The New Age of Sail

Contributed by Dmitry Orlov
14 August 2006

[Editor's note: In this timely and comprehensive work, the author charts a most resonable future. Dmitry Orlov is known for writing and lecturing about the collapse of the Soviet Union as a guide to U.S. petrocollapse. World trade depends on cheap petroleum, especially bunker fuel for ships. As goods such as food have come to be transported further and further, involving also trucks, trains, barges and jets, modern societies have become dangerously dependent on a fast-dwindling, non-renewable resource. Peak oil and petrocollapse will not only end "growth" but will soon turn our artificial world of corporate global trade upside down. In its place people will look to sustainable systems, such as described below. As a matter of history at Culture Change, the Sail Transport Network was launched in 2000 - ahead of its time. Dmitry Orlov's tour de force may serve to relaunch STN, but with greater vision and expertise. - JL]

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1. Introduction

A sailboat is not the first thing that comes to mind when contemplating the range of useful responses to the set of intractable global problems that confront us. Nor the second. But once it does, a bit of further study makes it apparent that few things will possess greater long-term utility in the changed circumstances we should all be expecting. And it takes just one more leap of imagination to realize that it makes sense to pursue this long-term utility, rather than continuing to think of temporary measures and half-measures, while being mesmerized into paralysis by the unfolding deterioration of the status quo, in thrall to questions of political strategy and process.

And so, let us purge our minds of the inane buzz-words of today, such as "energy security" or "energy independence" and "green" this or that. ("It's easy to be green!" says Kermit the frog in an SUV commercial; I would beg to differ, but then who am I to disagree with a hand-puppet?) Let us drop the conceit that these are "problems," and that they can be "fixed." Let us instead try an experiment: let us dissociate from human history, and free-associate our way into the next chapter of natural history, which, let us bravely assume, a member of our ecologically challenged species will still be on hand to narrate.

2. The Easter Islanders and You

When in 1722 a European ship first anchored off Easter Island, the surviving islanders paddled out to it in their canoes, which the Europeans described as fragile, made of many small sticks ingeniously fastened together, not at all seaworthy, and entirely unlike the large ocean-going canoes that had carried the ancestors of these Polynesian settlers to the island across the vastness of the Pacific around 1200 AD. The islanders wanted to trade with the Europeans, and timber was high on the list of items sought by islanders. By that time, few trees still grew on Easter Island. It had once been heavily forested with palm trees, but was by then denuded, the palm nuts having been gnawed by rats, which were introduced by the settlers. The islanders survived this environmental calamity, shifting to grasses for making fire, and their population remained stable until the arrival of the Europeans. But they found themselves marooned. They had lost their boatbuilding and seafaring skills; moreover, they lacked a key boat-building material: large, old-growth trees. With no means of escape, they were easy prey for the conquering Europeans; thousands of them were enslaved and carried off; many others remained and died of disease. They should have built some boats, while they still could, and kept their options open.

Small islands such as Easter Island, the sudden collapses that befall their fragile ecosystems, and the subsequent cataclysms experienced by their populations, are considered to be objects worthy of study, because in microcosm they represent many of the same problems that are now besetting the planet as a whole. We live at a time when even the most concerted attempts at cultivating an optimistic outlook fail in the face of front-page news about catastrophic climate change, impending energy shortages, military quagmires and fiascos, and degradation of land and water resources, all of which are putting an ever-greater strain on a global population, whose precipitous decline will perhaps be no less spectacular than its recent exponential increase. The economic services on which we depend are in turn based entirely on ecological services, whether from living ecosystems, or from the remains of fossilized ones.

By most accounts, it is a certainty that at some point during the present century oil and natural gas will no longer be produced in significant quantities anywhere in the world. Attempts to replace these sources of energy with other, dirtier sources, such as tar sand, shale oil, uranium, coal, wood, dried sea squirrels (biomass), or anything else that will burn, will only accelerate the pace of environmental devastation and climate disruption. It is proceeding apace in any case, drawing the curtain on the last ten thousand years of unusually stable climate, which allowed agriculture to flourish and human populations to mushroom. In light of these developments, it seems implausible that the technological civilization which currently constitutes our communal life support system will hold together.

Perhaps we should be making some new plans, like the Easter islanders should have done, while there is still time. But there is hardly anything more enduring in the world than human folly, and there is no-one to steer this ship of fools away from the rocks of physical reality. Even if there was, this ship is not designed to turn, or even to slow down, but only to speed up. What other word is there for people who are working harder and harder in order to bequeath to their children a bankrupt country and a planet-sized disaster area – except fools? Some suppose it it our insect-like genetic programming to postpone desperate measures until it is too late for them to be of any use. I doubt that it is: we were free spirits once, before a millennium or two of settled, civilized labor of tending fields and serving a landlord (or serving as a landlord) bred it out of us.

It is our luck as a species that the foregoing applies to most of us, but not to all of us. Some far-sighted and courageous souls, whose initiative has not been entirely crushed by the forces of civilization, are taking their first, tentative steps in a direction away from certain disaster. They are making conscious choices that reduce their dependence on fossil fuels and on technologies that rely on them. They are attempting to form close-knit communities, and strive for self-sufficiency.

Some of them are starting to construct their own shelter, grow their own food, educate their own children, and provide their own entertainment. These are all very sensible measures, and I applaud the people who are trying to make them work.

In fact, I am one of them. I live in a place that is cheap to heat and cool. A few years ago, I sold my car, and I am now a year-round bicyclist. I limit myself to one airline trip a year. I have even made some tentative steps in the direction of growing my own food (more peas, anyone?). Some might say that by taking these steps, I have improved my inclusive fitness. Others might observe that I have only increased my exclusive smugness. Suits me either way, but really all I have done is take a few steps in the right direction, one step at a time, because I could. So can you. It's simple.

