John Todd is President of Ocean Arks International (www.oceanarks.org), "a non-profit ecological research, education, and technological development organization founded in 1981 by John and Nancy Todd. Our mission is to purify the waters of the earth, develop strategies for living more lightly on the planet, and foster the emergence of a lasting planetary culture."

See Also: The Restoration Of Waters. John and Nancy Todd have been pioneering in sustainability for twenty years -- and their most exciting work is happening right now. An interview with John and Nancy Jack Todd, by Robert Gilman, *In Context*, Summer 1990.

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John Todd

The New Alchemists

There is another underlying theme, which was borrowed from the teachings of Taoist science, of which I was a student, that is that science not practiced out of a context of sacredness or responsibility was a devil's bargain.

"will you recall for us the origins of the new alchemy institute?"

In the late 1960s there was a strong sense of revulsion against science. A lot of thinking people thought that most scientific activity led to destructive ends -- pesticides, herbicides, the triumph of the industrial culture over nature. It was our feeling, very strongly, that the revulsion was legitimate, but that science needed to be seen in a much more exquisitely whole light, as a science of assembly, where knowledge could be reintegrated around a whole theme of reverse stewardship.

From the very outset, we saw all of science as a kind of pigment in this great canvas we hoped to be able to paint. This canvas had to do with reintegrating society into a genuine partnership with nature. I was a young college professor, promoted too quickly, still in my twenties, to associate dean of 19,000 students. I was made the head of this new Center for Environmental Studies and I was realizing that a university department, for example, wasn't going to change the paradigms. We were talking about fundamental change.

At the time, Nancy Todd, who co-founded New Alchemy Institute with me, and Bill McLarney, a third co-founder, and I, were very taken with the notion that most of the way society goes to try and improve a bad situation is basically to work on the coefficient's structure of the system alone.

Through our friendship with people like Gregory Bateson, we realized that, technologically, we're a completely addicted society. Let's say that we're addicted to internal combustion -- the way we would solve the problem of using too much gas is to make it more efficient. But there was nothing in the society that would allow us to ask the fundamental question, "How would we get around?" The same was true of food production -- using too much energy from halfway around the globe, or simply poisoning the hell out of the planet.

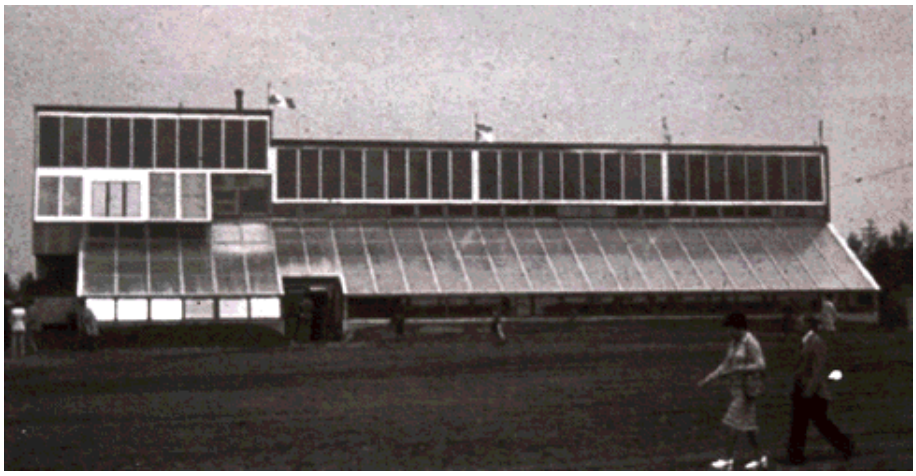
So to make things better, people were saying, "Well, maybe we should use lower impact strategies." But no one was asking the question, "Is the way we raise foods -- shuttling food several thousand miles before it ever reaches the table -- does it make sense?"

