Waste Equals Food - Our Future and the Making of Things
By William McDonough

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If Y2K interrupts business-as-usual, and industry grinds to a halt, will we have any choice in how it starts up again? If in fact we will, then I hope we could incorporate the design principles detailed below. The following is edited from a speech given at the Environmental Forum for Business in April 1997, in Spokane, Washington. Although William McDonough was not specifically addressing Y2K, his thoughts are remarkably pertinent for our consideration. JL

I'm going to talk today about design because I'm a designer. And there's an old joke that when all you have is a hammer, everything starts to look like a nail. Well, as a designer, everything looks like a design problem to me, so today I'd like to talk about design and design problems. And I'd like to be a little bit assertive and perhaps break some new ground here.

I'd like to look at redesigning design itself. It's interesting that I come now from Charlottesville, Virginia, where I live in a house designed by Thomas Jefferson, because we get to think often about Mr. Jefferson at "the University," as we call it. I think that he saw himself as a designer as well. All you have to do is to look at his tombstone, which he designed, and which has three things noted on it. It says "Thomas Jefferson. Author of the Declaration of American Independence. Author of the Statute of Religious Freedom for the State of Virginia." Which matured into the Bill of Rights. And "Father of the University of Virginia."

Notice he's only recording his legacy, not his activity. No mention of being twice President, Secretary of State, Governor of Virginia, Minister to France. Simply recording legacy rather than activity. And if we see that from a design perspective, we realize that when the Exxon Valdez disaster occurred, the GNP measurements of Prince William Sound went up, because there were so many people there cleaning up. So as long as our measuring system simply measures our activity and not our legacy, the instructions to our design, which I see as the First signal of human intention, aren't necessarily the right signals.

So I'd like us to consider a series of what I call "Retroactive Design Assignments," because I'm going to posit that all of the people in this room are also designers, because you all have intentions, you all put them into play. And I'd like to give us some retroactive design assignments.

But the two that I want to float before I go into the body of the talk are: "How can you love all the children?" not just your children, or some of the children but all of the children when you make a design decision. And as an architect I have to also ask this question, "Why can't I design a building just like a tree?" If Jefferson were a designer, what would be the design assignment of the Declaration of Independence? Could you author a document that calls for life, liberty and the pursuit of happiness free from remote tyranny? That would be the retroactive design assignment of the Declaration of Independence. In Jefferson's time, remote tyranny would be represented by a person, George III, for example. Someone who didn't understand local conditions and made decisions that were untenable. Remote tyranny.

I would posit that if [someone like] Thomas Jefferson came back today, she would come back calling for Declarations of Interdependence. And the issue would be the same. How could we have life, liberty and the pursuit of happiness? Can you imagine our current Congress using the word "happiness" in a bill? Life, liberty and the pursuit of happiness free from what I call intergenerational remote tyranny. Because from a design perspective, I think we have a problem in the way we take, the way we make, and the way we use things.

I think Jefferson understood this concept of intergenerational remote tyranny. In fact, I know he did, because in 1789 he wrote a letter to James Madison. In it he said, "The earth belongs to the living. No man may by natural right oblige the lands he owns or occupies to debts greater than those that may be paid during his own lifetime. Because if he could, then the world would belong to the dead and not to the living." The world would belong to the dead.

Oren Lyons, chief of the Onondaga people told me that Benjamin Franklin spoke Mohawk. Jefferson studied the Iroquois Confederacy , and the Iroquois Confederacy was brought together by their Great Peacemaker. And their Great Peacemaker instructed his chiefs that they should make all decisions on behalf of their seventh generation, even if it required them to have skin as thick as the bark of a pine.

I think it's clear that Jefferson was writing the Declaration of Independence for his seventh generation, because it's interesting to note that the people sitting in this room are Thomas Jefferson's seventh generation. We are it. So it's our turn to write declarations of interdependence for our seventh generation.

The founding fathers, in all their wisdom and acuity, would never have given an individual, a company, or a government, the right to slowly poison the planet and kill children. When did we think we had the right to do that? It would never have been put in the Bill of Rights because they would never have imagined that we would even think to do such a thing. Thomas Jefferson lived in a world that was solar-powered. Oil had not been discovered yet.

So we need a retroactive design assignment, and we need to look at some new designs based on ethics, based on ethical principles. This is all about doing good business. Because we need to separate the moral dimension, I think, from our fundamental engine of change, which is commerce itself.