Such steps, followed to their logical conclusion, are sometimes grouped under terms such as powerdown, relocalization, and ecovillages. These approaches will probably be viable in some areas, but not others. None of them addresses an important question: What are we to do about all the many places that will no longer have the carrying capacity to sustain a permanent settlement of any size? We should expect this to be the norm, not the exception: before the recent ten-thousand-year period of predictable weather, agriculture was not reliable enough, and people had to remain on the move, leading a migratory or nomadic existence, surviving through hunting and gathering food over a wide area. Given an environment characterized by droughts, floods, a long and violent hurricane season, coastal inundations due to rising sea levels, soils depleted by a century of mechanized agriculture, and forest ecosystems undermined by the northward spread of diseases and pests, is it not perfectly conceivable that the migratory, nomadic lifestyle will once again become for the majority of us the only survivable option?

In a climate where the tropics are only survivable during the winter, and the temperate regions only during the summer, we would still stand a chance if we establish a lifestyle where we chase good weather by wandering back and forth between the two, and practice Permaculture by establishing edible forest gardens and gathering food as we travel up and down the coasts and inland waterways. If we establish this lifestyle before we are crippled by the onset of permanent crisis, while bold experiments are still possible, we would stand a chance. And if we pass this lifestyle on to our children, they would stand a chance as well.

This brings us full circle back to the hapless Easter islanders with their leaky canoes made of small sticks: we will certainly need better boats than that. Because a nomadic life does not have to be particularly hard or dangerous – provided you can take your home with you wherever you go. As a practical matter, this means that your house has to be a sailboat, and as any one of a whole tribe of live-aboard cruising sailors will attest, in some ways this is an arrangement that is superior to the settled existence of a landlubber. Since, prior to the onset of reliable weather, we were nomads, we can revert, and once we do so, the enslavements of settled life will probably start to seem like an odd bargain. I can testify that I have improved my life dramatically by becoming car-free. Might I improve it yet further by becoming house-free as well?

3. A Brighter Future

Let us imagine what that would look like. Being something of Pollyanna, I will assume a rosy business-as-usual scenario. Given the abject failure of political initiatives such as the Kyoto Protocol, as well as of our contemporary environmental movement, not only to arrest and reverse, not even to slow down, but even to reduce the acceleration of our headlong plunge toward environmental oblivion, this seems like a reasonable assumption.

Perhaps you are a fan of Al Gore, who in his recent book and movie, An Inconvenient Truth, draws a rather facile comparison between the problem of curbing CFC production to preserve the ozone layer, and the problem of stopping global warming. Beware of Al Gore's siren song: "The system is good, the system works, work within the system." The system was good for Al – it made him Vice President, and a lifelong member of that club. The goodness of his system, plus a winning lottery ticket, would be good for you too. For the rest of us, business-as-usual is not helpful, nor are people like Al who try to talk it up. But if we assume that they are rich enough and powerful enough to get their way, keeping us sold on "clean coal," hybrids, and hydrogen dreams of their corporate techno-fix utopia, and politely excluding us when we refuse to do their bidding, our future may very well end up looking as follows.

A few decades from now, just off the coast...

It is nearing sunset when the vegan ship sights land. There are two vegans on deck; two more are roused from their hammocks below the deck to help with the landing. They lower and furl the sails, take down and secure the masts, then row and scull the boat through the surf. When she finally noses up onto the beach, they jump down into the water and wade ashore hauling lines, then labor mightily to get her up onto level ground, panting in the stuffy air. They thrust pieces of driftwood under the bow, tie lines around trees and rocks, and roll the boat out of the water and well away from it. To lighten the load, they drain the ballast tanks that kept the boat upright and stable while it was underway. Once the boat is high and dry, and sitting upright on level ground like a giant piece of furniture, they unload their cargo of dried sea squirrel. Finally, they post a watch, and the other three retreat below, stretch out in their hammocks, and rock themselves to sleep, for once without any assistance from the sea.

Sea squirrels are pale, sickly-looking, and, above all, sad. Dried ones doubly so. They are endowed with flabby bags for a body, some ineffectual spiny tendrils, and dangling dark bits of uncertain purpose. One might conjecture that they are mutant shellfish that survived having their shells dissolved by the carbonic acid in the seawater. Being vegans, the vegans would never think of eating one; nor anything else that washes up on the shores of that brownish, carbonated ocean, almost lifeless after that final, desperate binge of coal-burning that occurred just as oil and gas were running out. Picking dead sea squirrels off the beach with a pointed stick is an unpleasant chore, making it useful for teaching children the subtle difference between work and play. Sea squirrels have but two charms: they are at times plentiful, and, dried into flat chips, they burn with a clean, yellow flame – not bad for illumination, and convenient for cooking the food which the vegans both plant and harvest all along the shore.

The Vegans' passion is for spreading seeds and gathering and consuming the proceeds. They are on an indefinite mission to boldly grow food where no one grew it before. They are carried forth by their ship, which looks like a long box sharpened into a wedge on one end, but is capable of a full warp four knots to windward, and double that in anything more favorable. Their mission is of an indefinite duration because their home port is under several feet of water, and although that water came from pristine, ancient glaciers and icecaps, it is now briny and laced with toxins. And although their grandparents never tire of telling them how at one time their home port had not one, but several excellent vegan restaurants, now there is hardly anything there that a vegan would want to eat, and hardly anyone to eat it with.

