Chapter Fourteen
Decentralized Production Technology

Introduction

According to Langdon Winner, one of the central problems of the alternative technology movement is its lack of perspective:

> Insofar as they had a coherent idea of how their labors would change the world, the appropriate technologists usually entertained the better mousetrap theory. A person would build a solar house or put up a windmill, not only because he or she found it personally agreeable, but because the thing was to serve as a beacon to the world, a demonstration model to inspire emulation. If enough folks built for renewable energy, so it was assumed, there would be no need for the nation to construct a system of nuclear power plants. People would, in effect, vote on the shape of the future through their consumer/builder choices. This notion of social change provided the underlying rationale for the amazing emphasis on do-it-yourself manuals, catalogues, demonstration sites, information sharing, and "networking" that characterized appropriate technology during its heyday. Once people discovered what was available to them, they would send away for the blueprints and build the better mousetrap themselves. As successful grass-roots efforts spread, those involved in similar projects were expected to stay in touch with each other and begin forming little communities, slowly reshaping society through a growing aggregation of small-scale social and technical transformation. Racial social change would catch on like disposable diapers, Cuisinarts, or some other popular consumer item.
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> The inadequacies of such ideas are obvious. Appropriate technologists were unwilling to face squarely the facts of organized social and political power. Fascinated by dreams of a spontaneous, grass-roots revolution, they avoided any deep-seeking analysis of the institutions that control the direction of technological and economic development. In this happy self-confidence they did not bother to devise strategies that might have helped them overcome obvious sources of resistance. The same judgment that Marx and Engels passed on the utopians of the nineteenth century apply just as well to the appropriate technologists of the 1970s: they were lovely visionaries, naive about the forces that confronted them.
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> Far and away the most grievous weakness in their vision, however, was the lack of any serious attention to the history of modern technology. Presumably, if the idea of appropriate technology makes sense, one ought to be able to discover points at which developments in a given field took an unfortunate turn, points at which the choices produced an undesirable instrumental regime. One could, for example, survey the range of discoveries, inventions, industries, and large-scale systems that have arisen during the past century and notice which paths in modern technology have been selected. One might then attempt to answer such questions as, Why did developments proceed as they did? Were there any real alternatives? Why weren't those alternatives selected at the time? How could any such alternatives be reclaimed now? In some of their investigations in agriculture and energy, appropriate technologists began to ask such questions. But by and large most of those active in the field

were willing to proceed as if history and existing technical realities simply did not matter.[1]

Of course there's nothing wrong with attempting to provide a demonstration effect, a "beacon to the world," through the use of appropriate technology. But it's not likely to make much progress if it relies entirely on the overcoming of immediate self-interest by ideological zeal, and involves swimming upstream against the incentives of the market. So long as the market incentives work against the adoption of appropriate technology for reasons of genuine cost-efficiency and economic independence, appropriate technology will be adopted only by those who value it as a consumption good rather than as a means to an end. As I argued in Chapter Twelve, any successful demonstration effect will rely on the fact that appropriate technology is better than the conventional alternatives *in terms of cost*. And the reason alternative technology has had so little demonstration effect is that the state has artificially lowered the cost of energy and transportation inputs, as well as the cost of large scale and centralization; as a result the cost differential between conventional technology and decentralized, human scale technology is far less than it would otherwise be. As we saw in Chapter Twelve, people will adopt alternative technology when they see it being used by their neighbors, and it is demonstrated to be significantly cheaper and provide more economic independence and security than conventional technology.

So I've tried to avoid the failings of the alternative technology movement as described by Winner. My discussion in this chapter, of the rivalry between conventional and alternative technology, is intended to be understood in the context of the analysis of the power structures of state capitalism presented in the preceding chapters of this book. And I mean for the prospects for the adoption of alternative technology to be understood squarely in the context of the input crises of state capitalism, which are rendering conventional technology economically untenable. In short, my treatment is meant to be "scientific" rather than "utopian."

The basic vision of libertarian economics, at least for those of us on the decentralist Left, was summed up pretty well by Colin Ward, in describing Kropotkin's economic goals:

> Kropotkin sought a society which continued labour-intensive agriculture and small-scale industry, both producing for local needs, in a decentralized pattern of settlement in which the division of labour had been replaced by the integration of brainwork and manual work, and he was optimistic enough to believe that trends current in his day were leading to this kind of society. His picture of the future appealed to his fellow-anarchists as the kind of economic structure which would suit a worker-controlled federation of self-governing workshops and rural communes.[2]

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[1] Langdon Winner, *The Whale and the Reactor* , pp. 79-80.
[2] Colin Ward commentary, in Peter Kropotkin, *Fields, Factories and Workshops Tomorrow*. Edited, with introduction and commentary, by Colin Ward (New York, Evanston, San Francisco, and London: Harper & Row, Publishers, 1974), p. 201.

E. F. Schumacher, in *Small is Beautiful*, outlined the basic principles of liberatory technology:

> What is it that we really require from the scientists and technologists? I should answer: We need methods and equipment which are
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> --cheap enough so that they are accessible to virtually everyone;
> --suitable for small-scale application; and
> --compatible with man's need for creativity.[3]

Elaborating on the first criterion, he cited Gandhi's dictum that "there should be no place for machines that concentrate power in a few hands and turn the masses into mere machine minder, if indeed they do not make them unemployed."

Decentralized, small-scale technology, Schumacher quoted Aldous Huxley as saying, would provide the average person with the means of

> doing profitable and intrinsically significant work, of helping men and women to achieve independence from bosses, so that they may become their own employers, or members of a self-governing, cooperative group working for subsistence and a local market... [T]his differently orientated technological progress [would result in] a progressive decentralization of population, of accessibility of land, of ownership of the means of production, of political and economic power.[4]

Schumacher's criterion of affordability, formulated as a general rule of thumb, amounted to enterprise capitalization per worker equivalent to an average worker's annual income.[5]

On the benefits of the second criterion, small-scale application, he predicted that "men organized in small units will take better care of their bit of land or natural resources than anonymous companies or megalomaniacal governments...."[6]

Schumacher contrasted "mass production" with "production by the masses": the latter "mobilises the priceless resources which are possessed by all human beings, their clever brains and skilful hands, and *supports them with first-class tools*...."