But before I get into the relationship of commerce and design, I'd like you to think about a design assignment for me while I go into this. And I want you to consider whether or not this is an ethical assignment. Am I asking you to do something that's ethical? Could you design an industrial system for this country that produces billions of pounds of highly hazardous toxic material and puts it in your soil, your air and your water every year? Could you design a system of production that measures productivity by how few people are working? Measures prosperity by how much of your natural capital you can cut down, dig up, bury, burn, and otherwise destroy? Measures progress by your number of smokestacks and, if you're especially proud of them, put your name on them? Requires thousands of complex regulations to keep you from killing each other too quickly? And while you're at it, produce a few items so highly toxic that they'll require thousands of generations to maintain constant vigilance while living in terror? Can you do that? Is that an ethical assignment? If design is a signal of human intention, who designed this? Did we intend for this to happen? I don't think

so. I don’t think this is the result of design. This is a result of thousands, millions of tiny decisions based on fundamental self interests that have amalgamated into a retroactive design assignment that’s obviously questionable from an ethical perspective.

So let’s give ourselves a new set of design assignments. Wouldn’t it be wonderful if we could design things that didn’t produce any hazardous material that is put into our soil, our air, and our water? Wouldn’t it be wonderful to measure productivity by how many people are working? Prosperity by how much natural capital and solar income we can accrue and put into closed cycles of investment for future generations? To measure our progress by how many buildings have no pipes? Wouldn’t it be wonderful if we didn’t require regulations at all because we’re not trying to kill each other? If we didn’t produce anything that results in intergenerational remote tyranny?

Basically we’ve seen capitalism, socialism and all the dialogue of where we are in between. And we’ve seen that socialism certainly hasn’t been good for the environment. Russia’s chief scientist has declared that 16 percent of the Russian land mass is uninhabitable. We see that pure capitalism is not good for the environment because its interest is too isolated.

What has been missing is what the chemist Michael Braungart and I call ecologism. We haven’t been factoring the environment into that dialogue. We have three points that have to be accommodated: economy, equity, and ecology. But an ecologistic response would be just as dangerous as a pure capitalist or a pure socialist response. Any "ism" is dangerous. The Germans have an example of this. Look at an ecologistic response from an industrial perspective as a design failure. Watch this slide.

They set up a new recycling system for waste you’ve probably heard of: the take-back law in Germany. If you make something, you have to be able to take it back. And they went to the Tetrapak Company, the people who make juice boxes, those little packages made of plastic, paper and aluminum. And they said, "You must recycle." Ecologism. You must recycle. And so Tetrapak has spent $2 billion building recycling plants to recycle those packages. It’s costing them three and a half times as much to recycle one of them as it costs to make one.

And what are we getting out of these recycled packages? We’re getting flower pots, park benches, building materials. I don’t want plastic and aluminum in my walls. Why are we taking what we would call technical nutrients and burying them in our buildings? The problem is that package was never designed to be recycled. This is way too aggressive a response, to make people recycle something that was never designed to be recycled.

So we have to be careful to balance these three issues of ecology, equity and economy without being extreme in any position. If we’re going to need a new design assignment, we better find out how to work within the natural world that we inhabit. I was asked by the city of Hannover, Germany in 1991 to write the design principles for the World’s Fair for the year 2000. They’re called The Hannover Principles and we can get copies for you if you’d like them. In it we explore the question of the relationship between humanity, nature and technology, the theme of the World’s Fair.

The first question is, "What is Nature?" And if we go back in history, we can see Emerson effectively asking the question in 1836: "If human beings are natural, are therefore all things

made by human beings natural?" And his conclusion was that nature is all those things that are immutable, things that are too large for humans to affect, in his words, "the oceans, the mountains, and the leaves." I think Thoreau understood, and we now understand, that we can indeed affect the oceans. Just ask Jacques Cousteau. We can indeed affect the mountains. Just look around. And we can indeed affect the leaves. Go to the Adirondacks.

We realize that perhaps we have been given a kind of dominion over nature. There's been a debate about how unfortunate it was that Genesis talks about God giving humans dominion over the world. People ask, "Isn't it too bad it wasn't stewardship?" I would have to posit, isn't stewardship implicit within dominion? Because how can you have dominion over something you've killed? And ultimately the question is perhaps the Native American question, which is not really even stewardship, because that's still anthropocentric. Perhaps the question is, how do we find ourselves in kinship with nature? How do we find ourselves as part of nature? How do we find a rightful, meaningful place within nature?

What is design? If design is the First signal of intention, what is our intention? What designs do we have? Let's look at Emerson again in the 1830s. He went to Europe after his wife died, and he went over on a sailboat and returned in a steamship. Now let's abstract this for fun. He went over on his solar-powered recyclable craft operated by craftspersons practicing ancient arts in the open air. And he returned in a steel rust bucket, putting oil on the water, smoke into the sky, operated by people working in the darkness, shoveling fossil fuels into the mouth of a boiler.

These are designs. And guess what? We're still designing steamships. We are in a steamship right now. The sun is shining out there and we're in here, producing nuclear isotopes, carbon dioxide, chewing up rivers. And we're sitting in the dark for all intents and purposes. So from a design perspective we are still in the dark, shoveling fossil fuels into the mouth of a boiler. We need a new design.

