

## The Philosophy of Design for Disassembly

By Jonathan Larson

Reduce. Reuse. Recycle. Most everyone sees this slogan every day--some of you may even have it on your business stationary. There is a genius in this environmental slogan--for the scientist, it is often represented as a triangle, the strongest and most elemental geometric shape. For the religiously inclined, it calls to mind the authority of the Trinity. It is simple, direct, and because of all iteration, easy to teach to children.

Yet the presence of every one of you here today is testimony to the fact that there is a huge gulf between the three 'commandments' of pollution reduction and the very difficult work of implementing them. Reduce/reuse/recycle only tells us what we should do--it does not tell us how to do it. How? is the important question for environmental professionals. All over the world, people of good will are saying, "I want to do the right thing by the environment. Tell me how to do it and still live!"

A PLAN! A plan of action is what people and their governments are demanding. It is up to us to demonstrate that we do have a plan they can live with. And we had better come up with a working strategy very soon for time grows short.

This morning you have heard about German design-for disassembly practices. You probably have already guessed that DFD is not a panacea for all problems. DFD critics point out that there is more to pollution reduction than labeling the type of plastics used in automaking. After all, the \$125,000 Mercedes with the 12-cylinder engine conforms to all the requirements of German DFD regulations. It is something of a stretch to label a 165 mile-per-hour gas-guzzler 'green.'

Yet in this exercise in eco-hypocrisy lies an idea of such importance that der grosser Mercedes should be thought of as an object lesson. DFD is a glimmer of light that shows us that sophisticated environmental planning is possible. Whatever your feelings about blazing down the autobahns at triple-digit speeds, the fact that Mercedes proudly extols its 'green' efforts for its flagship model says volumes about DFD as an environmental strategy.

DFD is a subset of the emerging environmental redesign movement which assumes that:

- a) humans cause pollution (apes and dolphins may be bright but they have never caused a toxic waste dump)
- b) humans are conscious beings (for those who disagree and have examples--insert your own joke here)
- c) pollution is caused by the conscious acts of these humans
- d) the more difficult the act of humans, the more planning it takes
- e) the truly difficult pollution problems are caused by acts of significant planning and design. Therefore: Pollution is a function of design!

In the United States, the notion that design has anything to do with pollution is not immediately obvious. For Americans, design is associated with fancy stitching on blue jeans or overdone

dwellings for the idle rich. Industrial design is thought of as the business of turning kitchen appliances into objects of yuppie admiration.

But think about it for a minute! Nuclear power and the resulting waste problems were brought to us by the creative genius of scientists, inventors, and design engineers. Global warming is the product of planning by geologists, mining engineers, shippers, civil engineers, automotive designers, and the clever folks who solved the problems of mass production. The ozone hole is courtesy of organic chemists who were merely trying to give the world a safe way to preserve food and medical products with refrigeration. In fact, virtually every thing that can be considered pollution is the product of intense planning and design--down to the last bubble-pack and plastic milk carton clogging our waste dumps. Remember, EVERYTHING that is called 'disposable' was DESIGNED from day one to be garbage--as its PRIMARY and overriding design consideration.

When it is understood that pollution is a function of planning and design, a whole host of options opens to the environmental community that never existed before. It also exposes the shortcomings of traditional environmental strategies.

Take, for example, the original environmental strategy of conservation. It is true that every environmentalist must first be a conservationist. And, some environmental problems, such as species extinction and the resulting loss of biodiversity, can only be solved with a conservation strategy.

Yet conservation by itself, is doomed to failure. Roping off a wilderness will never save it from the pollution without borders—such as acid rain, ozone depletion, or global warming.

In the context of environmental design, conservation means that the fewest number of resources are disturbed in the struggles to support human life on this planet. This requires quite different thinking in a modern industrial setting than the creation of wilderness areas, which has no more sophisticated model than the old king's hunting preserves. Conservation must be more than nostalgia for life before industrialization. There is no "Garden of Eden" solution to modern problems--humans have altered the biosphere far too much to return to any fictional paradise.

The legislate, litigate, regulate environmental strategies have also proved to be insufficient because genuine environmental solutions are ultimately about organizing work. The problem is that every dollar wasted on legal maneuvering is one dollar less for environmental restructuring. And when the regulations are written and the money is spent, the work still needs to be done and then everyone wants the work done on the cheap. Trying to organize industrialization on the cheap may be THE root cause of our environmental dilemmas.

Some environmentalists seem to assume that because production is 'dirty business', the only proper role for environmentalists is the encouragement of wise consumption. Environmentalism as consumer education seems to postulate that we can somehow shop our way out of impending doom. The European environmentalists I know consider the American infatuation with consumerist strategies to be utterly infantile. If the last twelve years have taught us anything, it is

that peoples and nations who know how to successfully produce, eventually dominate those who merely know how to shop.