New Alchemy was really begun to go back to first principles. There is another underlying theme, which was borrowed from the teachings of Taoist science, of which I was a student, that is that science not practiced out of a context of sacredness or responsibility was a devil's bargain. If you think about it from that point of view, if science were practiced in that context, nuclear power wouldn't have developed the way it developed. I don't think modern society would have developed the way it has developed. So we had to change the rules. There were all kinds of great minds floating around to which one could turn for inspirations.

The name was completely unpremeditated. I was sitting in San Diego and turned to Nancy and said, "It's New Alchemy!" And she said, "Yes." It just sprang up out of the unconscious. So those are the origins, I guess.

We asked ourselves the question: Is it possible to grow the food needs of a small group of people in a small space without harming the environment and without enormous recourse to external sources of energy and materials on a continuing basis? The whole idea was: Could we design a system that is self-sustainable and capable of functioning as a system?

John Todd



Nova Scotia Ark, Prince Edward Island. Opened by President Trudeau in 1976.

Living Machines

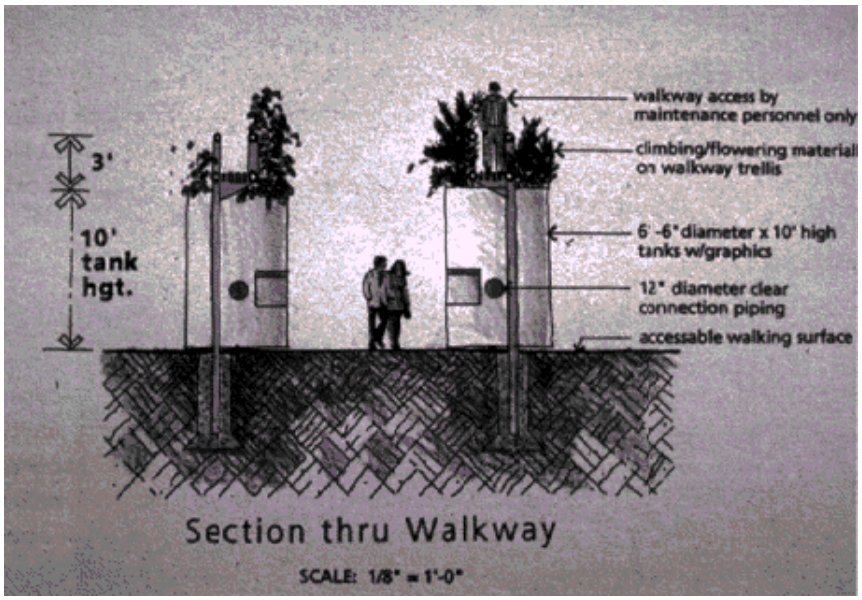
It has been a long journey from the original idea to the sophisticated living machines that we've developed today to provide food, waste treatment, fuels, climate, heating and cooling, architectural integration. All those things that have become possible weren't even visible in the beginning. An enormous amount has happened in this brief span of twenty-two years.

The basic concept of ecological design as being a powerful tool -- perhaps one of the most powerful tools of this century -- had been pretty much proven by the late 1970s. A lot of what had to be done in the 1980s was to prove that these could work in an economy which was not foreign to our time. . . . The bulk of my work has to do with dealing with toxins in the environment, which are damaging to many people.

John Todd

Early experiments in Living Machines, Cape Cod.

There are a series of lessons, which I think led to the development of an ecological science of ecological design. The first lesson was when I was asked by a community in the mountains of Tecate [California], north of the Mexican border, to help them become self-reliant. These were mostly middle-class people who felt that humans were living too heavily on the planet, and they were looking for a lighter Model. Again, very much characteristic of the mood of the times -- a mood, incidentally, which is welcome at any time, but which happened to very dominant then.



A Living Machime promenade coming to your town soon?

So I went out with Bill McLarney, and Nancy Jack Todd, and a group of people to this beautiful site high in the mountains. And these people said, "How can we capture our own energy and recover our own moisture, and are there ways of integrating with this quite difficult, semi-arid place?"