Who is going to do this? Us. All of us. We're all designers here. Peter Senge at the Sloan School of Management at MIT has something called a learning laboratory where they study how organizations learn how to learn. And within that he has a leadership lab where they bring in CEOs, Chairs, and so on, and his first question to them is, "Who is the leader on a ship crossing the ocean?" Everybody comes back with captain, navigator, helmsman, chef. And he says, "No. The leader on a ship is the designer of the ship." Because you could be the best captain in the world, but if the ship isn't designed to be seaworthy, and you get caught in a storm, you're going down. His point is that leaders must become designers. Designers must become leaders.

What I'm talking about here, I'm going to be a little aggressive. I am not talking about eco-efficiency. The thing that separates me, I think, from all of my colleagues is that I'm actually not that interested in eco-efficiency. I think eco-efficiency's wonderful and it's very important, but ultimately I'm focusing on the design assignment. And so I'll be a bit strident about this.

If we look at the development of species, we realize that nature is not efficient. Everybody talks about how we should model ourselves on nature because it's so efficient. I even get written up as a person who models his designs on the efficiency of natural systems. But

nature’s not efficient. Nature’s effective.

I took a walk this morning with Dave Crockett onto your fairgrounds over here and we walked by a cherry tree in full bloom. And I thought about it and I said, "I’m going to talk about this tree this morning." I don’t look at that tree and wag my finger and say, "Boy, are you inefficient. Look at all those cherry blossoms." You know, "How many does it take?" The thing that’s nice about nature is that it’s safe. We don’t care if there’s a lot more blossoms than necessary. Nature is abundant. Nature celebrates itself. Nature is beautiful because it’s effective, not efficient. But everything it makes is safe and it returns to the soil. It returns to natural cycles, so, we’re not afraid of it. Humans are trying so hard to be efficient because the stuff we make is typically so dangerous, you have to be efficient about making it.

Look at all the men in this room. A hundred million sperm in each one of you, just in case a couple of them get lucky. You’re not very efficient. So I’d rather celebrate the world as a world of abundance, rather than a world full of limits. When I gave the closing address to EPA, for their 33/50 program on voluntary toxic reductions, I was standing there with some of our clients. And they were getting awards for 90 percent reduction of toxins over five years, for example. And I said, "The only problem with this from a design perspective is that we’ve got Zeno’s Paradox here." Zeno’s Paradox is about the fact that an arrow on its way to a target can always been seen as being halfway there. You can always say, "Stop. Freeze frame." The arrow can be halfway to its target at any given moment. Therefore, it never gets there. That’s the paradox. Because it can always be seen as halfway at a certain point in time.

In a way, eco-efficiency has a similar built-in paradox. Because now that you’ve got your reduction by 90 percent, guess what? You’ve got a new 100 percent. You’re never going to reach your target. At the same time, we’re starting to see EPA changing its regulations to start to focus on safe levels for children instead of adults because children are not small adults. They have different surface to volume ratios. They breathe through their mouths and not their noses. Things get directly to their lungs without being filtered, and so on. And all of a sudden we realize, also, that microscopic particles of man-made materials are now causing questionable effects in our endocrine systems; that parts per billion, even parts per trillion seemingly infinitesimal amounts of these things can cause serious problems. And so the question has to be, "Why are we making these things in the first place? Can’t we really redesign?

I like to use Dave Crockett’s driving analogy to illuminate this point. When I leave Charlottesville, I can go north to Washington or I can go south to Lynchburg. If I find myself going 100 miles an hour toward Washington, but I’m supposed to be going to Lynchburg, it’s no help to me to slow down to 20 miles per hour. Because I’ll still be going in the wrong direction. I have to turn around.

What I’d like to do is talk about that turning around. I’d also like to look at the issues of energy and mass. Remember Einstein’s equation had two sides: $E = mc^2$. I think we’re going to solve the energy problem because we do have current solar income. I don’t think we’re going to solve the mass problem: the problem of the loss of genetic information and the problem of persistent toxification. There are 500 manmade chemicals that nature never saw before that are in our fatty tissue and in the fatty tissue of animals all over the planet

including Antarctica. This is something we will not be able to change, certainly not within thousands of lifetimes. It's persistent. It's pernicious. It's bioaccumulative. And we are doing a mass experiment that we have no idea how to stop.

If we're going to need design principles, what would be the retroactive design principle of the first industrial revolution? The only one I've been able to figure out is that, "If brute force doesn't work, you're not using enough of it." That seems about it. In architecture we design the same building in Reykjavik and Rangoon. We heat one; we cool the other. If you 're not hot enough, add energy. If you 're not cold enough, add energy. One size fits all. If brute force doesn't work, you're not using enough of it.