Ultimately, consumer re-education without production redesign is an exercise in futility. Big pollution problems BECOME big pollution problems because everyone wants the output of the polluting process. On the margins, changes through re-education in consumer behavior are possible. Some problems, like the proper disposal of waste oil, have no other solution than re-education. Education has its vital role in recycling but without industrial redesign, many efforts merely result in waste piling up in warehouses rather than landfills.

Of course, someone must scientifically define the environmental dilemmas. And further, good-government environmental regulations are necessary. The regulate/legislate/litigate environmentalists have as important a niche in an overall environmental strategy as the old-fashioned conservationists. Yet defining problems and solving problems are different skills. It is at this critical point where the strategy of environmental redesign becomes so important.

The Germans produced DFD regulations because they understood the importance of production issues and environmental issues coming together. It is the logical outcome of the Red (Social Democrat) Green coalition. The Social Democrats believe that for workers to prosper, industry must prosper. The Green Party believes that for industry to prosper, it must be environmentally sustainable. The combining strategy is industrial redesign.

In some ways, it is not surprising that the Germans would reach such a conclusion. For them, industrial design is a valued profession. Mies Van der Rohe said that "Form follows function" in the 1920s and they have believed him ever since. If Germans could be convinced that environmental sustainability is simply a design target, and they have been largely convinced, then industrial-environmental design is the necessary logical outcome. It is why 1992 German cars already conform to DFD regulations, and automakers have established sophisticated recycling facilities, while in the U.S., DFD is still an essentially unknown concept.

Industrial-environmental redesign is rapidly becoming the environmental strategy of choice in Europe and increasingly in Japan. The reason is that design has emerged as the dominant economic factor as well. Good design decisions lead to prosperity.

Of course, the free-market followers of Adam Smith do not agree. They claim that markets can decide everything by setting price. Trapped by this preindustrial thinking, free-marketeers fail to understand that markets only determine which product designs people wish to buy--expensive AND cheap goods succeed in the marketplace. Free-market ideologues have not only produced the present world-wide depression with their flawed thinking, but are totally unable to formulate a model for environmental renewal.

The Marxists, who believed that all value is determined by labor, got a bit closer to describing what happens in the industrial states. But their economics also failed because equal labor does not produce equal outcomes. The person who bolts on the wheel of a Mercedes or a Yugo works equally hard. In fact, the Lexus 400 is assembled with about 1/3 the labor of an equivalent Mercedes. The difference is design--the design of the car and the design of production. And, it

should not be forgotten, Marxism also produced the ugly combination of economic failure and environmental destruction. Folks! Environmental destruction was neither a commie nor capitalist plot! Both were simply irrelevant!

The strategies for economic prosperity and environmental renewal can ultimately be fused around the complex subject of design. Green design is more than good environmentalism--it is sound economics.

Some environmental problems have no other solution BUT environmental redesign. Global warming is the perfect example because it is so easy to define design targets. The international consensus on global warming (almost everywhere except in the U.S.) says that the atmosphere can absorb approximately 1/6 the current emission of greenhouse gasses.

Recently, I was involved in a superb demonstration project of a Florida/sun-belt house designed to use 1/6 of the prevailing energy consumption. 5/6 energy reduction is quite a feat--especially since this project had to meet a strict cost target of less than \$70,000.

It was assumed that a \$2 million demonstration house would demonstrate very little. Further, all technologies had to be commonly available from a Knox/Home Depot type of retail outlet. Experimental or foreign technologies were eliminated as excessively costly or unreliable. This ruled out photo-voltaic cells, among other things.

These seemingly drastic design constraints--especially cost—made cost-free design considerations absolutely critical. Because energy-efficiency was assumed to be a design problem, the costs of premium energy-saving materials became a small fraction of the total costs of construction. Less than \$4000 was spent for high-performance windows, thick walls, extra insulation, dual and reflective vapor barriers, low-watt bulbs, extra paddle fans, and so on.

Premium materials in a design strategy became less a factor than the much bigger efficiencies which came from proper siting, well ventilated roofs--properly orientated, large and sheltering eaves keyed to the solar path, computer-designed ducting, and so on. But it was the interior layout that was most clever. This house lacks none of the comforts associated with middle-class housing, yet by simply renaming rooms, and functionally redesigning living spaces, it lives like a big house yet has the cooling needs of a small one. By concentrating on cost-free design considerations, the goal of 5/6 energy reduction seems to have been reached.

But if design for energy-efficiency is obvious, design for waste reduction is far less so. Producing anything means dramatic human intervention. People who produce like to think that their products will last forever. Durability is also a certain sign of quality. Moreover, durability is a VALID environmental strategy. Both the commandments of 'reduce' and 'reuse' imply products that last. Producers are predisposed not to even THINK about their products growing old and failing any more than they wish to think about their own mortality.