The vegans abstain from eating animal flesh not because of their tastes or their sense of ethics, but because most animal flesh has become toxic. The increased mining and burning of coal, tar sands, shale, and other dirty fuels, dust storms blowing in from desertified continental interiors, and the burning and degradation of plastic trash, have released into the biosphere so much arsenic, cadmium, lead, mercury, dioxins, and numerous other toxins, that the vast majority of predatory species, non-vegan humans among them, have become extinct. Since toxin concentrations increase as they travel up the food chain, certain top predators, such as belugas and orcas, went first, followed by most non-vegetarian animals. Along with chemical toxins, the biosphere became inundated with long-lived radionucleotides from derelict nuclear installations left over from the hasty attempts to ramp up nuclear power generation. Those built near the coasts are still bubbling away underwater due to rising ocean levels. And so the only surviving humans are those clever enough to realize that only the plants remain edible.

Although the vegans rarely want for food, this is only because of their Permaculture skills, because growing food has become an uncertain proposition. Droughts and wildfires alternate with torrential rains that wash away the topsoil, the ocean keeps spreading further and further inland, and in better years insects sometimes stage a revival and devastate much of what the vegans have planted. Were they to settle in any one place, they would certainly starve before too long. But because they have boats, and because climate upheaval is constant but uneven, they can be sure that something of what they have planted is growing and bearing fruit somewhere. It is solely by virtue of being migratory, and, over the years, nomadic, that they are able to persist from one generation to the next. They carry what they gather with them, and, carefully conserving the seed stock and constantly experimenting with it, manage to renew it. When a period of devastation runs its course, they step in and plant a new forest garden ecosystem. When they revisit it, after a few weeks or a few years, it may be dead, or overgrown with weeds, or it may be thriving, and yield a harvest of wood, nuts, berries, fruits, tubers, and herbs. And, of course, seeds.

The shore is for gathering food, for hauling out, making repairs, and for congregating. For everything else, there are the boats. They provide shelter, transportation, and a place to store food and other supplies. They carry all the tools needed to repair them, and even to reproduce them. They provide fresh water for drinking and washing, by capturing the rainwater that falls on their decks: one good torrential downpour is enough to fill their freshwater tanks, which hold several months' supply. They provide escape from wild weather, being fast enough to outsail it. In open ocean, away from flying and floating debris, they dutifully pound their way up and down towering waves, rattling the bones of the crew hiding in the enclosed cockpit and below the deck, but remaining impervious to either wind or water. It is little wonder, then, that boatbuilding and seafaring skills are at the top of the vegan home schooling curriculum: they are what keeps them afloat.

4. Humankind's Greatest Invention

In November 2004, a survey published in the London Times chose the bicycle as the country's greatest invention of the past 250 years, surpassing electricity and vaccination. The early history of the modern safety bicycle is somewhat marred by the atrocities committed by Europeans to secure a supply of rubber for tires and inner tubes. Dunlop patented the rubber bicycle tire in 1888. A mere three years later Belgium's king Leopold II decreed that residents of the Congo must either supply the needed rubber, or have their children murdered and their hands cut off. The Palais de Laeken, built with the proceeds, is disfiguring Brussels to this day.

The bicycle may be the best thing the British have given to the world, but to my mind, humankind's greatest invention overall, so far, is the sailboat. The last significant conceptual breakthrough in the area of sailing technology arrived some two thousand years ago, when Arab sailors in the Mediterranean invented the Lateen rig, which, unlike all earlier sails, has the ability to pull a vessel toward the wind, allowing it to sail in any direction. The Lateen rig consists of a triangular, flat piece of sailcloth stretched between two straight sticks. When the wind fills it, it forms a conic section – an efficient airfoil that generates lift. The Chinese Junk rig is perhaps two centuries younger, and works on a similar principle.

Around the 1300s, it finally dawned on the Europeans that they might want to do something similar, and giant naval empires were the result. So powerful was this innovation that it allowed the vast majority of the world's islands and coastlines to be colonized using vessels that were almost exclusively wind-powered. Once explored, conquered, and exploited, far-flung colonies communicated and traded with home ports using more sailing vessels. Sailing ships gradually grew in size and improved in speed, so that by the end of the age of sail, a small crew could move many tons of cargo over large distances with wind power alone, the sole energy inputs being those embodied in the ship itself, and those needed to house and feed the crew. This level of energy efficiency in transportation has never been exceeded.

With the increased mining of coal and expanded steel production, sail was supplanted by steam. The last European country to carry freight by sail was Finland, whose sailing merchant fleet continued to carry cargo up until World War II. The steamships' one significant advantage over sailing ships was in their predictable schedules, because they did not depend on the winds to make steady progress on an arbitrary course. Steam engines were supplanted by diesel and, for smaller craft, gasoline-powered ones, until at present time only a small percentage of vessels is built to carry sail, and a vanishingly small percentage of overall displacement. Moreover, all of the larger sailboats are built with an auxiliary motor, and spend quite a lot of time motoring rather than sailing.

It must be recognized that this state of affairs is temporary. Coal, oil, and gas are part of a one-time bounty of convenient, concentrated energy, which is being expended quite rapidly. Over half of the stuff has been used up already, and the second half is much poorer in quality, and is being used up at a much faster rate than the first. The current trend toward ever-higher energy prices will be followed by chronic energy shortages. Over the next several decades, the majority of our oil-based machines will stop moving, boats and ships among them.

In the interest of conserving energy, let us not waste any more of it discussing the tedious subject of fossil fuel depletion.

There are people more expert than I who can explain, over and over again if necessary, how existing reserves and new discoveries are woefully inadequate to maintain current production levels, and how energy is not the result of technological innovation, the free market system, or wishing upon a star. They will also tell you how far along we are along the depletion curve; the optimists among them will even claim that there is nothing to worry about, because we have two or three decades of production left at the current level. It is to be expected that we will run out of fossil fuels before we run out of optimists, who are, along with fools and madmen, a renewable resource.