We need some richer design principles. I use three in my work. And they are waste equals food, use current solar income, and respect diversity.

Waste equals food. I coined this term and also use the term cradle-to-cradle to describe the way we design with life cycle in mind. And the life cycle is not what Michael Braungart and I have characterized as "down cycling." It's true recycling. Right now we're making park benches out of our plastics. This is good news for the homeless. It's bad news for the rest of us. We figured out we're making about 83 park benches per capita right now. This is down cycling. This is not recycling. This is taking valuable technical materials and sending them to the landfill as they stop off as a park bench on their way there.

We need to design for true recycling, so that waste equals food. Use current solar income. Nature doesn't mine the past; it doesn't borrow from the future. It uses current income. So should we. You'll see that all our buildings are daylit. Respect diversity. Look at the people in this room. No two people are the same. No two places in the world are the same. No two cultural flows, spiritual flows, materials flows, energy flows are the same anywhere. Why are we designing one size fits all? Why can't we design working with local conditions, working with local culture, and celebrate natural energy and material flows?

Well, if waste equals food, then there's no such thing as waste. If there's no such thing as waste, and everything is food, then food are nutrients and therefore they are nutrients of metabolisms. And so what are the metabolisms with which we work? I have mentioned I work with a chemist named Michael Braungart. We've started a company called McDonough Braungart Design Chemistry , and we design processes and systems for industries. We're working with a whole raft of industries right now, with major corporations. This is not marginal. This is big business.

We say there are two fundamental metabolisms. There's the organic one, the one we physically inhabit and reside in, the world of nature. The other we call the technical metabolism. It's the metabolism of human industry. We should design things to go into either the organic cycle or to the technical cycle, and we should design nothing else. Everything else we would call an unmarketable because it can't return to these cycles.

Watch what happens when you start to design like this. I'll go through some projects to explain what happens. There are two characteristics you need to know. One is that if you end up with what we call a Product of Consumption the thing gets truly consumed. That means it goes to an organic cycle.

Let’s look at this notion of "consumers" for a moment. I came to the United States from the Far East, and I spent my childhood summers in the Puget Sound. My father’s from Washington. But I used to come here from Hong Kong, and I was always amazed that in America we had stopped being people with lives at some point and we had become consumers with lifestyles. When did that happen? Even on television they talk about "consumers" this and "consumers" that. How do you consume a TV set? If I had a television set hidden in this podium and I said, "I have this amazing object, it provides an incredible service. But before I tell you what it does, let me tell you what it is. You tell me if you want this in your house. It’s 4,360 chemicals. It has large amounts of toxic heavy metals. It has an explosive glass tube. And we think you ought to put it eye level with your children and encourage them to play with it. Do you want this in your house? Why are we selling people hazardous waste? Future generations will look back and say, "What did you do with all those valuable technical nutrients? The chromium, the antimony, the mercury, the lead? Why were you taking all these materials and then dispersing them into little holes all over the planet so that we’ll never be able to get them back, while you persistently toxify the earth’s surface? What were you thinking? What was your design intention?"

And so we advise people to design things to go back to soil safely with no mutates, no carcinogens, no heavy metals, no persistent toxins, no bioaccumulative substances, no endocrine disrupters.

Otherwise, design things to be what we call Products of Service. Something that is designed to provide you with a service, like a television set. But when you’ve finished with it, you’ve effectively leased it from the manufacturer, and it goes back to them because it is now designed to become a TV again, forever. And so our clients include companies that make televisions, computers, cars, shoes, carpets, fabrics. And we’re designing all of these products so that they will go back to the industries from whence they came so that waste equals food. Whose food is this waste? It’s the food of the electronics industry, in the case of a TV set. It’s the food of an automobile industry in the case of a car. Amazing things start to happen to the design once you take on this protocol.

We also need to enrich our criteria. Typically the design criteria that we’ve all used are cost, performance, and aesthetics. Can I afford it? Does it work? Do I like it? Or in architecture school we reverse that. We do aesthetics, performance, and cost. But it doesn’t matter. Still the same three. We need to enrich that by adding three new ones. Is it ecologically intelligent? Is it just? And is it fun? And now I’d like to show you some projects quickly. And we’ll discuss them in terms of their ecological intelligence, their justness and their fun.

(Shows slides.) This is a fabric. We were asked by DesignTex, part of the Steelcase Corporation, the largest manufacturer of office furniture in America, to design a new fabric for furniture along with Richard Meier, Aldo Rossi from Italy, Robert Venturi, Denise Scott Brown -- some very well-known architects, known for their design. We were honored to be in that company, but we said, "We’re going to have to design not only what it looks like but also what it is." And their director said, "Yes, we figured you’d say something like that and we are delighted at the prospect. So we’ve already figured it out for you to help move this along. And we’re going to propose to mix cotton, which is natural, with PET from Coke bottles, which is recycled. And that way we have natural and recycled. We’ve got all the buzzwords. It’s cheap. It’s durable. It works fine. What do you think?"