But mortality is the great design imperative of natural creation. Products created by humans are NOT exempt. Just as humans create by intervening in the natural order, so they are required to design an end to their creation's life. Design for disassembly is nothing more than the planned

mortality of human creation. (repeat) Everything that is made outside the natural function of decay, must be unmade at some future date. This is the natural imperative. Everything must eventually be recycled, therefore, everything that is introduced into the biosphere must have a plan for its disposal when it is created!

This is the true genius of design for disassembly. It is a simple commandment to human creativity--you made it, you tell us how to get rid of it when its useful life is over or don't make it in the first place. Of course, what make DFD so effective is that environmental problems are placed in the hands of those people most likely to have a solution--the product designers themselves.

Already, basic DFD strategies have emerged: eliminate adhesives (things that are glued together are hard to separate) eliminated coatings, (same reason) reduce the number of materials, use easily recycled materials, employ reversible fasteners, and reduce parts count.

These strategies not only appeal to the ultimate recycler, they have benefits to the original producer that are so significant, they usually pay for the costs of DFD conversion.

For example, because one goal is fewer parts, a DFD product often takes less time to produce--in some cases significantly so. Fewer parts also mean lower inventory costs.

A product that is easy to disassemble is easy to repair or modify. Products can last longer because only a failed subpart needs to be replaced. Waste can be reduced if a large product does not have to be scrapped because a small part fails or becomes obsolete. Regionalized custom production becomes more possible if modifications become easier.

In one DFD project I worked on, production costs were cut by over 50%, service calls and consumer relations were greatly simplified, toxic processes were eliminated, and so much solid waste was removed and so much recycled material was introduced into the production systems that this manufacturer became a net consumer of waste products.

DFD works. Rest assured, those serious Germans and diligent Japanese would not be toying with DFD strategies if they did not work! Because design for disassembly has payoffs at both ends, one might assume that there would be no resistance to this clearly superior design strategy. One's assumptions would be wrong!

There is all sorts of resistance to goes far beyond a producer's need for product immortality. Change involves risk. There are few successful products as it is--why tamper with success. DFD requires management commitment and worker retraining. More importantly, it requires rethinking. In a world where even committed environmentalists seem to believe that saving the environment will cost jobs and money, changing these assumptions is probably the biggest problem of all.

Yet change is necessary. Time runs short for an environmental solution. Fortunately, everyone is clamoring for change. We must order our societies differently. Industrial redesign offers the brightest hope by far for producing prosperity while saving the environment. Actually, the social

imperative is quite simple--there is so much work to be done and there are so many who need work, that a society which cannot combine these needs deserves to fail.

A working strategy has emerged. Let me suggest a new trinity for the environmental professional--rethink, redesign, and rebuild.

So where do we start? We must first understand that these environmental strategies are going to become a minimum admission to the global economy. Germany is the 500 pound gorilla of the European Community. It is quite possible that DFD may become an EC trade barrier. If German manufacturers are required to provide disposal methods, why should they import products that have no disposal strategies--their landfills are full too. In like manner, we may expect Japan to set the rules for all of Asia.

Environmental concerns are certain to emerge as even bigger trade barriers. Already, the Canadian ambassador has his hands full because German environmentalists have accused Canadian paper producers of having 'worse logging practices than a third-world country like Brazil' and are seeking to bar imports of Canadian paper.

Better, if flagship industries make a commitment to waste reduction through redesign, can governments and the service industries be far behind. In fact, until rethinking takes place at the source of the waste stream--the productive capacity of industrialization, all other efforts are essentially sweeping up after the parade. Source reduction of pollution begins at the very source--the thinking that leads to the production of man-made goods.

Of course, we Americans can do nothing, watch as the Germans and Japanese master and dominate 'green' technologies like they did everything else in the past 20 years, hope that we will only have to be good little consumers, and pray that they will keep lending us enough money to buy their technologies because they are tired of seeing us trash the planet. But don't count on it. After 50 years of useless American arrogance, the rest of the world is taking perverse pleasure in watching our economic collapse and loss of imperial pretensions.

Rethink. Redesign. Rebuild. There is a bright possible future if only we are brave enough to grasp it. There has never been a time like the present for attempting a new environmental strategy. Of course, governments have a role in all of this and capital for conversion must be forthcoming. We must have new definitions of how we organize our societies. And, as in any human endeavor, not all DFD strategies will be successful. But the promise is so immense and the alternatives so grim, the efforts necessary to learn this new strategy are well worth it.

Design as an environmental strategy, and DFD in particular, is a complicated subject. If these remarks today have been excessively theoretical, be assured that I will be happy to answer more specific questions about the nuts and bolts of DFD at the session following these remarks.

I want to thank the Recycling Association of Minnesota for inviting me to speak. You people are very important--in essential ways, the very survival of the biosphere rests in your hands. Rethink, redesign, rebuild! using the blueprint of the natural order, can become the 'how-to' environmental strategy of the 21st century.