We had degrees and boatloads of academic credentials amongst us. And we stared at this land and realized that we'd been tricked. That our knowledge was abstract. That none of us

could make a piece of the world work. And that was the beginning of the beginning.

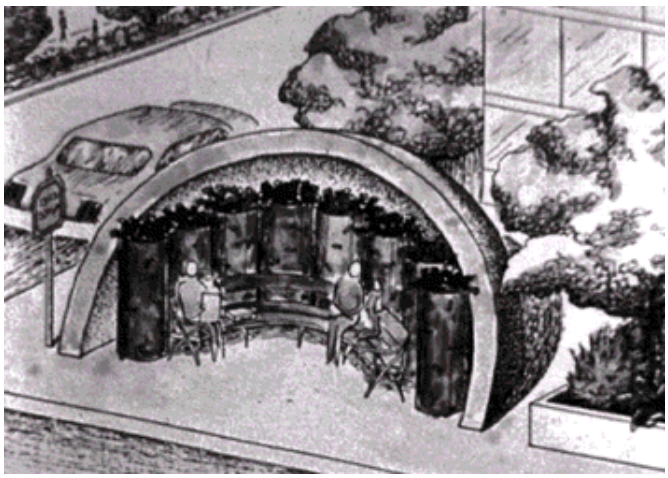
Our response to that experience was to learn all we could about that place, its microclimates, geology, its botany, its zoology. As we studied it, it began to tell us what the latent potential of the area was. Working in that particular spot, we began immediately to move into bodies of knowledge, some of which were thousands of years old, of civilizations that worked with very few resources but did extraordinary things. What did they have? What were their sciences like?

So we looked at stuff going on in the Middle East, and we looked at stuff going on in the ancient native civilizations, and, all of a sudden, this site just simply opened up the whole idea of an earthly science that had to encompass the most advanced ideas and material engineering. We had to know about chemistry, we had to know about light. We had to know about intelligent materials, even about things like artificial intelligence, communication, everything.

The Dream of Balance

But it had to be recast in a new light, this dream of balance. One of the beautiful things about using ecology as a model is this concept of balance, this concept of all kinds of strange things that technologists don't think about, pulses -- day and night, seasons, cold, warm -- how to design all these things so that they dance with each other to create a whole system that self-designs, that becomes intelligent. All of a sudden you are talking about a technology that is alive, a living machine.

So meditating deeply on the question for a while, we began to realize that there is only one model. The one we knew worked over time and had the attributes we were looking for was planet earth. So the very first experiment was to create, much in the fashion of the alchemists of old, a microcosmos, a miniature earth. To do that we had to simulate the dynamic processes of the earth.



Living machine bus stop

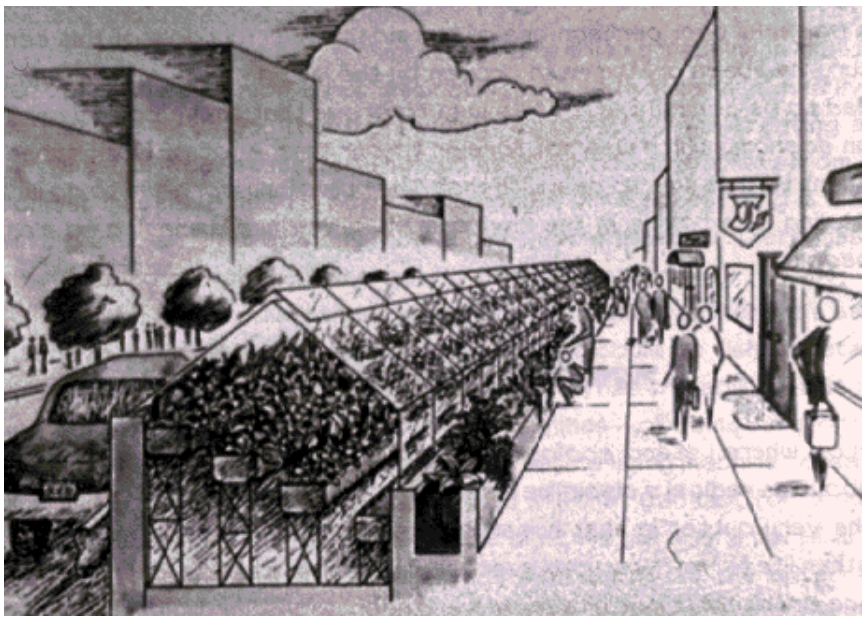
For beginnings, we had to create an atmosphere that is part of this earth. And in order to create an atmosphere we had to think very much in the analogue of the river or the stream.