What do you think? Is that a good product? Is that something we should make? Based on our criteria, is that an organic nutrient? Does that go back to soil safely? Not with the PET. Is it going to go back to technical cycles? Not with the cotton. Isn't that interesting? A product that should not be made. How many times have you heard that? Can you imagine people sitting around the room going, "Oh, well, there's another one we shouldn't make"? Wouldn't it be great if this kind of discussion was going on with genetic engineering? Some wizard sitting there saying, "Gee, we could cross the animal kingdom with the plant kingdom. God never tried it. But maybe we could." Wouldn't it be nice if somebody sitting in the room said, "Somehow I don't think we should try that one. Because we don't know what that's going to mean."

And they call this science? You do the experiment, release it into the world, then you watch what happens and talk about it. Remember PCBs and CFCs? Amazing! This is actually primitive science, a non-ecologically intelligent product design. Let's look at it from a deeper perspective. Cotton requires over 20 percent of the world's pesticide use. It causes hydrological disasters. Goodbye Aral Sea. And it has never been associated with social fairness. PET is a petrochemical full of anti-oxidants, UV stabilizers, plasticizers, antimony residues from catalytic reactions. It was not designed to be next to human skin. Why would I want to put these two things together?

So, for DesignTex, we decided to do an organic nutrient, a fabric we did in Switzerland at the most advanced mill there. They're trying to be an eco-mill, doing their eco-efficiency reductions, trying to get their cadmium levels down to thresholds and so on and so forth. I talked to the president and I said, "Wouldn't it be great if waste equals food?"

The previous week the trimmings of his bolts of cloth had been declared by the Swiss government to be hazardous waste. They couldn't be buried or burned in Switzerland. He had to export them to Spain. Now, we've hit the wall of the first industrial revolution when the trimmings of your product are declared hazardous waste, but you can sell what's in the middle. You don't need to be Einstein to work out what it is you're selling. The most eco-efficient thing he could have done is sell the product untrimmed. Because the customers are going to cut it up anyway.

So he realized what his problem was. I said, "Wouldn't it be great if the trimming of your bolts of cloth became compost for the local garden club? So let's design that." And he did a magnificent job. Over the course of a year we developed a fabric based on the idea that people have to sit and be warm in winter, cool in summer. We designed a fabric using wool, which is an absorber it absorbs 30 percent of its volume in water and ramie, which is a nettle family plant from the Philippines, organically grown. And the wool is from happy sheep in New Zealand.

We designed it based on interviewing people in wheelchairs, because we considered that worst-case sitting, and it turns out their biggest problem is moisture buildup. So we designed a fabric that absorbs moisture and then wicks it away. It's a structural fiber stronger than steel in tension when it's wet. It absorbs the water and then wicks it away. After we had done that, we had the process. But now we had to make it beautiful, and make the colors and so on. And we said, the filters of the future, our design filters, we're not going to put them on the ends of pipes and chimneys. We're going to put filters in our heads. More intelligence.

Less stuff. And the filter is this: no mutates, no carcinogens, no heavy metals, no persistent toxins, no bioaccumulative, no endocrine disputers.

We went to 60 chemical companies in Europe and said, "Who wants to put their products through our filter?" Within three days, they'd shut us down. It was amazing how quickly they talked to each other. Everybody was going around, "Are you going to do it?" "No, no." "Are you going to do it?" "No, no, no." Three days. "Sorry." Nobody was going to do it. So we went to Ciba Geigy in Basel, and we explained our idea. Michael Braungart and his team looked at 8,000 chemicals in the textile industry and, with that filter, had to eliminate 7,962. We were left with 38 chemicals out of 8,000. We did the entire fabric line with only those 38 chemicals. It's won gold medals. It's in the marketplace. It's a big success. It exists, therefore it is possible.

The ironic part was that we had every color we wanted except black. Remember Henry Ford's first industrial revolution, "You can have any color you want as long as it's black"? Now you can have any color you want as long as it's *NOT* black. (We've since figured out black.)

But the part that's really exciting to me from a design perspective is that after the fabric was in production, the factory's director called me and said, "Listen. You have to know what happened when we ran your protocol." The Swiss inspectors had come to test the water as they are required to do legally every day. And they thought their equipment had broken. They checked the water coming into the plant and, sure enough, the equipment was fine. It was Swiss drinking water. It turned out that the fabrics were filtering the water. The water coming out of the factory was as clean as the water going in.