Once energy reserves are exhausted, all that remains are energy flows, all of which, with the exception of atomic decay, originate from sunlight. Technologies do exist to exploit these flows: windmills, waterwheels, forestry, and agriculture have been used for centuries to tap into these flows, and will be again. However, all of these energy flows put together will amount to only a small percentage of the fossil fuel energy we are accustomed to using today. Furthermore, there will be no question of using these renewable sources of energy in the same way we are currently accustomed to using fossil fuels: we will want to eat the corn, not burn it in stoves or engines. Windmills will be used to pump water, not illuminate parking lots. Waterwheels will be used to mill grain, and saw lumber, not heat dwellings. The word "fuel" will be largely forgotten, replaced in everyday speech by the words "firewood" and "fodder." Our boats will once again have to move by wind power, or muscle power.

5. Keeping the Waterways Paved

Water-based transportation is just about the only form of transportation other than the bicycle that requires little or no roadway maintenance. There are no surfaces to grade and pave, no tracks to true, no bridges or trestles to maintain. Canals need to be dredged periodically; navigation channels need to be marked with buoys; locks and lighthouses need to be manned and maintained. But unlike motorway or railroad maintenance, these activities do not require a large industrial base, and are far less energy-intensive than any of the alternatives. The 363-mile-long Erie Canal system, which links the Atlantic Ocean with the Great Lakes, and has been operational since 1825, was built using manual labor, and can be maintained the same way. The cost of maintaining it is tiny compared to the cost of maintaining 363 miles of highway. It and other artificial and natural waterways in the United States and Canada comprise the greatest set of transportation assets on the North American continent, and will regain their status as vital lifelines once the railroads and the highways have disappeared or reverted to dirt footpaths.

Nor is an industrial infrastructure required for the construction and maintenance of the boats themselves. The key ingredients can all be found in nature. The hull can be constructed out of timbers and planks, sawed or split from fir, pine, or cedar logs, and sealed with pitch from wood tar. Sails can be made of flax canvas or bamboo matting, and rope can be spun from hemp. Of the man-made materials that are needed, all are preindustrial: forged iron hand tools for working the wood, and some amount of bronze for fasteners, blocks, cleats, latches, hinges, and other hardware, which can be cast using bronze age technology. A cast iron anchor and a wrought iron anchor chain are helpful as well.

For anyone faced with an unpredictable future, but one guaranteed to be disrupted and resource-poor, and to require frequent relocation in search of scarce remaining resources, a sailboat designed for the job would be a remarkable asset. It can provide not only transportation, but housing and storage. It is a residence that does not require one to own land. It can serve as a floating workshop, kitchen, or clinic. It can help one flee from danger. It can make it possible to live on land that is prone to floods. It can be maintained with the help of basic skills, such as carpentry, spinning, and weaving, using materials available within the environment. It can carry all the tools needed to repair it or even reproduce it. In short, it is difficult to think of anything that would be more useful to have.

6. The Sorry State of Sail

None of the sailboats currently in commercial production will do at all. Since the end of the age of sail, sailing has been relegated to a number of niches, none of them of much practical value. Overall, they have become a luxury item. An important element of this luxury is the freedom from the buzz or throb of the engine, the stench of fuel, and the noxious fumes of the exhaust plume: freedom to enjoy nature without assaulting it. An early application of steam power was in powering sailboats out of doldrums, but steam sailboats were quickly supplanted by steamboats that did not carry sail. A similar fate awaits the many modern sailboats that are designed to rely on their diesel or gasoline auxiliaries, but for the

exact opposite reason: they will be trapped in the permanent doldrums of fuel scarcity.

The particular applications still reserved for sail include recreation, sport, and historical preservation, with dollops of luxury thrown in for each one. Recreational vessels range from small sailing canoes and dinghies to daysailers and small coastal cruisers. Sport encompasses a wide variety of racing boats, which are designed for speed, especially speed to windward. Historical preservation includes various old sloops and schooners, as well as newer boats constructed entirely of wood by master craftsmen. The realm of pure luxury gives us an assortment of cabin cruisers, which often have plenty of teak and mahogany paneling and trim, fancy navigational electronics, on demand hot water, and a sound system. Although they are capable of crossing oceans, they are mainly used for ostentation, to motor around the harbor, and to throw dockside parties.

Most contemporary sailboats make extensive use of modern synthetic materials, composites, and advanced metallurgy. Most of the hulls are made of fiberglass and epoxy composites, although some are welded together out of steel or aluminum, some are made of ferrocement (cement over steel mesh), and a few designs use fiberglass and epoxy over plywood. The choice of material influences the design: fiberglass is strongest when the vessel is egg-shaped, and thus we have a lot of hulls that are rounded below the waterline, while steel hulls have to be built up of flat rolled sheets, and consist of a series of panels joined together along horizontal ridges known as chines.

Epoxy resins, which hold together the layers of fiberglass cloth, are the end-products of a technological chain that starts with crude oil. The petrochemical feedstocks used in epoxy resin manufacturing are primarily propylene and benzene. The recent doubling in oil prices has already started to put a squeeze on the profit margins of epoxy resin manufacturers. Oil shortages will cause much of the world's epoxy resin industry, currently around US$15 billion a year, to scale back production and eventually to shut down. The situation will be similar for wool fiberglass, of which fiberglass cloth is made, and which requires a great deal of energy for melting and spinning the glass. Thus, rising energy prices and ensuing shortages will make the construction and even the maintenance of a fiberglass hull an uncertain and expensive proposition.

The masts, booms, and other spars of a modern sailboat are usually extruded out of aluminum alloys. Although bauxite, which is the primary feedstock for aluminum manufacturing, is quite plentiful, making it into aluminum requires a great deal of electricity. The energy crisis of 2000-2001 in the Western United States has caused much of the aluminum manufacturing in that region to shut down due to high electricity prices. Rising energy prices and dwindling energy availability will make aluminum spars very expensive and in ever shorter supply. Similar relentless forces will impact the supply of stainless steel cable, used for the standing rigging (forestays, backstays, and shrouds).