We had other species, including the one here behind me, which were capable of living off the bottom of the food chain, off the microscopic algae.

The microscopic algae, in turn, were providing the gases to drive this microcosm. Everything about it was global but, again, in the traditional alchemical sense of the world, it was miniaturized. We did not try to literally simulate an ocean. We simulated the ocean's processes. We did not literally try to simulate a river. We tried to simulate the river's processes. This is the difference of what we do and perhaps a lot of what you have seen at Biosphere Two.

Getting back to the whole cycle, the seventy percent water then had to feed terrestrial ecologies thirty percent. Now you can begin to see the water providing not only a climate but providing the nutriment and the moisture for multidimensional terrestrial structures providing fruits and vegetables. Then, as the process began to evolve, the whole idea of dealing with pulses, the great regulators. We began to superimpose on these systems wind engines, which sometimes would blow, sometimes would be still, again, sometimes contributing to the system.

As this science of assembly -- I was trying to get the relation ships right -- came together, a whole series of extraordinary possibilities began to emerge. They were very productive, they were beautiful to be in, and they worked. We didn't set out to try and race and create world records of anything, but along the way these systems began to evolve. They were doing just that. But we always played that down.



Living machines integrated into a public promenade

That original experiment blossomed out into four or five different directions -- into the direction of food, into the direction of housing, into the direction of climate control and regulation, into the direction of waste treatment, and finally into the direction of the whole idea of designing a village which is in fact an ecology.

"in what ways can the discipline of ecological design transform our civilization?"

There was a wonderful gathering that was held in 1980 in which a number of truly wonderful people, including some of the people you've talked to, came to try to visualize this dynamic system that would be alive. It even led to working with sailing ships or ocean arks which were in themselves ecologies designed to take materials that were missing in one part of the world, or where ecologies were degraded.

But the basic concept of design, of ecological design, as being a powerful tool, perhaps one of the most powerful tools of this century, had been pretty much proven by the late 1970s. A lot of what had to be done in the 1980s was to prove that these could work in an economy which was not foreign to our time. A lot of work subsequent to that was to deal with that. The bulk of my work has to do with dealing with toxins in the environment, which are damaging so many people.

Significance of Ecological Design

From where I stand, ecological design and ecological engineering are about as radical a discipline as you can get. Because what they say at the very outset is that human beings are going to be partners with other life forms. Now your average designer in a studio, or your average architect, or your average engineer isn't going to think much of that. But what I am proposing is that ecological engineering has the potential to transform how we run our society.

We define ecological design as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes."
Sim Van der Ryn, Peter Calthorpe

It's possible, using ecological engineering, to create living machines that will generate the fuels we will need in the future, that will transform our wastes, culture our foods, regulate our climate, and integrate our buildings with the larger world. That's an extraordinary thing to say, but it is true. We've already proven it in most of the areas that I just mentioned.

So what's a living machine? How is it designed? What does it look like? It has engineering components. It has material components. It has living components. And they are all completely integrated. The engineering in them is both familiar and different. The ecology in them is completely unfamiliar. The use of materials is familiar to a few people, but is basically unfamiliar -- namely, materials that are intelligent, that change their properties with the conditions around them.

The best way to describe the science of this ecological design that leads to living machines is to say that living technologies have their fundamental power source from the sun, and inside all of them are photosynthetic activities. That's a must, so that there are tiny cells capturing radiant energy and transforming that into growth and gas production. Where it goes from there depends on the needs of the society and the ecological engineer.