The implications of this are astonishing when your effluent is as clean as your influent, which is Swiss drinking water. You can then use your effluent for process. And guess what happens then? You cap the pipe. That's what the mill is going to do now. There will be no effluent from this factory. There will be nothing to regulate. Nothing to measure. Why? Because they're not trying to kill anybody.

This fabric is what we consider the flag of what Michael and our friend and collaborator, Paul Hawken, call the Next Industrial Revolution.

We're now applying these concepts to carpets with Interface Inc. The idea is that they'll take carpets back forever. We're also working with the Herman Miller company. We did a new factory for them in Zeeland, Michigan. It's right next to a site with sculpted lawns and a few Canadian geese and a couple of pine trees and then a big metal building. There's a big pond with a pump fountain. We looked at that and said, "Do an inventory of biodiversity." Two species of flora: pine and fescue. One species of fauna: Canadian geese, unloved. The grass was being hacked back as it tried to go to seed. It was really quite an ironic message when you think about it. We pump grass full of fertilizers and then hack it back every time it tries to grow. Then we poison it to make sure that nothing else can enjoy its presence.

On our site, the water travels through swales all over the site, so it produces absolutely no storm water problems. It's called the "roly poly site." We now have great blue herons nesting, egrets and songbirds. We decided to measure our success by how many songbirds

return to the site. It's made with local materials as much as possible. It's a factory for recycling furniture, forever. We engaged everyone in the factory in the design of the building from day one. It was designed and built within 18 months, one week off schedule early. And it was exactly on budget to the penny. It was ten percent more than a normal building: $48 a square foot instead of a metal Butler building, which is $44 a square foot in Michigan. We used all local materials, which has multiplier effects in the local economy. But the part that's really interesting is that we created an urbane situation in a sub-urbane place. The bottom of the plan is where the offices are and the factory is in the back. And where they meet is a street, so that people spend their day bumping into each other along a street. If anyone wants to get a cup of coffee or have meetings or whatever, they meet on a street. We actually brought daylight into the building with glare.

We celebrate glare. Engineers are always worried about this stuff. They say, "No. We have to neutralize everything." So you end up with buildings with no windows. And we said, "No. Let the employees control the shade." So the people on the factory lines have clickers and they can aim at a window if sun's in their eyes. They can click, aim at it, and the shade comes down for half an hour. Then it goes back up. They control it themselves. They never have to turn the lights on during the full daylight hours. We had Battelle National Labs analyze this company for productivity for a year before they moved. And they've been in now for over a year. The result is what we expected and we're very excited about it. But listen to this. Many people told us at the beginning that they didn't expect productivity improvement because this company was so spunky. They figured it was already 95 percent productive. Well, they've monitored it for a year and it looks like they've increased productivity by over one percent. [Lately I have been told overall productivity is up over 20% in the company. W.M.]

One percent may not seem like much, but if you make $250 million worth of furniture every year, and you pick up a one percent productivity increase we know it's from the building, and we know it's the daylight because it came from the first two shifts, it didn't come from the night shift. That increase is worth $2.5 million a year with the same employee cost. Amortize the extra profit with the financing and you could finance the building improvements in no time. Someone at Herman Miller told me that William McDonough & Partners gave them the building as a present.

So when people say to us, "How do you talk your clients into spending ten percent more?," we're not talking about changing a few light bulbs. The cost of the building is insignificant next to the value of people. For example, people can see what they're doing. The roof has these monitors so there's daylight everywhere. They can see what their work looks like. They can look under their bench when they drop something, and they feel like they spent their day outdoors.

This slide is a competition we won for a corporate campus in San Bruno, California. We're a small firm: they called us "the kids." We competed against the two largest companies in America, HOK and Gensler, and we won. It was a fun competition because the assignment from the chairman of the company wasn't a specific program, it was to design a concept for a building. Don't design a building. We didn't have to worry about where the bathrooms were. We had to design a concept for a building. This is the last green site in San Bruno, California. We decided we would design the building from the air, so that a bird would look

down and say, "This is nice." The roof is grass. The roof is the oak savanna of the original landscape. And we saved all the live oaks that are on the site, every one, and then designed the building around them with this giant meadow. And we won the competition and made the design real, broke it into two phases. It'll open this fall [1997]. It has an undulating grass roof and daylighting everywhere.

The metaphor here is that from the air, the roof is the earth. So as far as birds are concerned, nothing happened. There's no storm water problems as a result of this building because it still absorbs and makes oxygen. The roof is absorbing water and making oxygen. But from the inside, it's a giant undulating curve because we've been able to use raised floors for air and for computer access. And nobody wants to pay for that -- it costs more for raised floors.

But our idea was to use the raised floor to move nighttime air through the floor all night to cool down the slabs of the building. So we actually use the nighttime coolness of San Francisco to cool the building. We get free cooling. We were able to cut the mechanical equipment by over half and the energy bills by well over half. That paid for the raised floor and left the ceiling clean. People feel like they've spent their day outdoors. The entire building is daylit, so we're not adding heat and then having to air condition it out, which is what typically happens in office buildings today.