> The technology of *production by the masses*, making use of the best modern knowledge and experience, is conducive to decentralisation, compatible with the laws of ecology, gentle in its use of scarce resources, and designed to serve the human person instead of making him

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[3] *Small is Beautiful*, p. 34.
[4] From *Towards New Horizons* by Pyarelal (Navajivan Publishing House, Ahmedabad, India, 1959), in Schumacher, Ibid., p. 35.
[5] Ibid., p. 35.
[6] Ibid., p. 36.

the servant of machines.[7]

In another attempt to articulate the principles of human scale technology, in the context of Third World development, Schumacher wrote:

> The task... is to bring into existence millions of new workplaces in the rural areas and small towns. That modern industry, as it has arisen in the developed countries, cannot fulfill this task should be perfectly obvious. It has arisen in societies which are rich in capital and short of labour and therefore cannot possibly be appropriate for societies short of capital and rich in labour....
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> The real task may be formulated in four propositions:
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> *First*, that workplaces have to be created in the areas where the people are living now, and not primarily in metropolitan areas into which they tend to migrate.
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> *Second*, that these workplaces must be, on average, cheap enough so that they can be created in large numbers without this calling for an unattainable level of capital formation and imports.
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> *Third*, that the production methods employed must be relatively simple, so that the demands for high skills are minimised, not only in the production process itself but also in matters of organisation, raw material supply, financing, marketing, and so forth.
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> *Fourth*, that production should be mainly from local materials and mainly for local use.[8]

The good news is that the choice of such technologies would not require imposition by the state, or any heroic individual act of voluntary renunciation. In Chapter One, we have already seen that decentralized, less capital-intensive production for local markets using general-purpose machinery would likely be cheaper overall compared to large-scale, centralized, capital-intensive production using highly specialized machinery—cheaper, that is, when all costs are actually internalized in the price of finished goods, rather than footed by the taxpayer. And as we saw in Chapter Twelve, when all the subsidies to long-distance distribution costs, capital-intensiveness, research and development, and to the other costs of large-scale enterprise are eliminated--and when all the state's cartelizing regulations, entry barriers, and other protections against the competitive costs of inefficiency are likewise eliminated--it is likely that such a model of production will be the spontaneous outcome of market forces.

A. Multiple-Purpose Production Technology.

Perhaps the most important concept for decentralized economics is the multiple-

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[7] Ibid., pp. 153-54.
[8] Ibid., pp. 174-76.

purpose production technology described by Murray Bookchin and Kirkpatrick Sale. The basic principle, though, was stated by F. M. Scherer:

> Ball bearing manufacturing provides a good illustration of several *product-specific* economies. If only a few bearings are to be custom-made, the ring machining will be done on general-purpose lathes by a skilled operator who hand-positions the stock and tools and makes measurements for each cut. With this method, machining a single ring requires from five minutes to more than an hour, depending on the part's size and complexity and the operator's skill. If a sizable batch is to be produced, a more specialized automatic screw machine will be used instead. Once it is loaded with a steel tube, it automatically feeds the tube, sets the tools and adjusts its speed to make the necessary cuts, and spits out machined parts into a hopper at a rate of from eighty to one hundred forty parts per hour. A substantial saving of machine running and operator attendance time per unit is achieved, but setting up the screw machine to perform these operations takes about eight hours. If only one hundred bearing rings are to be made, setup time greatly exceeds total running time, and it may be cheaper to do the job on an ordinary lathe.[9]

In a Ploughboy Interview with *Mother Earth News*, Ralph Borsodi spoke of the superior overall efficiency of small-scale production for most commodities, when internal economies of scale were offset by distribution costs.

> ….Adam Smith completely overlooked what factory production does to distribution costs. It pushes them up. Goods cannot be manufactured in a factory unless raw materials and fuel and workers and everything else are brought there. This is a distribution cost. And then, after you've put together whatever you're making in that plant, you've got to ship it out to the people who consume it. That can become expensive too. Now I've produced everything from tomato crops to suits of clothing which I've hand spun on my own homestead and I've kept very careful records of every expense that went into these experiments. And I think the evidence is pretty clear that probably half to two-thirds--and it's nearer two-thirds--of all the things we need for a good living can be produced most economically on a small scale . . . either in your own home or in the community where you live. The studies I made at Dogwoods--the "experiments in domestic production"--show conclusively that we have been misled by the doctrine of the division of labor. Of course there are some things-from my standpoint, a few things-that cannot be economically produced in a small community. You can't make electric wire or light bulbs, for example, very satisfactorily on a limited scale. Still virtually two thirds of all the things we consume are better off produced on a community basis.[10]

In fact, as Kirkpatrick Sale pointed out, even Borsodi overstated the superiority of large-scale factory production. Sale questioned Borsodi's specific example of copper wire. The average lighting and wiring factory, even under present conditions, employs

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[9] F.M. Scherer and David Ross, *Industrial Market Structure and Economic Performance*. 3rd ed (Boston: Houghton Mifflin, 1990), p. 97.
[10] "Plowboy Interview," *Mother Earth News*, March-April 1974 <http://www.soilandhealth.org/03sov/0303critic/Brsdi.intrvw/The%20Plowboy-Borsodi%20Interview.htm>.

only around 65 workers.

> Posit an efficient plant, limited differentiation, and a market of 3,500 households, and the factory could be many times smaller; then figure that the quality could be improved by careful work on a limited number of items... so production quotas could be considerably reduced and the plant made even smaller; lastly, add in the effect of recycling on limiting annual production..., and the operation could be smaller still....[11]

This would be made possible by the adoption of multiple-purpose production machinery for frequent switching from one short production run to another--as opposed to the current practice, in large-scale, capital intensive manufacturing, of using expensive, specialized production machinery that can only pay for itself with long production runs for giant market areas. Murray Bookchin, in *Post-Scarcity Anarchism*, described the concept:

> The new technology has produced not only miniaturized electronic components and smaller production facilities but also highly versatile, multi-purpose machines. For more than a century, the trend in machine design moved increasingly toward technological specialization and single purpose devices, underpinning the intensive division of labor required by the new factory system. Industrial operations were subordinated entirely to the product. In time, this narrow pragmatic approach has "led industry far from the rational line of development in production machinery," observe Eric W. Leaver and John J. Brown. "It has led to increasingly uneconomic specialization.... Specialization of machines in terms of end product requires that the machine be thrown away when the product is no longer needed. Yet the work the production machine does can be reduced to a set of basic functions--forming, holding, cutting, and so on--and these functions, if correctly analyzed, can be packaged and applied to operate on a part as needed."
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> Ideally, a drilling machine of the kind envisioned by Leaver and Brown would be able to produce a hole small enough to hold a thin wire or large enough to admit a pipe....
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> The importance of machines with this kind of operational range can hardly be overestimated. They make it possible to produce a large variety of products in a single plant. A small or moderate-sized community using multi-purpose machines could satisfy many of its limited industrial needs without being burdened with underused industrial facilities. There would be less loss in scrapping tools and less need for single-purpose plants. The community's economy would be more compact and versatile, more rounded and self-contained, than anything we find in the communities of industrially advanced countries. The effort that goes into retooling machines for new products would be enormously reduced. Retooling would generally consist of changes in dimensioning rather than in design.[12]

As Kirkpatrick Sale observed, the same plant could (say) finish a production run of 30,000 light bulbs, and then switch to wiring or other electrical products--thus "in effect becoming a succession of electrical factories." A machine shop making electric vehicles