Sails are made of Dacron (long-strand Polyester fiber), Nylon, or Kevlar, which are all synthetics, and whose fate will be similar to that of epoxy resin. Thus, sails will once again have to be made of flax canvas. The other potential material for weaving sailcloth is cotton, but cotton cultivation is no longer possible without the use of chemical fertilizer, which is derived from natural gas, and pesticides, insecticides, and fungicides, which are oil-based. About a quarter of all insecticides used globally are lavished on cotton; without them, the crop is destroyed by weevils. (Even with these chemicals, the weevils seem to be winning the battle, evolving resistance faster than new chemicals can be developed.) Thus, the future availability of cotton is likely to be too low to make it a useful source of sailcloth fiber. On the other hand, flax can be cultivated without the use of fertilizers or pesticides, provided proper crop rotation techniques are used.

Thus, most of the ingredients of a modern sailboat will not be available in an energy-scarce, post-industrial environment. Eventually, hulls will be once again made of wood timbers and planking, and sealed with pitch. Spars will be made of wood, and rigged with hemp line. But although it is highly unlikely that late this century anyone will be able to construct a sailboat from fiberglass cloth, epoxy resin, aluminum, stainless steel, and Dacron, the transition period is likely to be uneven, with some materials available in limited quantities, through small-scale manufacturing or salvage. Thus, it seems premature to immediately shift to all post-industrial materials. Instead, a practical sailboat design must be flexible with regard to the choice of materials. The current materials of choice for constructing a sailboat hull are either fiberglass or polyester cloth and epoxy over Douglas fir marine plywood, fastened with bronze nails or stainless steel screws. The same hull shape can be executed in steam-bent quarter-sawn timbers and planking, caulked with hemp and sealed with pitch, but this is only feasible if you own a large stand of Douglas fir and have nothing but time. Sails can be made of

Dacron for as long as it is available, but of a shape that can be made from the stretchier and weaker flax canvas, such as the Junk rig.

The path back to all-wood sailboat construction is complicated by the increasing shortage of good quality wood. Houses are now often built out of many small sticks screwed together, and sheathed using oriented strand board, vinyl, and plasterboard. Furniture is now mostly made of particleboard dressed up with faux-wood plastic veneer. Wooden boats have to be built of more structurally sound materials, such as boards cut radially from old growth logs. As old growth forests are clear-cut and replanted, lumber of such quality is becoming increasingly rare and very expensive. The new growth trees are planted farther apart, to maximize growth rates, resulting in more widely spaced growth rings, and a weaker wood.

In the near future, as even wood pulp becomes scarce due to increased demand for cellulose-based fuels, we will no doubt remain supplied with furniture made of rammed earth, with an attractive faux-plastic adobe veneer, that is designed to fall apart when you first try to install it, rather than when you first try to move it. It would be used to furnish suburban mansions made of "housing bubbles," which also sounds like a weak material. But boats built in this manner would not stay afloat for very long.

A revival of wooden boatbuilding could be used to breathe life into forest conservation. It can provide a market for a high value added forestry product that requires forests to be managed sustainably, squeezing out the pulp and firewood farmers. If the boat hulls are constructed close to where the timber is grown and harvested, this can serve as the basis of a thriving local economy, allowing it to diversify from logging and sawmills. Such efforts cannot begin soon enough, because forests are under great stress throughout the planet, from the encroachment of agriculture, from logging, and from insects that are spreading further and further north due to global warming.

Regardless of one's choice of materials, it is possible to do quite a lot better than the majority of production sailboats by building one's own, backyard-style. Production boats are typically designed with recreation in mind, to be used during relatively warm weather, not for year-round on-board living in a cold climate. Many production boats lack insulation, and often have little more than a thin fiberglass shell between you and freezing water. Even when equipped with electric, propane, or diesel heaters, they tend to be cold and dank except during the summer, and prone to condensation and mildew.

At some point in time, perhaps months, perhaps years after the onset of the permanent, global energy shortage, those who had a hand in engineering the current transportation cul de sac will have an epiphany: the only remaining viable option is to revert to water freight, using sail power wherever possible. Since constructing entire new fleets of sailing ships while in the throes of a global energy crisis will hardly fall within the realm of practical possibility, their options will be limited to retrofits, and to the repurposing of existing vessels.

One such retrofit is already being marketed by a German company, under the name SkySails, and involves fitting out vessels such as oil tankers and container ships with large kites that can pull them downwind, allowing them to reduce oil consumption when moving in the general direction of prevailing winds. Although potentially valuable as a retrofit, it must be pointed out that this development is regressive, sending us back 2000 years to a time when it was only possible to sail downwind.

But we need not wait for epiphanies from those whose paycheck depends on them not having any. Any able-bodied person with the required skills, tools, materials, and half a year's time, can build a perfectly acceptable boat that can serve as a floating house and be used to cross oceans. The only thing missing from that list is a set of plans.

7. A Reasonable Set of Requirements

Nothing focuses the mind of a design engineer like a list of requirements. Let us then list out the requirements for a boat that would work best for our stated purposes. It would certainly be splendid if a credentialed naval architect or two rose to the challenge of carrying out the design work. But even if all self-respecting naval architects turn up their noses at something so unmarketable and unfashionable, this should not spell disaster: sailboat design is a rewarding area for a creative amateur as well as a professional.