This slide is the new Environmental Studies Center for Oberlin College in Ohio, and the question here is the one I posed earlier: Why can't a building be like a tree? Let me give you the retroactive design assignment of a tree. Could you design something for me that purifies water, provides habitat for hundreds of species, builds soil, accrues solar income as fuel, provides food and micro-climate, makes oxygen, fixes nitrogen and sequestors carbon? Can you do that for me? How many buildings do you know that produce oxygen? Wouldn't it be amazing if we could design a building like a tree? Compared to a tree, our buildings are incredibly crude.

That's what we're doing at Oberlin. We gave ourselves a design challenge with David Orr, the head of Environmental Studies there, to design a building that's a net energy exporter. The idea is, the building would produce more energy than it needs to operate and it becomes fecund and it gives something back. Because if sustainability is simply maintenance, if it's just going to be that edge between destruction and restoration, then all we're giving our children as a legacy is maintenance. Ultimately, that's an impoverished agenda because it's like eco-efficiency.

If I look at eco-efficiency as a design assignment, what would it be? I'd have to say, "I wake up in the morning feeling really bad. I spend my day trying to feel better by being less bad and my goal is zero." Is this fun? I'd rather look at it and say, "What does 100 percent sustainable look like?" I'd rather wake up in the morning and say, "I'm only 21 percent sustainable today. Tomorrow I'd like to be 22." Because that means I'd have to imagine what 100 percent looks like. It means I have to re-imagine the world. That we don't accept it as it is and just try and be less bad about it. We actually posit what 100 percent good would look like and get onto that track.

This slide shows an experimental project to articulate the concept of a building like a tree. On the north side there are offices. That's a grass roof that absorbs the water of the building.

The big wing of a roof is south facing; it has solar collectors; it has photovoltaics which produce as much energy as is needed to run the building and then some. On the south side, in the lobby at the bottom of the drawing, is a living machine designed by John Todd, a marine biologist. It's a botanical garden that purifies all the water waste of the building to drinking water standards. So the building actually purifies its own water and accrues solar energy. It is fully daylit, and it has natural ventilation systems. We're working with Amory Lovins and his teams to develop energy systems that I think will astonish you. If you want to get into detail, I'd be happy to talk to you about them.

This is a project we're doing in Indiana, outside Gary and Chesterton,d Indiana. It's a new community on a square mile of land, an extension of a small town. But the reason I want to show it to you is that the real estate developer who did golf course developments asked one of the largest real estate advisories in the world to tell him what the future looked like way out ahead of the curve. We were brought in to look at it. We spent a day with them. And a year later they called up and said, "Okay, let's do it."

This slide shows what we got when we arrived there. This is four-lane highways leading to arterials leading to subdivisions with cul-de-sacs the original plan. We transformed it into a pedestrian-oriented community. These are all neighborhoods with gardens, with parks. We're redesigning retail commerce itself. We're using the concept of distribution inherent in a Wal-Mart to solve the problem created by a Wal-Mart, basically letting them do custom distribution to Mom and Pop stores within each neighborhood. So everybody will be able to walk to one of those little red corner stores and get whatever they need.

The houses will have south-facing roofs and the utility will rent their space and the entire town will be photovoltaic. It will be its own utility. The solar collectors will be provided as Products of Service by the utility. In other words, people aren't going to have to be asked to buy ugly blue rectangles made of heavy metal combinations. They'll be asked to rent their south-facing surfaces for energy and then some. We have a global positioning transit system. The transit vehicles will know where you are and will be able to pick you up and take you anywhere you want to go. We've even got horse-drawn carriages that'll move though here, because $8 a day worth of oats is a lot cheaper than running off to Saudi Arabia. There are only 600 breeding pair of Percherons left, which is unfortunate, so we'll bring some of them back.

There's a transit loop that moves through it and makes it very convenient. And the point here is that if you look at a young family in America trying to get a house, the cheapest thing they can afford right now is a double-wide on the nearest acre at the fringe. That's what cancer looks like under a microscope if you look at that from the air. What we realized is, it's not just our subdivisions, it's actually this creeping requirement of our people to go to affordable housing, because that's all we have to offer.

We need to spend more time with our kids. Remember that question: "How do you love all the children?" By design. We're forcing people into remote circumstance. All of a sudden, if there are two parents and kids, you've got to have two cars because you can't leave people isolated. The average car in America costs $7,000 a year. So that's $14,000 a year going into cars for that family. Both of those parents have to work, and one of them is working for the cars, because after taxes $14,000 is a living wage.