The other interesting thing about a real living machine is that it must have, in my opinion, three distinct ecologies. In other words, a living machine -- let's say that's providing foods for you or treating all your wastes, doesn't matter -- has to have borrowed ecology from a

pond, it may have had to borrow ecology from a forest, and it may have had to borrow ecology from a marsh or a meadow. There must be at least three of them interacting with each other.

But if you produce these three, you put them together (let's say you have a machine you want to grow food; it could be fish, vegetables, all sorts of things), [the resulting machine] has the ability -- this is another extraordinary aspect of living machines -- of being very long-lived. There is no reason why you can't create a living machine to, say, produce foods for an automobile, if you will, that can last for thousands of years. All the spare parts are alive. All the spare parts are self-designing. All the spare parts are interacting as the external variables change. One of the things we find about designing these systems is that we can't know a fraction of what they know. That's why I call it a true partnership. I mean, they know more than we do.

What the human ecological engineer does is two things. Say the organism is for waste treatment. When you set up the living machine you don't know what organisms will recombine in the presence of the waste. So you get thousands of different species of organisms from all kinds of different aquatic environments and you seed them preferably every season, or four times a year. They begin to recombine in ways to adapt to your waste. It can be as deadly as hell. They'll figure it out. You can't. But you must honor the system by making sure the cast of characters is there. The other interesting thing about living machines -- and this is the part that particularly the genetic engineering types find very difficult to understand -- is that all the filogenetic levels need to be represented. Not just the bacteria and a little algae, but the higher plants and the trees, the mollusks, including the clams and the snails, the fishes, the vertebrates. They all have to play a role.

Fundamentally you start with the sewer.
The sewer is the background to any plan.

Bernard Maybeck

And it's interesting. The more dangerous the role they have to play, the more ancient the organism. So, when I am working on a Superfund site or a toxic waste site where most of the compounds are carcinogens, the first phase of the living machine -- the organisms that are in it -- are the cynobacteria, the most ancient forms, and the ancient anaerobic, phototropic bacteria, the ones that were here on earth before there was an oxygen atmosphere. The design process is one that has, in part, taken place in the wild and is brought into the this new domestic, if you will, environment.

The other aspect of all of this is the materials. Ninety percent of our thinking is what I call gossamer engineering. This is the kind of thing that Bucky thought a lot about -- membranes, intelligent membranes. I'm much more fascinated by hang gliders and windsurfers and these ultralight phenomena because those, combined, say, with some of the computer-based electronic integration possibilities, are really where the future is going. It's not going to be mass transfer or mass combustion. It is going to be these delicate, intelligent structures. By intelligent I mean able to change their properties so that they are one state when the internal state inside the machine is one way, and they are another state when the external [statel is the other way. That is really the most sophisticated materials chemistry. From our point of view, it's where the action is.

The Benefits of Regenerative Design

The real news in all of this is that if living machines are allowed to develop in the twenty-first century, we begin to break down (and this was what Bucky was getting at) the old inequities between north and south and rich and poor; they don't exist in the same way in this new context.

The tropical world is so poor, and the northern world has some of the mineral resources, the libraries, and knowledge to bring to bear. The arid areas, now so "depoverished," have certain kinds of intelligence that are brought to bear in this age. So living machines actually can do as well in Beirut as they can in Iowa. This kind of concept of an ecological design is breaking down the global inequities. It strikes right at the heart of so much of Bucky's thinking.

We know and have already proven that living machines could reduce the amount of space that humans require by 90 percent. In other words, we could give back the wilderness to itself, by miniaturizing the processes that sustain us. That's extraordinary.

One of my goals would be to give the wildness back to the planet and the humans could then live with relatively little impact on the wild. It would be nice to be able to walk through wilderness from Gape Cod to San Francisco, with a side journey to an elegant, sophisticated city -- maybe a day and a half downwind -- every now and again, when one had the feeling for it. And that is really all possible.