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[11] *Human Scale*, p. 405.
[12] Murray Bookchin, *Post-Scarcity Anarchism*, pp. 110-111.

could switch from tractors to reapers to bicycles.[13]

Some special-purpose machines, of course--Bookchin specifically mentions bottling and canning machines--would continue to be useful even in the context of a decentralized economy. At the same time, some kinds of production (like heavy engine blocks), that can only be done with large, specialized, capital-intensive facilities, would likely face drastic reductions in demand for their products--if the products continued to be used at all:

> A major shift from conventional automobiles, buses and trucks to electric vehicles would undoubtedly lead to industrial facilities much smaller in size than existing automobile plants.[14]

The connection between decentralized, small-scale production technology and demand-pull distribution was explained by the authors of *Natural Capitalism*, regarding the inefficiencies of the cola industry:

> All this results from the mismatch between a very small-scale operation--drinking a can of cola--and a very large-scale one, producing it. The production process is designed to run in enormous batches, at very high speeds, with very high changeover costs. But that logic is the result of applying to business organization precisely the same design flaw--discussed in the previous chapter at the level of components--namely, optimizing one element in isolation from others and thereby pessimizing the entire system. Buying the world's fastest canning machine to achieve the world's lowest fill cost per can presumably looks like an efficient strategy to the canner. But it doesn't create consumer value at least cost, because of such expenses as indirect labor (in such forms as technical support), the inventories throughout the value chain, and the pervasive costs and losses of handling, transport and storage between all the elephantine parts of the production process.... [F]rom a whole-system perspective, the giant cola-canning machine may well cost more per delivered can than a small, slow, unsophisticated machine that produces the cans of cola locally and immediately on receiving an order from the retailer.[15]

Recall, in Chapter Eight, an example we cited from Waddell's and Bodek's *Rebirth of American Industry*. A corporate bean-counter, trained in the Sloan system of accounting, demanded that an auto plant production manager tell him the exact cost of installing the steering wheel in each car. Sloan accounting obsesses on minimizing the cost and optimizing the efficiency of each individual step in the production process, in isolation from the process as a whole. Toyota accounting defines efficiency in terms of optimizing the flow of the overall process.

Eric Husman, commenting on Bookchin's and Sale's treatment of multiple-purpose

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[13] *Human Scale*, pp. 409-410.
[14] Bookchin, *Post-Scarcity Anarchism*, p. 112.
[15] Paul Hawken, Amory Lovins, and L. Hunter Lovins, *Natural Capitalism: Creating the Next Industrial Revolution* (Boston, New York, London: Little, Brown and Company, 1999), p. 129.

production technology as described in the initial draft of this chapter, points out that they were to a large extent reinventing the wheel:

> *Human Scale* (1980) was written without reference to how badly the Japanese production methods (especially those of Toyota, but also Honda) were beating American mass production methods at the time.... What Sale failed to appreciate is that the Japanese method (derived more from Fordism than from Taylorism, and almost diametrically opposed to the Sloan method that Sale is almost certainly thinking of as "mass production") allows the production of *higher* quality articles at *lower* prices....
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> ....Taichi Ohno would laugh himself silly at the thought of someone toying with the idea [of replacing large-batch production on specialized machinery with shorter runs on general-purpose machinery] 20 years after he had *perfected* it. Ohno's development of Toyota's Just-In-Time method was born exactly out of such circumstances, when Toyota was a small, intimate factory in a beaten country and could not afford the variety and number of machines used in such places as Ford and GM. Ohno pushed, and Shingo later perfected, the idea of Just-In-Time by using Single Minute Exchange of Dies (SMED), making a mockery of a month-long changeover. The idea is to use general machines (e.g. presses) in specialized ways (different dies for each stamping) and to vary the product mix on the assembly line so that you make some of every product every day.
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> The Sale method (the slightly modified Sloan/GM method) would require extensive warehouses to store the mass-produced production runs (since you run a year's worth of production for those two months and have to store it for the remaining 10 months). If problems were discovered months later, the only recourse would be to wait for the next production run (months later). If too many light bulbs were made, or designs were changed, all those bulbs would be waste. And of course you can forget about producing perishables this way. The JIT method would be to run a few lightbulbs, a couple of irons, a stove, and a refrigerator every hour, switching between them as customer demand dictated. No warehouse needed, just take it straight to the customer. If problems are discovered, the next batch can be held until the problems are solved, and a new batch will be forthcoming later in the shift or during a later shift. If designs or tastes change, there is no waste because you only produce as customers demand.[16]

The serial production runs on multiple-purpose machinery favored by Bookchin and Sale, and the simultaneous production of different products using different dies on the same general-purpose machines favored by the Japanese, seem to be alternative approaches to solving the same problem.

Interestingly, H. Thomas Johnson, in his Foreword to Waddell's and Bodek's *The Rebirth of American Industry* (something of a bible for American devotees of the Toyota Production System) speculates along exactly those lines:

> Waddell and Bodek call for restoring American industry by replacing the Sloan model of

[16] "Human Scale Part II--Mass Production," *Grim Reader* blog, September 26, 2006 <http://www.zianet.com/ehusman/weblog/2006/09/human-scale-part-ii-mass-production.html>.

> financial management with lean management. Rightly, they refrain from describing in any detail what form this restoration might take. That issue is the next frontier of research and practice concerning lean management. Some people, I am afraid, see lean as a pathway to restoring the large manufacturing giants the United States economy has been famous for in the past half century.
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> Overlooked in this picture are the unfortunate environmental consequences of building such global production systems. The cheap fossil fuel energy sources that have always supported such production operations cannot be taken for granted any longer. One proposal that has great merit is that of rebuilding our economy around smaller scale, locally-focused organizations that provide just as high a standard living [sic] as people now enjoy, but with far less energy and resource consumption. Helping to create the sustainable local living economy may be the most exciting frontier yet for architects of lean operations. Time will tell.[17]

Johnson expanded on this theme, referring to the common perception that economic decentralism "would cause consumers' standards of living to fall because it would reduce the economies and efficiencies of large-scale production and distribution systems that we ostensibly have in the world today."