The boat must provide accommodation, storage, and transportation for a family. She must be seaworthy enough to cross oceans, with generous fresh water tanks and plentiful storage space. She should have shallow draft, to float over flooded lands and shoals, into estuaries, and up and down rivers and canals, and a flat bottom, to settle upright. The masts should be stepped in tabernacles and rigged for easy lowering to pass under bridges and other obstructions. She must be designed to be beached and dragged or rolled ashore without suffering hull damage. She must be cheap to build, to maintain, and to operate. She must not require the use of advanced metallurgy or synthetics.

She must be designed not just for fair weather sailing, but also to survive the typical set of worst case scenarios. The increased frequency of extreme weather events will not add to the list of worst case scenarios with which sailboats must be designed to cope. However, since they will become more frequent, it will be even more important that all boats be designed to handle them well. If the boat has an open cockpit, causing the crew to swallow salt spray, which causes dehydration, hallucinations, and kidney failure, or has a keel that trips on water and causes a capsize, or has a tall mast and heavy standing rigging that catches enough wind to cause pitchpoling when running under bare poles, or insufficient internal ballast, causing wild motion that breaks crew's ribs as they are tossed about the cabin, then the design must be considered unacceptable, regardless of its other advantages.

She must be both well-insulated and well-ventilated, to protect her crew from the weather in any climate and season, both hot and cold. The cockpit must be enclosed and all control lines must lead inside the cockpit through baffles, protecting the crew from hypothermia, heat stroke, being washed overboard, or swallowing seawater. Since we expect there to be few rescue ships and helicopters available, our boat must be able to serve as its own lifeboat, containing enough flotation along the sides and the deck, and enough solid ballast along the bottom, to be unsinkable and self-righting even when holed and swamped.

She must look like a proper yacht, and not a shanty boat or a barge, because she must give coastal property owners no reason to complain to the harbormaster about the ugly thing spoiling their precious view. She may be stacked to the gunwales with dried sea squirrel, but to outward appearances (at least from a distance) she should give the impression that she is sailed by people of obvious quality and distinction, of the sort that snooty coastal property owners might want to invite over for gin and tonics, to catch up on the goings-on in San Tropez. She must have clean lines, a proper naval paint scheme, a modicum of shiny fittings and varnished wood, and be rigged to fly the appropriate flags in the customary way. In the future, I expect coastal property owners to get downright excited when they sight any sailboat, whether it looks fashionable or not, paddle out their leaky canoes, and try to barter jewelry, silver cutlery or pretty seashells for the things they desperately need. But until that happens, it is important to appease their sense of sailboat aesthetics.

She should also look sufficiently conventional and shipshape to give the U.S. Coast Guard no excuse to declare her "manifestly unsafe," pull the crew off the boat unceremoniously, and leave her foundering, which they have the right to do. But she should look sufficiently unmarketable to avoid giving state and federal authorities the impression that they could raise some money by seizing her through forfeiture, for some made-up transgression, and auctioning her off, which they also, unfortunately, have the right to do, and may start doing out of desperation.

8. The Simplest Solution that Works

Since almost all contemporary sailboats are designed for either sport or luxury, we can start with a blank slate, and dispense with most of the preconceived notions of what a sailboat must be like. However, there is an established style of boat that is so close to what we want that there seems to be no reason not to start with it. It is called the square boat, or

the Bolger Box, after Phil Bolger, a naval architect from Gloucester, Massachusetts, who is a renowned designer of square boats and other unusual craft.

The shape is based on a fishing boat native to the Atlantic coast of the United States, called sharpie, which started as the local Indian dugout, and which was once common all along the east coast from Maine to the Florida Keys. The sharpie has a sharp, vertical, wedge-like bow, from which it probably got its name, a flat, rockered bottom, and vertical sides, stem, and transom. Sharpies have been built in many sizes, from ten to fifty feet, but the sweet spot seems to be around 32 feet. Sharpies are light and fast, and were at one point banned from yacht racing because they won much too often, causing embarrassment to paying members of the yacht-racing set, who would rather lose than allow themselves to be seen sailing anything so obviously working class.

That such simple shapes can be so effective seemed paradoxical even to Bolger himself, who once wrote (of a boat of his, a perfectly serviceable dinghy called "The Brick," which really is just a box): "It's disconcerting that these box boats do everything better than elaborately modeled boats of the same overall dimensions..." There are few legitimate complaints about hull shape of the sharpie; among them is the annoyance caused by the slapping, or, in heavier weather, the pounding of the flat bottom against the water. Although this problem can be remedied by giving the bottom a slight v-shape, called "deadrise," at the bow and the stern, a much simpler and equally effective solution is to extend the bottom of the bow a few inches below the waterline.

Since a square boat is basically just four flat pieces curved around and fastened to several bulkheads and a transom, building one does not require molds or lofting (the painstaking task of transferring dimensions from a scaled drawing to a loft floor), and is well-suited to backyard construction. Bulkheads and the transom are cut out according to measurements and aligned upside-down along two straight pieces of dimensioned lumber, which is placed on two or more sawhorses. The sides are glued up from plywood panels, then fastened and glued to the stem and around the bulkheads, followed by the bottom. The hull is then flipped, and interior structures are installed, followed by the deck. In the process, flat pieces take up the right curves, and the structure remains symmetrical by virtue of starting with a stiff triangular box at the front. An outer layer of fiberglass cloth and epoxy makes for a longer-lasting, harder-wearing boat.

A 40-foot sqare boat cabin cruiser built using the best modern materials and methods available (plywood, fiberglass, and epoxy) requires approximately half a year of near-full-time effort by one person before she is ready for launch. The design is economical, and can be realized for a fifth or less of the cost of a production sailboat of similar size, putting it within reach of those whose means are quite limited. With proper care, the resulting hull will last three decades or more.

And then there are some shortcuts. With some up-front computer work using a CAD program, all the shapes can be pre-cut and pre-drilled using a CNC machine to fit together like pieces of a jigsaw puzzle. Using such a pre-cut kit, the hull can be assembled by a team, using a few hand tools: mixers, rollers, and spatulas for epoxy, drills for screws, and hammers for nails.

