of inadequate education that alienates us from life in the name of human domination.

Ecology of Commerce by Paul Hawken (New York: HarperCollins Publishers,1993)
Explains how business is the only mechanism powerful enough to reverse global environmental and social degradation. Fundamentally, commerce must be re-oriented from a process of continuing growth without limits to an ecologically centered approach.

Energy and Form: An Ecological Approach to Urban Growth by Ralph L. Knowles (Cambridge, MA: MIT Press, 1974)

Erik Asmussen, Architect by Gary J. Coates (Stockholm: Byggforlaget, 1997)
Describes the architecture of a recently deceased Danish-born architect, with a focus on his designs for the cooperative community in which he lived and worked near Jarna, Sweden.

Factor Four: Doubling Wealth, Halving Resource Use by Ernst Urlich von Weizsäcker and Amory and L. Hunter Lovins (London: EarthScan, 1997)
Sums up the philosophy of Rocky Mountain Institute: live better, pollute and deplete less, make money, harness markets and enlist business, multiply use of scarce capital, increase security, and be equitable and create more employment.

Gentle Architecture by Malcolm Wells (New York: McGraw-Hill, Inc., 1981)
Specific performance criteria that can be used in studios and classes as the basis for envisioning, predicting and then evaluating outcomes, are represented. "All site improvements, at any scale, should seek to: create pure water, store rain water, produce its own food, create rich soil, use solar energy, store solar energy, create silence, consume its own waste, maintain itself, match natures pace, provide wildlife habitat, moderate climate and weather, and be beautiful."

Heating Cooling Lighting: Design Methods for Architects by Norbert M. Lechner (New York: John Wiley & Sons, 1991)
The book was written to help architecture students design energy conscious buildings with a major emphasis on solar design. They learn how to harvest the winter sun, reject the summer sun, and collect daylight all year. To accomplish these goals, the students need a good understanding of solar geometry.

Home Economics by Wendell Berry (San Francisco: North Point Press, 1987)
A collection of essays.

How Buildings Learn by Stewart Brand (Viking Books, 1994)
Buildings that can evolve over time due to sensitive initial design values are far more reusable and sustainable.

Idea of Building: Thought and Action in the Design and Production of Buildings by Steven Groak (Routledge, 1993)
Educators focus on the object, a sustainable environment, rather than the process. Groak looks at the word as both noun and verb. The current focus is too much on the passive, subject aspect of sustainability. The author thinks we should teach process.

LAND MOSAICS: The Ecology of Landscapes and Regions by Richard T.T. Forman (Cambridge, England: Cambridge University Press, 1995)
Animals, water, wind, and people flow at different rates according to spatial patterns common to almost all landscapes and regions. This up-to-date synthesis explores the ecology of heterogeneous land areas, where natural processes and human activities interact in an ever-changing mosaic.

Natural Capitalism: The Proper Use of People and Resources by Paul Hawken and Amory and Hunter Lovins (Boston: Little, Brown, 1998)
Explores conventional economics which came into being when people and capital were scarce, and natural resources were regarded as essentially free and infinite, as compared to now when industrialized societies are reaching a point where increased prosperity is not limited by man-made capital but by "natural capital."

Nature & The Idea of a Man-Made World by Norman Crowe (Cambridge, MA: MIT Press, 1997)

People, Land and Community: Collected E. F. Schumacher Society Lectures edited by Hildegarde Hannum (New Haven, CT: Yale University Press, 1997)
An outstanding collection of talks devoted to the late economist E. F. Schumacher's "small is beautiful" ethic. The Society sponsored lectures by noted scholars and thinkers on problems of land use, agriculture, urban planning, and other eminently practical fields. The 21 lectures gathered here, address Schumacher's call for small-scale economies and policies, a call that the Kentucky farmer-poet Wendell Berry, for one, has made his own. Berry's talk on the need for local production and local consumption, provides the title for the collection.

Power Surge: Guide for the Coming Energy Revolution by Christopher Flavin and Nicholas Lenssen (New York: W. W. Norton, 1994)
Explores the occurring shift in the world energy economy from imported oil and environmentally damaging coal to a new generation of energy efficiency and mass generation of renewable electricity.

Reconstructing Architecture: Critical Discourses and Social Practices edited by Thomas Dutton and Lian Hurst Mann (Minneapolis, MN: University of Minnesota Press, 1996)

Resettling America: Energy, Ecology and Community by Gary J. Coates (Andover, MA: Brick House Publishing Company, 1981)
Describes how (and why) we might create a humanly and ecologically sustainable society based on the principles of cooperative community. With foreword by Amory Lovins.

The Solar Electric House by Steven Strong (White River Junction, VT: Chelsea Green Publishing, 1993)
Provides an introduction to the history and development of PV and uses a series of case studies to detail how PV can power homes both on and off the utility grid.

Sun Rhythm Form by Ralph L. Knowles (Cambridge, MA: MIT Press, 1981)

Thermal Delight in Architecture by Lisa Heschong
Makes a compelling case that thermal senses are under-addressed in contemporary architecture; that design should engage all the senses. Buildings that are truly responsive to environmental forces (sun, wind, light, water...) and human preferences and aversions, will and always have generated unique form. Heschong believes we can look forward to a plethora of beautiful "new" forms through ecological design.

To Heal the Earth: Selected Writings of Ian L. McHarg edited by Ian L. McHarg and Frederick R. Steiner (Covelo, CA: Island Press, 1998)
McHarg has joined with Frederick Steiner, a noted scholar of landscape architecture and planning, to bring forth a valuable cache of his writings produced between the 1950's and the 1990's. The editors have each provided original material that links the writings together and places them within the historical context of planning design work and within the larger field of ecological planning as practiced today.

What are People For? by Wendell Berry (San Francisco: North Point Press, 1990)
A collections of essays.

Additional Articles and Papers

"A Declaration of Sustainability" by Paul Hawken (*Utne Reader*, Sep/Oct 1993)
A plan for recycling (return or resynthesize elements) for all manufactured products including packaging and transportation.

"Architectural Research: A House to Heal the Earth" by Paul Lusk An illustrated paper presented to ASES Conference, Albuquerque, New Mexico, June 15, 1998. Hard copy is available.
Pursuit of performance rather than form can create entirely new, unexpectedly beautiful forms and an enhanced environment rather than just trying to minimize the negative impact.

"Conservation is Good Work" by Wendell Berry (New York: The Amicus Journal, a publication of the National Resources Defense Council, Volume 14, No. 1, Winter 1992)
James Marstin Fitche's; Measure; *Architectural Forum* (November, 1948)

"Energy for Planet Earth" from *Scientific American* (Freeman Press,1991)
Selected readings.

Greening the Building and the Bottom Line by William D. Browning and Joseph J. Romm. (Snowmass, CO: Rocky Mountain Institute, 1994)
Eight documented case studies that show how energy efficient design may be one of the least expensive ways for a business to improve the productivity of its workers and the quality of its product.

John Root's article published in *Inland Architect* (Illinois: June 1890)
As presented to the Art Institute of Chicago.

Small Is Profitable: The Hidden Economic Benefits of Making Electrical Restructuring the Right Size by Amory Lovins and André Lehmann. (Snowmass, CO: Rocky Mountain Institute, 1998)
A comprehensive guide on distributed resources which is an alternative approach to delivering electricity with smaller decentralized power sources, such as photovoltaic panels, wind turbines, and fuel cells.

Solar Electric Buildings: An Overview of Today's Applications from the National Technical Information Service: 703–487–4650

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