> Herein lies the importance of understanding the fallacies of scale-economy thinking. In reality, production systems designed along the lines of Toyota's turn scale-economy thinking on its head: they make it possible to build manufacturing capacity on a much smaller scale than ever before thought possible, yet produce at unit costs equal to or lower than those of large-scale facilities now thought so necessary for cost-effective operations.
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> An example of this is found in Toyota's organization. Compare the plant that makes Camry and Avalon models in Melbourne, Australia with the plant that makes the same models in Georgetown, Kentucky. Located within or nearby each plant are complete facilities for engine build, axle build, plastic trim and bumper production, stamping, body weld, seat build, and final assembly. According to Toyota, these two vertically integrated plants are equally efficient and effective on all dimensions that matter to Toyota customers. However, the Melbourne plant currently produces about 90,000 vehicles per year, primarily for the Australian market, whereas the Georgetown plant produces about 500,000 vehicles per year.
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> If a fivefold difference in capacity yields no unit-cost differences between these two plants, then what is to be said on behalf of scale economies? In fact, Toyota people have said they probably will not build another plant as large as Georgetown in the future. The company currently is building new plants, smaller in scale and located as close as possible to customer markets. Carried to its logical extent, Toyota's example helps show how bioregional economies of 10 to 30 million people could support high-variety and low-cost manufacturing facilities for a wide range of products. Indeed, the relatively isolated Australian economy, with about 20 million people and a vast land area, supports several auto manufacturing operations in addition to Toyota's, as well as facilities producing a wide array of other

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[17] H. Thomas Johnson, "Foreword," William H. Waddell and Norman Bodek, *Rebirth of American Industry: A Study of Lean Management* (Vancouver, WA: PCS Press, 2005), p. xxi.

products just for Australian consumers.

> There are now ample technologies available to support efficient small-scale operation of almost every commercial activity. Some examples among many include the continuous-casting, mini-mill technology that transformed steel making in the last 30 years, small-scale refineries and chemical plants for almost all current petroleum and chemical processing, and Japanese paper-products plants that efficiently produce on a much smaller scale than American papermakers, for example, might think possible.[18]

And the market area Johnson writes of, with a population starting at ten million, is an upper-range estimate applying only to the most capital-intensive forms of production. Bear in mind that conventional auto design, with heavy internal-combustion engine blocks, is an "answer" to a manufactured need. The light electrical vehicles mentioned by Bookchin above, and the hypercar mentioned below, are examples of alternatives that can be produced on a much smaller scale for local markets. In short, the kind of heavy internal combustion vehicle Toyota makes might end up as a latter-day buggy whip. Johnson acknowledges as much:

> Especially interesting are eco-designer Amory Lovins's paradigm-breaking examples of how the industrial economy can flourish at a much smaller scale than ever thought possible by rethinking, for example, the design of automobiles (with carbon composite bodies and hydrogen-cell power trains)....[19]

Michael Shuman, in *The Small-Mart Revolution*, cites Johnson on the adaptability of lean methods to small-scale production for local markets. He also quotes Paul Kidd, author of *Agile Manufacturing*, on the use of "economies of scope" ("the principles that machines should be used to make a wide range of product lines with small batch sizes") to tailor product lines to specific markets.[20] The efficiencies of lean local production become even greater, as Shuman points out, when the high costs of large-scale distribution enter the picture.[21] That's especially true given the nature of the global distribution system which, as we will see immediately below, amounts even in large-scale lean production to the outsourcing of excess inventories to warehouses on wheels or on the ocean. And local, demand-pull, customer-driven distribution chains (for example, community-supported agriculture and other subscription-based services) can drastically reduce the marketing costs of push distribution.[22]

Husman himself is an enthusiastic advocate for the superior cost-effectiveness of localized production, and its special suitability to lean production:

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[18] Johnson, "Confronting the Tyranny of Management by Numbers," *Reflections: The SoL Journal*, vol. 5, no. 4 (2004), pp. 8-9
[19] Ibid., p. 9.
[20] Michael H. Shuman, *The Small-Mart Revolution: How Local Businesses are Beating the Global Competition* (San Francisco: Barrett-Koehler Publications, Inc., 2006, 2007), pp. 70-71.
[21] Ibid., pp. 71-72.
[22] Ibid., p. 72.

> For another view of self-sufficiency - and I hate to beat this dead horse, but the parallel seems so striking - we have the lean literature on local production. In *Lean Thinking*, Womack et al discuss the travails of the simple aluminum soda can. From the mine to the smelter to the rolling mill to the can maker alone takes several months of storage and shipment time, yet there is only about 3 hours worth of processing time. A good deal of aluminum smelting is done in Norway and/or Sweden, where widely available hydroelectric power makes aluminum production from alumina very cheap and relatively clean. From there, the cans are shipped to bottlers where they sit for a few more days before being filled, shipped, stored, bought, stored, and drank. All told, it takes 319 days to go from the mine to your lips, where you spend a few minutes actually using the can. The process also produces about 24% scrap (most of which is recycled at the source) because the cans are made at one location and shipped empty to the bottler and they get damaged in transit. It's an astounding tale of how wasteful the whole process is, yet still results in a product that - externalities aside - costs very little to the end user. Could this type of thing be done locally? After all, every town is awash in a sea of used aluminum cans, and the reprocessing cost is much lower than the original processing cost (which is why Reynolds and ALCOA buy scrap aluminum).
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> Taking this problem to the obvious conclusion, Bill Waddell and other lean consultants have been trying to convince manufacturers that if they would only fire the MBAs and actually learn to manufacture, they could do so much more cheaply locally than they can by offshoring their production. Labor costs simply aren't the deciding factor, no matter what the local Sloan school is teaching: American labor may be more expensive then [sic] foreign labor, but it is also more productive. Further, all of the (chimerical) gains to be made from going to cheaper labor are likely to be lost in shipping costs. Think of that flotilla of shipping containers on cargo ships between here and Asia as a huge warehouse on the ocean, warehouses that not only charge rent, but also for fuel.[23]

Just-in-Time methods, as they are applied in the existing global market, rely pretty intensively on such "warehouses on the ocean" or (for the domestic market) warehouses on wheels. If they are scalable to decentralized production for local markets, so as to eliminate the need for such expensive distribution pipelines, then they would seem to be a viable local production alternative to the Bookchin-Sale model.

Husman, incidentally, describes a localized "open-source production" model, with numerous small local machine shops networked to manufacture a product according to open-source design specifications and then to manufacture replacement parts and do repairs on an as-needed basis, as "almost an ideally Lean manufacturing process. Dozens of small shops located near their customers, each building one at a time."[24]

And the authors of *Natural Capitalism* see small-scale local production as the ideal embodiment of lean thinking, as well:

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[23] "Human Scale Part III--Self-Sufficiency," *Grim Reader* blog, October 2, 2006 <http://www.zianet.com/ehusman/weblog/2006/10/human-scale-part-iii-self-sufficiency.html>.
[24] Eric Husman, "Open Source Automobile," *GrimReader*, March 3, 2005 <http://www.zianet.com/ehusman/weblog/2005/03/open-source-automobile.html>.