This
type of construction is common and practical using modern materials and
construction techniques. But even in their absence, the same hull shape
can be built using traditional techniques – the way it was once done by
fishermen from Maine to the Chesapeake.

The assembly can take place in three stages: sides and bottom; interior; and deck, with sufficient time in between for epoxying, fiberglassing, filleting, and painting. This barn-raising approach can reduce construction time considerably, especially if several boats are constructed in parallel. It can also be used to teach valuable skills, and to help cement the relationships within a nascent floating community.

The best places to build a boat are near water. In many of the more developed parts of the world, the oldest and most

economically depressed parts of town are those near rivers and canals. Many towns were founded on a river or a canal, but later turned toward the railroads, and then the highways, leaving the old infrastructure unused and decaying. It is often still there, and available. And although upscale marinas and boatyards that service luxury yachts are often busy and expensive, there are many working-class boatyards that service workboats and fishing boats, most of which have been idled due to depleted fish stocks, and much more affordable.

9. Lateral Resistance

Any boat that carries sail must provide for sufficient lateral resistance to keep the boat from developing sideways motion (known as leeway) when it is moving in any direction other than directly downwind. The device usually employed to counter this effect is a keel. All the more recent racing designs use long, thin fin keels. Keels are helpful on one point of sail: going to windward. They also suffer from many serious shortcomings.

Keels tend to hit things underwater, or, even worse, get stuck. In a particularly severe hit, the keel can come off, causing the boat to float upside-down. This puts a limit on how close to shore the boat can get, sometimes making it quite difficult to find an anchorage that is simultaneously deep enough, sheltered enough, and close enough to the shore. Boats with a fixed keel cannot be used on rivers and canals. Some of them can no longer safely navigate parts of the Intercoastal Waterway in the southern United States, which is not being dredged due to cutbacks in federal funding. Deep-water marinas tend get crowded mid-summer, and cost more than shallow-water marinas.

When riding out a storm, keelboats can trip over their keel while sliding sideways down a steep wave and capsize, sometimes losing their mast in the process. When caught in the shallows during an ebbing tide, keel boats don't just settle – they fall over and lie on their side. Keelboats cannot be pulled out of the water using a boat ramp, but require a crane. Keels are usually ballasted, to make the boat more stable, but this also makes the boat's motion in the waves more severe than if the ballast is internal to the hull.

One of the alternatives to a fixed keel is a centerboard, a pivoting fin that can be raised when approaching shallow water, or simply be allowed bounce along the bottom without suffering damage. A centerboard is housed in a centerboard trunk, a flat vertical box that takes up the most valuable piece of cabin space, directly in the center of the cabin. It also requires a slot to be cut through the bottom of the hull, and a box built around it, which is flooded to the waterline, and a hole in the bottom of the boat is not something to be taken lightly. It gives seafood a place to dwell, and in cold weather the outside of the centerboard trunk tends to form condensation. In spite of these detractions, a centerboard is an excellent alternative to a fixed keel.

Another alternative to a keel is leeboards, which are downward-pointing fins hung on the outside of the hull. They are ugly, noisy, and gather floating debris, which is a growing problem. (There are now areas known as oceanic garbage zones, made up of photodegraded plastic debris, one of which, in the Pacific, near the U.S. coast, has grown to the size of Texas.) On the plus side, leeboards free up cabin space.

Lastly, there is the new but reasonably well-tested concept called "chine runners," pioneered by a dedicated hobbyist by the name of Matt Leyden, who has used it on some tiny but quite shockingly capable and seaworthy cruising sharpies. They were used on 32 and 40 foot sharpies designed by Chris Morejohn. Chine runners are only applicable to square boats with vertical sides, and are formed by extending the edges of the flat bottom sideways by a few inches past the vertical sides, allowing the sides to act like keels.

Early experiments used chine runners to supplement a centerboard; however, it was soon discovered that small boats can sail quite passably to windward with the centerboard retracted. Chine runners are structurally very simple, their cost is low, and they suffer from none of the detractions of fixed keels, centerboards, or leeboards. They are less effective for larger boats, because in order for them to be effective the boat has to heel over quite far, presenting a large vertical surface to the water, and it is easier to make a small boat heel over than a large one, especially in light winds.

The best combination seems to be a sharpie with both chine runners and a centerboard, that goes well to windward with the centerboard down, and can still sail passably to windward over shallows, with the centerboard retracted. On a larger sharpie, windward performance with the centerboard up is about 55-60 degrees to the wind, no better than four knots, and sluggish tacking.

It is by no means certain, but quite conceivable that sharpies with chine runners in addition to a centerboard will follow the same path as other great inventions. They will initially be met with widespread incomprehension and outright dismissal. Once their many advantages become apparent, they will come to be ridiculed. This may seem strange but it is in fact quite typical. For instance, the modern safety bicycle was initially greeted with derision by cavalry officers, because bicyclists could not effectively fire weapons or wield sabers while riding. When ridicule fails to check its spread, the new invention comes to be accepted, albeit grudgingly. The last stage of acceptance is reached when those who initially opposed the idea begin to claim that they have been in favor of it all along.

10. One Boat, Many Uses

By far the simplest thing to do with a square boat once it is finished is to move in and live aboard without ever launching it. Its vertical sides and flat bottom make its interior more like that of a trailer home than a typical cruising sailboat. This may be a sensible thing to do in an area prone to floods: the boat can be tethered between two posts, floating up and settling as needed. When the land is dry, one bicycles to get around; when flooded, one rows a canoe, or a dinghy. This approach avoids real estate taxes, but may still require one to own or lease land.