What we're saying is, wouldn't it be wonderful if that family didn't need two cars because of a transit system, and they could have just one car? What would the implication be? Free up $7,000 a year and see what it's worth. It's worth $70,000 worth of mortgage. So instead of somebody being stuck with a $50,000 double-wide on the fringe costing incredible services from the county and causing sprawl, they could be living in a $120,000 house financed by their not having to have that car, or the other person doesn't have to work. They could stay with the children if they wanted to. All of a sudden we realize that our families can go back to being families and not to being chauffeurs or consumers of tires, gasoline, automobiles, et cetera.

We studied the prairie of Indiana and it turns out these are the roots of prairie grasses; they're up to 16 feet deep. It turns out that the prairie was a giant sponge. There was no such thing as runoff. The upper Mississippi reaches were all fed by groundwater. So the entire community is being designed to absorb water everywhere. There are no gutters. There are no concrete curbs. The roads are all brick. They're 22 feet wide instead of 44 feet wide. And all the surfaces are being designed to absorb water. (In our office we see "asphalt" as two words assigning blame.)

If we ask, "Why can't a building be like a tree?" we find ourselves doing amazing things and rediscovering the creative joys of designing. I'll give you one quick example. On the Oberlin building, when we first did the runs, it turned out that it was only 43 percent solar-powered. Amory and I asked, "Where's all the energy being used?" A lot of it was in the pumps driving the system, because the south side of the building was used to heat the north side. Two ground-connected heat pumps were linked, so they actually used the heat built up on the south to heat the north, etc. We looked at the pumps and said, "What if we change the way we design?"

Most engineers sit and do the piping diagram. They try to save material and so they'll say, this is a half-inch pipe, this is this and that, and they add it all up. They find out what the friction loss is and then put in a five horsepower pump to run the water through the system. We said, "What if we reverse the design? What if we designed it from the pump out?" In other words, what if we design for zero friction? What if all the pipes got bigger because the real job is the sweating of the joints, etc. It's not the cost of the pipe; whether it's this big or that big is almost irrelevant in terms of overall cost. So we designed it without friction. The pump sizes dropped by 95 percent.

Because what you realize is that we're going to pay for those pumps in energy consumption over and over and over again. In fact, we're going to spend as much on energy as the pump cost in one year. What if we could actually design the system so that it was frictionless? There's a nice metaphor here. Let's remove stress. Let's get rid of friction. Let's let our systems go limp. Let's make them fun and friendly. All of a sudden you realize that the building could easily power itself because we had taken the stress out of the system.

It never would have occurred to us to do this until we realized we only had this finite energy budget. That forced us to rethink the way we design systems. The essential questions are, "Why can't a building be like a tree?" In other words, why are we here in this steamship? And "How can we love our children, all of the children?" When you ask yourself that question, interesting things happen to design.

I'll close with a story from Curitiba, Brazil. Jaime Lerner, the former mayor and now the governor of the state of Parana, was recently at the university because he won the Thomas Jefferson Medal in Architecture, the highest prize in architecture in the world, as far as we're concerned anyway.

When Curitiba had a visit from the former mayor of Jerusalem, he said to the mayor, Rafael Greco, at the time, "Where's your library?" They realized Curitiba didn't have a library. Here's a city trying to keep up with expanding growth. They've gone from 600,000 to almost two million since 1970. And they didn't have a library. So the consensus was, "Oh, we've got to do a library." Instead of doing what San Francisco did, a $150 million mausoleum for books at the Civic Center, the question was, "How do you build a library and love all the children?" They realized that a central library wasn't going to be any good to most of the children, because they wouldn't be able to get there, they wouldn't have time, they wouldn't have money, even though the transit system there is spectacular.

So the question became, "How do you build a library and love all the children?" What they ended up doing was building tiny libraries, the size of little houses, with a lighthouse in front called a "beacon of knowledge." Volunteers sit in this glass room about ten meters up and read books: a fireman, teacher, parent, or forester. They make sure all the kids are safe because these are built within 12 minutes' walking distance of every child in the city. When kids get to this library, this friendly little building, they find all the reference books they need for school. If they can't afford to buy the books that they want to take home for school, they can pick up garbage on their way there and trade it for books.

Every little kid, even the barefoot one coming from the hinterlands that arrives in the city, is loved by the city. Jaime's point is that if we don't love the children, how will they love the city? Every kid in Curitiba is getting access to the World Wide Web. How are we doing here in comparison? That's supposed to be a Third World country.

How do we love all our children? How do we love our seventh generation? How do we design things in such a way that when they look back at us from seven generations hence, they realize that what we were doing was signaling a new intention based on new information that we now have about the acts of human artifice. They will realize that we began at this point in history to start to imagine what it might be like to find a meaningful, rightful, and responsible place within nature to be in kin with nature and that we accepted the challenge.

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