> The essence of the lean approach is that in almost all modern manufacturing, the combined and often synergistic benefits of the lower capital investment, greater flexibility, often higher reliability, lower inventory cost, and lower shipping cost of much smaller and more localized production equipment will far outweigh any modest decreases in its narrowly defined "efficiency" per process step. It's more efficient overall, in resources and time and money, to scale production properly, using flexible machines that can quickly shift between products. By doing so, all the different processing steps can be carried out immediately adjacent to one another with the product kept in continuous flow. The goal is to have no stops, no delays, no backflows, no inventories, no expediting, no bottlenecks, no buffer stocks, and no *muda*. Surprisingly, this is as true for small- as for large-scale production.[25]

This is, incidentally, the model that prevails in Italy's Emilia-Romagna region, which is organized on a "cluster model" of "[s]mall firms operating in cooperative networks...." There is very little vertical integration, with most firms subcontracting with the minority of firms that produce finished goods. Not only is it a regional manufacturing economy built around the cooperative networking of small firms, but it has the highest rate of cooperative ownership in Italy--some eight thousand of them in the region, in fact (with cooperatives producing some 45% of the region's GDP).[26] Sebastian Brusco, an authority on the region, writes that the artisans and small entrepreneurs of Emilia-Romagna have

> created associations to provide administrative services for themselves and to coordinate purchasing and credit, thus establishing on a cooperative basis the conditions of achieving minimum scale of operation....
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> These associations also establish technical consultancy offices, consortia for marketing and the purchase of raw and semi-fabricated materials, and most importantly, cooperatives which provide guarantees for bank loans which can thus be obtained at the lowest possible rate of interest.[27]

The heart of Emilia-Romagna's economy is its "flexible manufacturing networks." Bruce Herman, another specialist on the region, describes how they came about:

> "Initially the small firms of Emilia Romagna served large enterprise as dependent subcontractors. To overcome the negative consequences of this situation, small shops learned to diversify their client base through horizontal linkages to small firms. Relationships of trust grew as firms subcontracted among themselves rather then refusing to take on contracts too large for the individual shop."
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> Flexible specialization evolved and this strengthened commercial linkages and these

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25 *Natural Capitalism*, pp. 129-130.
26 Robert Williams, "Bologna and Emilia Romagna: A Model of Economic Democracy," paper presented to the annual meeting of the Canadian Economics Association, University of Calgary. May/June 2002, pp. 8-9, 24 <http://www.bcca.coop/pdfs/BolognaandEmilia.pdf.>
27 Sebastian Brusco, Emilian Model: Productive Decentralization and Social Integration, Cambridge Journal of Economics, 1982, 6, pages 167-184, in Ibid., p. 10.

> SME’s then began to coordinate their respective enterprises, creating value-added partnerships and value-added goods.
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> > This cooperation allowed these players to jointly bid on larger contracts, which led to the growth of flexible manufacturing networks.

The region's average wage is double that of Italy as a whole, and has among the highest productivity rates in Europe.[28]

So it seems Husman was right. Bookchin's system of localized batch production, using multiple-purpose machinery and switching serially between production runs, would indeed be a step in the right direction. It would not be fair, strictly speaking, to dismiss it --as Husman does--as a "slightly modified" version of Sloanism. But while far more efficient and localized, it would still be a more efficient and localized version of Sloanism, and only a partial step toward the efficiencies that could be realized by lean production at the local level.

The need to make efficient use of small facilities (even with Single Minute Exchange of Dies) would rule out what Sale described as "the incessant and needless turnover in products, made not to be better or more useful but only to be marginally new and infinitesimally different."[29] The need for a single factory, in many cases, to switch back and forth between products another might limit the variations in style that could be made without prohibitive increases in production cost (the cost of annual model changes is roughly 40% of a car's sticker price).[30] But the shift away from the current push distribution model, which came about mainly to dispose of overproduction by overbuilt factories, would do away with the primary motivation for such dreck. It's likely, under such conditions, that product design would take on a quasi-Fordist model of finding a cheap, durable, reliable and easy-to-repair model, and then sticking with it in between major generational changes of technology.

There are a few products, arguably, that require large-scale, capital-intensive forms of production: the automobile, the jumbo jet, and so forth. But the demand for such products, arguably, would likely be far less in the first place if they were not subsidized. Some of them most likely would simply never have come into existence in a free market, because their production would have entailed massive losses without the state making them artificially profitable. The clearest example is probably the jumbo jet which, as we saw in Chapter Three, would probably not have been profitable to produce without the government's heavy bomber program to guarantee production runs long enough to fully utilize the expensive capital equipment.

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[28] Bruce Herman, "Industrial Development: Targeting New and Basic Industries," National Council for Urban Economic Development, October 1988, in Ibid., p. 12.
[29] *Human Scale*, p. 90.
[30] Barry Stein, *Size, Efficiency, and Community Enterprise*, pp. 41-42.

Other products, like the automobile, have taken far more capital-intensive production paths than they might otherwise have. The heavy internal combustion engine, for example, is by no means the only feasible option for powering a private automobile, as we already saw Bookchin suggest above. The use of research funds to develop more efficient electric motors would have made possible decentralized automobile production without the huge factories needed to produce heavy engine blocks. Or consider the hypercar, which the authors of *Natural Capitalism* compare to "computers with wheels."[31]

Even internal combustion automobiles were produced at quite small levels of capitalization and output at one time, as shown by the facilities at which the first Model-Ts were produced. The unit costs were considerably higher. But in a society where the cost principle encouraged walkable communities with public transit, there was little need for long-distance shipping, and most people lived close to where they worked and shopped, the demand for private automobiles would probably be far lower, with a much smaller customer base paying the higher price only when an automobile was a practical necessity, or when they were rich enough to afford a luxury. The main demand for automobiles in such circumstances would likely come from dispersed rural populations, those who didn't live within convenient distance of a railhead, but needed frequent transportation in and out of town (truck farmers, for instance). And in such circumstances, the main deficiency of the electric vehicle--its limited range without recharging--wouldn't be a problem.

In any case, the great majority of the products we consume could be produced by small factories serving local markets. The New Towns in Britain were inspired by Ebenezer Howard's Garden City prototype, intended to be "largely self-reliant in food, services, and industry at a population of 32,000."[32] Howard, heavily influenced by Kropotkin's vision of the decentralized production made possible by small-scale electrically powered machinery,[33] wrote that "[t]own and country *must be married*, and out of this joyous union will spring a new hope, a new life, a new civilization."[34] Howard envisioned the city as being laid out as a compact circle of about 1.5 miles in diameter, surrounded by an agricultural belt of roughly 3 miles diameter.[35] The town itself was to be laid out in concentric rings of residences, with arterial roads radiating from the center. At the center of the town would lie a combined garden and park area of roughly one fourth square mile: the garden would be ringed by the major public buildings, with a larger park area outside of that. The entire circumference of the garden-park area would be bounded by a circular "crystal palace," or covered market area much like the covered

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[31] Hawken, et al, *Natural* Capitalism, p. 39.
[32] Sale, *Human Scale*, pp. 402-403.
[33] Colin Ward, Commenter's introduction to Ebenezer Howard, *To-Morrow: A Peaceful Path to Real Reform*. Facsimile of original 1898 edition, with introduction and commentary by Peter Hall, Dennis Hardy and Colin Ward (London and New York: Routledge, 2003), p. 3.
[34] Howard, *To-Morrow*, p. 28 [facsimile p. 10].
[35] Howard, *To-Morrow*, p. 30 [facsimile p. 13].