The second simplest thing is to have your new waterproof home launched and towed out to a mooring, which, since the boat only draws a couple of feet, does not have to be in deep water, and can even dry out at low tide. For more money, one can rent a slip at a marina, gaining access to such modern conveniences as pumped water, electricity, on-shore showers and laundry, sewage pump-out services, and wireless Internet access, available while global supplies last. A mooring may work well during the warm months, when marinas are crowded and cost more, while the services provided by a marina matter more during the cold months.

The next, but by no means final step, is to outfit the boat for inland and coastal sailing and motoring, with a small four-stroke outboard motor, and a wardrobe of sails. A lot of other sundry sailing gear is needed as well, some of it required by the Coast Guard, some just useful: boat hooks, swim ladders, fenders, life jackets, anchors, flares, and so on.

The motor can be omitted if there are two or more strong-backed crew members, by equipping them with long oars, and the boat with oarlocks and sculling notches in the bow and transom. Without an engine, electricity for mooring lights (which are required) and cabin lights can to be supplied by a solar panel and a wind turbine. An inboard diesel is available as an option for those who enjoy unnecessary expense, water and oil in the bilge, dragging a propeller when under sail, and soot.

Sails need not cost thousands of dollars: for making short trips in decent weather, a Junk sail can be rigged using lumberyard supplies and construction tarp. For purely aesthetic reasons, white tarp works better socially than the more common blue tarp. If the boat only needs to move a short distance, at a time of your choosing, in order to comply with local regulations for how long you may remain anchored in any one place, this is all you would need.

At the other extreme, ocean passages require quite a lot more equipment and preparation. There are, however, no technical problems with a square boat taking to the open ocean, provided she is well-built, equipped, and sailed with sufficient attention and skill. It has been done many times by many people, in square boats big and small.

11. Living Aboard

A small cottage in the woods can be fitted out in a number of ways. At one extreme is the self-sufficient rustic cabin, with a quaint outhouse, a wood stove, and firewood stacked neatly under the eaves. At the other extreme is a posh computer-controlled techno-pod with every conceivable gadget built in, and a fat umbilical chord that connects it to technological civilization, which supplies it with a steady stream of high-tech replacement parts. Similarly, a boat can be fitted out in any number of ways, from shantyboat-style to luxury yacht-style.

The shantyboat may feature a stove that can burn charcoal, wood, or dried sea squirrels. The heads (the nautical term for latrine) can consist of a bucket with a tight-fitting lid and a toilet seat. Water can be provided by a foot pump and some hoses connecting it to the sink and the water tank. Refrigeration can be provided by an icebox, illumination by flashlights, a kerosene lamp, or candles. Mid-range, we find propane stoves, solar panels, wind generators, composting toilets, (or flush toilets with on-board septic tanks, which are not an unmitigated blessing by any means), and electric or propane refrigerators.

The realm of pure luxury includes such things as on-board washers and driers, central heating and air conditioning, and a world-class fossil fuel habit to go with them. But that seems quite unnecessary: plenty of people have managed to live aboard, and even circumnavigate the globe, without such power-hungry gadgetry. A tank of propane and a few of jerricans of fuel can last for many months at sea.

Regardless of whether the accommodations are Spartan or palatial, living aboard and sailing have a great organizing effect on the mind, and provide plenty of exercise for the body. The human mind reacts well to challenging and even dangerous circumstances provided the danger can be controlled without resulting in stress. Living a long, happy life just a few consecutive mistakes away from drowning is just that sort of danger.

For the body, the work of opposing the motion of the boat, which is more or less constant, provides isometric exercise similar to a Pilates workout, and people who live aboard are rarely overweight. When the boat is underway, everyone has a job to do, acting as a team, and someone always has to be in command. Some families and friends find that they cannot do this; others take naturally to it, are sometimes much improved by it, and in the end come resemble a well-oiled machine, with set roles and sure, almost choreographed movements.

The transition to living aboard can be quite tricky. Firstly, one's earthly possessions must be pared down to the bare essentials, which are all that will fit on a boat. Then one must get used to the constant motion, the sounds, the smells, and the lack of privacy. Everyone, including cats and dogs, initially gets seasick, but eventually adjusts, although a stormy night in an unprotected anchorage never becomes pleasant.

Living aboard is just fine for infants, a bit tricky for toddlers, and just fine for preadolescent children. Adolescents are, of course, difficult, sometimes to the point of requiring a boat of their own, which can be towed when underway, in case they become too preoccupied with being adolescents to steer a course. Old people range from salty dogs who have trouble falling asleep "on the hard" to landlubbers who get queasy just looking at sailboats bobbing about while toying with their food at the marina restaurant.

A good marina can provide a community of a quality that is not often found on land, with the proviso that one likes quite a lot of company and does not mind spending a lot of time in close quarters with other people. Marinas tend to be like small villages, where everyone gets to know everyone else's business, sometimes inadvertently. This can get to be too much, and degenerate into soap opera. Sound caries well over water, and people who cannot hear themselves shouting at someone close by often can and do hear the ensuing chuckles, or groans, coming from quite far away. But living aboard makes it relatively easy and inexpensive to get away and stay somewhere else, for a night, a week, or a season, at a

nearby anchorage, or, given enough time, halfway across the world.

While it is by no means for everyone, living aboard is one of the few ways available to people of modest means to live in a city of their choice, own their residence free and clear, never pay a penny of real estate tax, and vacation for as long as and wherever they please, remaining debt-free all the while. It can be much less expensive than living on land, freeing up much time for things other than work, such as providing home schooling for one's children, traveling the world, spending time with friends and family, or just quietly contemplating this crazy world, which is spinning further and further out of control with each passing day.

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No one left to scream and shout

People walking on the moon

Smog gonna get you pretty soon

Ship of fools, ship of fools

Climb on board