arcades on historic London Bridge.[36] Colin Ward, in his commentary, considered the crystal palace an anticipation of the modern shopping mall.[37] But as a public space integral to a mixed-use town, and accessible with at most a walk of three-quarters of a mile from any residence in the town, it can arguably be compared more accurately to a covered Main Street. Larger markets, warehouses, and industry, would be located along a ring road on the outer edge of town, with markets and industry serving the particular ward (i.e., one of the six segments of the circle) in which its customers and workers lived; any point on the periphery would be, at most, 1.5 miles from any residence in town.[38] The markets and industry would also front on a railway encircling the town.[39] A cluster of several individual towns (the "social city" of around a quarter million population in an area of roughly ten miles square), in turn, would ultimately be linked together by "[r]apid railway transit," much like the mixed-use railroad suburbs which today's New Urbanists propose to resurrect and link together with light rail. Larger industries in each town would specialize in the production of commodities for the entire cluster, in which greater economies of scale were necessary.[40]

The businesses included in the industrial belt of the projected City included "coal, lumber, and stone yards, furniture, clothing, boot factories, a printing press, a 'cycle works,' an engineering center, and even a 'jam factory.'" Frederick Osborn, who created the actual Garden Cities of Letchworth (1903) and Welwyn (1920), concluded that "[a] town which is designed for modern industry, employing people living on the spot," should have a population of from 30-50,000. The New Towns built from 1947-58, "mostly in the hinterlands," have been "quite self-contained" and "achieved rough degrees of independence" with populations averaging around 39,000.[41] The first Garden City, Letchworth,

> quickly attracted a variety of crafts and industries--bookbinding, printing, the Iceni Pottery, the St. Edmundsbury Weaving Works, motor car manufacturers, and a corset-company--and this first town (and later its younger sister Welwyn) proved economically self-sustaining and socially coherent in all the ways Howard had predicted.[42]

Kirkpatrick Sale observes that, even with the currently predominating scale of production, a village of 500 would be a sufficient population base to staff a few small manufacturing plants and consume their products, in addition to producing most of its own food and energy. Of course, if such small population units did not pool their markets to support more diversified production, the range of goods would be rather sparse.

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[36] Howard, *To-Morrow*, p. 34 [facsimile p. 14].
[37] Ward commentary, in Howard, *To-Morrow*, p. 35.
[38] Howard, *To-Morrow*, p. 14 [facsimile p. 34].
[39] Howard, *To-Morrow*, p. 38 [facsimile pp. 16-17].
[40] Howard, *To*-Morrow, pp. 156-162 [facsimile pp. 130-133].
[41] Sale, *Human Scale*, pp. 402-03.
[42] Florence S. Boos, "*News From Nowhere* and 'Garden Cities': Morris's Utopia and Nineteenth-Century Town Design," *Journal of Pre-Raphaelite Studies*, Fall 1998 <http://www.morrissociety.org/agregation.boos.html>.

> A village of, say, 500 people could probably grow its own food, operate its own energy systems, create its own handicrafts, perhaps carry on some manufactures, much as the Israeli kibbutzim do; but it would be hard-pressed to go in for much in the way of extensive manufacture or construction, would not likely have much variety in its wares, would have to keep its services quite simple, and would have to accept fairly limited opportunities of conviviality and culture. Even figuring a labor force of 250 in such a settlement, ...there would probably be no more than 100 people or so available for manufacturing or recycling, the rest employed in agriculture, energy and transportation, services, and handicrafts. That would certainly be sufficient for a dozen small manufacturing plants, since... 65 percent of all the plants in this country operate with fewer than twenty people..., and in those *the average number of employees is only 5.5*; and it would no doubt cover such basics as lumber, paper, and textile mills, a carpentry and brick works, and a few small factories (bikes, maybe, and hardwares). But that would plainly be insufficient to create a full range of metal products, electrical equipment, medical instruments, books, rubber products, soaps, and paints, to pick only the basic categories of contemporary manufacturing.

But if these villages or neighborhoods federated to form a population base of several thousand, enough to support larger factories, these latter goods could be produced as well with the largest plants employing not much over a hundred workers. So a community of 10,000 could be self-sufficient in most forms of basic industry (Sale lists textiles, apparel, lumber and wood products, furniture and fixtures, paper and allied products, primary metal industries, fabricated metal products, machinery, electrical and electronic equipment, motorcycles and bicycles, and instruments and related products) and even have several competing plants in each industry.[43]

This model of federated small units dovetails to a considerable extent with Jeff Vail's "hamlet economy" (which he also calls "rhizome economy" or "resilient community"): a system of networked villages based on an idealized version of the historical "lattice network of Tuscan hill towns" numbering in the hundreds (which became the basis of a modern regional economy based largely on networked production). The individual communities in Vail's network must be large enough to achieve self-sufficiency by leveraging division of labor, as well as providing sufficient redundancy to absorb systemic shock. When larger-scale division of labor is required to support some industry, Vail writes, this is not to be achieved through hierarchy, with larger regional towns becoming centers of large industry. Rather, it is to be achieved by towns of roughly similar size specializing in producing of specialized surplus goods for exchange, via fairs and other horizontal exchange relationships.[44]

Although he doesn't challenge the economic statistics for the New Towns, Husman argues that Sale went too far in his last assertion about the amount of industry that could be supported in a town of 10,000:

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[43] Sale, *Human Scale*, pp. 397-99.

[44] Jeff Vail, "Re-Post: Hamlet Economy," *Rhizome*, July 28, 2008 <http://www.jeffvail.net/2008/07/re-post-hamlet-economy.html>.

> In another section, Sale claims that a small number of people could locally manufacture all or most of the products we use today. He does so by listing 13 major industries and the number of people in an average size factory in each. He either does not realize, or does not wish the reader to realize, that each industry does not manufacture all of the products within that category in a single factory. Thus, for the electrical appliance industry, he only lists one factory, though the industry consists of washing machines, dryers, stoves, refrigerators, irons, clocks, stereos, telephones, faxes, lamps, toasters, mixers, coffee pots, food processors, grills, and so on. The metal industry includes steel mills, aluminum works, copper works, etc.... His calculations are surely off by an order of magnitude.[45]

I'm not sure whether his objection to listing only one factory each for industries with multiple products takes into account the possibility of switching between production runs for different kinds of appliances (either with the Bookchin or Ohno system). But even stipulating Husman's order of magnitude difference, a regional economy of 100,000 could be self-sufficient in most small- and medium-scale industrial production.

The local economies Sale describes would likely involve other changes besides the predominant use of general-purpose technology. There would be greater ingenuity in the substitution of local raw materials. There would, for that matter, be greater ingenuity in general, especially from workers tinkering with machinery in the small shops. As we will see in Chapter Fifteen, worker control of production is ideal from the standpoint of maximizing productivity and innovation.

Such local economies would also probably rely more heavily on recycling and repairing. Sale speculates that neighborhood recycling and repair centers would put back into service the almost endless supply of appliances currently sitting in closets or basements; as well as "remanufacturing centers" for (say) diesel engines and refrigerators.[46]

According to Lyman van Slyke, the Chinese achieved a considerable amount in this regard back in the 1970s, in meeting their own small machinery needs. This was part of a policy known as the "five smalls," which involved agricultural communes supplying their own needs locally (hydroelectric energy, agro-chemicals, cement, iron and steel smelting, and machinery) in order to relieve large-scale industry of the burden. In the case of machinery, specifically, van Slyke gives the example of the hand tractor:

> ...[O]ne of the most commonly seen pieces of farm equipment is the hand tractor, which looks like a large rototiller. It is driven in the field by a person walking behind it.... This particular design is common in many parts of Asia, not simply in China. Now, at the small-scale level, it is impossible for these relatively small machine shops and machinery plants to manufacture all parts of the tractor. In general, they do not manufacture the engine, the headlights, or the tires, and these are imported from other parts of China. But the

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[45] "Human Scale Part II - Mass Production."
[46] Sale, *Human Scale*, p. 406.

transmission and the sheet-metal work and many of the other components may well be manufactured at the small plants. Water pumps of a variety of types, both gasoline and electric, are often made in such plants, as are a variety of other farm implements, right down to simple hand tools. In addition, in many of these shops, a portion of plant capacity is used to build machine tools. That is, some lathes and drill presses were being used not to make the farm machinery but to make additional lathes and drill presses. These plants were thus increasing their own future capabilities at the local level. Equally important is a machinery-repair capability. It is crucial, in a country where there isn't a Ford agency just down the road, that the local unit be able to maintain and repair its own equipment. Indeed, in the busy agricultural season many small farm machinery plants close down temporarily, and the work force forms mobile repair units that go to the fields with spare parts and tools in order to repair equipment on the spot.

> Finally, a very important element is the training function played in all parts of the small-scale industry spectrum, but particularly in the machinery plants. Countless times we saw two people on a machine. One was a journeyman, the regular worker, and the second was an apprentice, a younger person, often a young woman, who was learning to operate the machine.[47]

This was by no means a repeat of the disastrous Great Leap Forward, which was imposed in the late 1950s. It was, rather, an example of local ingenuity in filling a vacuum left by the centrally planned economy. If anything, in the 1970s--as opposed to the 1950s--the policy was considered a painful concession to necessity, to be abandoned as soon as possible, rather than a vision pursued for its own sake. Van Slyke was told by those responsible for small-scale industry, "over and over again," that their goals were to move "from small to large, from primitive to modern, and from here-and-there to everywhere."[48] Aimin Chen, in 2002, reported that the government was actually cracking down on local production under the "five smalls" in order to reduce idle capacity in the beleaguered state sector.[49]

Sale's treatment of planned obsolescence is another item in Husman's thoughtful critique of *Human Scale*.

> The other claim - that appliances could be made to last longer but are intentionally not - is based on two mistakes. The first is based on a misunderstanding of statistical quality control (SQC). We can, after analyzing lots of appliances over time, figure out that an appliance will fail in a predictable manner. The failure probability looks like a bell curve. From that, we can say that Refrigerator X will last on average Y years. From this, people will infer that the refrigerator was designed to fail in Y years. In a sense, it was, since the

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47 Lyman P. van Slyke, "Rural Small-Scale Industry in China," in Richard C. Dorf and Yvonne L. Hunter, eds., *Appropriate Visions: Technology the Environment and the Individual* (San Francisco: Boyd & Fraser Publishing Company, 1978) pp. 193-194. [190-196]

48 Van Slyke, p. 196.

49 Aimin Chen, "The structure of Chinese industry and the impact from China's WTO entry," *Comparative Economic Studies* (Spring 2002) <http://www.entrepreneur.com/tradejournals/article/print/86234198.html>.

> refrigerator was designed within certain constraints: existing technology, cost points, market demand, competitive expectations, cost of inputs including capital and materials, etc. The end result of those design choices is a refrigerator that lasts, on average, Y years. But the direction of causality is from the design to the durability, not from a selected goal of durability to the design. This is a misapplication of statistics, and is usually committed either out of malice or ignorance. I'll assume Sale does so out of the latter.
>
> The other mistake is the idea that people should design 50 year refrigerators (or whatever). Keep in mind that you can, right now, buy outstanding appliances from companies like Viking. They are very expensive. At the same time, keep in mind the fact that technology is changing and that the rate of change is increasing. Given both of those, why would you want to pay extra for something that will be overtaken by scientific and engineering - not design - obsolescence within a few years? The examples are mind-boggling: a car radio of a few years ago does not have as good reception, disc capability, or perhaps even cassette playback capability; the incandescent lightbulb has been overtaken by the CFL and is about to be overtaken by the LED; a state-of-the-art computer from 1990 won't even begin to approach the capability of a modern computer for most of the modern applications (such as the internet, USB, etc.); the most economical and reliable car from 1975 won't even touch the most economical and reliable modern car for either of those measures or for safety (remember when airbags were only available on high-end Mercedes?). So why would anyone pay a premium for that which they could have in the future at a deep discount?[50]

Here I take issue with Husman's analysis. First of all, it's hard for me to understand why extended lifetime for an appliance, as a matter of design choice, should necessarily entail increased cost on the scale of Viking refrigerators. It's entirely plausible that for a given product, two designs with different longevities may not carry radical differences in cost--in which case the decision against longevity reflects some consideration besides the consumer's welfare.

Second, he seems to be defining "planned obsolescence" far too narrowly. Planned obsolescence refers not just to how soon or how frequently an appliance breaks down as a result of problems with individual parts, but also to the overall design's amenability to repair. Planned obsolescence, in this latter sense, includes 1) a deliberate choice among design alternatives in favor of a design that makes repair more costly, difficult, or complicated, and 2) the use of such expedients as patents to control the availability and pricing of replacement parts. In this case, a corporation artificially shifts the lifetime costing of repair upward, in order to make replacement artificially competitive.

In regard to this latter, Preston Glidden made an interesting observation. In a free market, he said,

> What I expect are "throwback designs", at least at first. Consider televisions. In the

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[50] "Human Scale Part I--Planned Obsolescence," *Grim Reader* blog, September 23, 2006 <http://www.zianet.com/ehusman/weblog/2006/09/human-scale-part-i-planned-obsolesence.html>.

early days of televisions, the sets were made for easy field servicing. Most of the time, all you had to do was look for a dark vacuum tube, and replace it. Drug stores had tube testers that you could use to test the tube yourself. A nearby cabinet had replacements. I don't expect the return to a vacuum tube, but that kind of modular design could be re-created for easy servicing. It would have the added benefit of being more environmentally friendly, because we could stop throwing away the whole gadget when one component goes bad.

The TV could be built for upgrades, as well. The currently scheduled transition of standard to digital TV is probably too much for a simple upgrade, but if some super-cool p2p digital broadcast idea came out , it could be integrated into a modular FM radio with a simple plug in card.

Also, if you've ever seen the inside of a modern television, or most any electronic gadget, you'd see that the parts are machine soldered onto the surface of the circuit board. Such parts are very difficult to solder by hand, but the older design of through-hole soldering was made for hand-soldering. So I'd expect a throwback there. Most kit ham radios that are still sold today use through-hole tech....

...[The manufacturers] don't want field service, they want replacement. They make more money that way. Non-modular designs are slightly cheaper to build in the first place as well. But IMHO, the advantages of field service far outweigh the slight extra initial cost.[51]

Joseph Juran discussed "involuntary obsolescence" in similar terms, contrasting "voluntary obsolesence" to

the case in which long-life products contain components which will not last for the life of the product. The life of these components is determined by the manufacturer. As a result, even though the user decides to have the failed component replaced (to keep the product in service), *the manufacturer makes the real decision* because the design determines the life of the component.

This situation is at its worst when the original manufacturer had designed the product in such a way that the supplies, spare parts, etc., are nonstandard, so that, in effect, the sole source for these needs is the original manufacturer. In such a situation, the user is locked in to a single source of supply.[52]

This is true, especially, of the prevalence of product design whose obvious purpose is to discourage or impede repair by the user.

... [A]n engineering culture has developed in recent years in which the object is to "hide the works," rendering the artifacts we use unintelligible to direct inspection.... This creeping concealedness takes various forms. The fasteners holding small appliances together now often require esoteric screwdrivers not commonly available, apparently to prevent the curious or the angry from interrogating the innards. By way of contrast, older readers will

[51] Preston Glidden, private email. June 5 and 12, 2007.
[52] J.M. Juran and Frank M Gryna, *Juran's Quality Control Handbook*. Fourth edition (New York: McGraw-Hill Book Company, 1951, 1988), 3.4-5.

recall that until recent decades, Sears catalogues included blown-up parts diagrams and conceptual schematics for all appliances and many other mechanical goods. It was simply taken for granted that such information would be demanded by the consumer.[53]

Julian Sanchez gives the specific example of Apple's iPhone. The scenario, as he describes it:

> (1) Some minor physical problem afflicts my portable device—the kind of thing that just happens sooner or later when you're carting around something meant to be used on the go. In this case, the top button on my iPhone had gotten jammed in, rendering it nonfunctional and making the phone refuse to boot normally unless plugged in.
>
> (2) I make a *pro forma* trip to the putative "Genius Bar" at an Apple Store out in Virginia. Naturally, they inform me that since this doesn't appear to be the result of an internal defect, it's not covered. But they'll be only too happy to service/replace it for something like $250, at which price I might as well just buy a new one. This is more or less what I expected, but I figure I have to at least give it a shot before tinkering with it myself.
>
> (3) I ask the guy if he has any tips if I'm going to do it myself—any advice on opening it, that sort of thing. He's got no idea. I head back. Round trip, door to door, a little over an hour.
>
> (4) Pulling out a couple of tiny screwdrivers, I start in on the satanic puzzlebox casing Apple locks around all its hardware. I futz with it for at least 15 minutes before cracking the top enough to get at the inner works.
>
> (5) Once this is done, it takes approximately five seconds to execute the necessary repair by unwedging the jammed button.
>
> I have two main problems with this. First, you've got what's *obviously* a simple physical problem that can very probably be repaired in all of a minute flat with the right set of tools. But instead of letting their vaunted support guys give this a shot, they're encouraging customers—many of whom presumably don't know any better—to shell out a ludicrous amount of money to replace it and send the old one in. I appreciate that it's not always obvious that a problem can be this easily remedied on site, but in the instance, it really seems like a case of exploiting consumer ignorance.
>
> Second, the iPhone itself is pointlessly designed to deter self service. Sure, the large majority of users are never going to want to crack their phone open. Then again, most users probably don't want to crack their desktops or laptops open, but we don't expect manufacturers to go out of their way to make it difficult to do.[54]

The kind of modular design that would be most amenable to cheap repair rather than

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[53] Matthew B. Crawford, "Shop Class as Soulcraft," *The New Atlantis*, Number 13, Summer 2006, pp. 7-24 <http://www.thenewatlantis.com/publications/shop-class-as-soulcraft>.

[54] Julian Sanchez, "Dammit, Apple," *Notes from the Lounge*, June 2, 2008 <http://www.juliansanchez.com/2008/06/02/dammit-apple/>.

replacement, interestingly, is also the most amenable to the kind of peer production we will examine in Chapter Fifteen. Modular design enables a peer network to break a physical manufacturing project down into discrete sub-projects, with many of the individual modules perhaps serving as components in more than one larger appliance. According to Christian Siefkes,

> Products that are modular, that can be broken down into smaller modules or components which can be produced independently before being assembled into a whole, fit better into the peer mode of production than complex, convoluted products, since they make the tasks to be handled by a peer project more manageable. Projects can build upon modules produced by others and they can set as their own (initial) goal the production of a specific module, especially if components can be used stand-alone as well as in combination. The Unix philosophy of providing lots of small specialized tools that can be combined in versatile ways is probably the oldest expression in software of this modular style. The stronger emphasis on modularity is another phenomenon that follows from the differences between market production and peer production. Market producers have to prevent their competitors from copying or integrating their products and methods of production so as not to lose their competitive advantage. In the peer mode, re-use by others is good and should be encouraged, since it increases your reputation and the likelihood of others giving something back to you.
>
> Peer producers jointly produce for their own use, which explains their tendency to put functionality first....
>
> Elegance is often closely related to functionality and to a certain simplicity that benefits modularity and re-use—"Elegance is the attribute of being unusually effective and simple," the Wikipedia (2007) defines. Free software producers tend to admire elegance especially, but not only, in design. Eric Raymond (2001, Lesson 13) expresses this by quoting Antoine de Saint-Exupéry: "Perfection (in design) is achieved not when there is nothing more to add, but rather when there is nothing more to take away."
>
> Modularity not only facilitates decentralized innovation, but should also help to increase the longevity of products and components. Capitalism has developed a throw-away culture where things are often discarded when they break (instead of being repaired), or when one aspect of them is no longer up-to-date or in fashion. In a peer economy, the tendency in such cases will be to replace just a single component instead of the whole product, since this will generally be the most labor-efficient option (compared to getting a new product, but also to manually repairing the old one).[55]

What's more, planned obsolescence is by no means limited to the kind of electronic goods or appliances Husman mentions, that one might expect to be rendered obsolete by technical progress. The shoddily built houses in new subdivisions in recent years seem deliberately designed to disintegrate. The shoddy materials that go into commodities designed to fall apart often cost as much to produce as better, longer-lasting materials. In such cases, planned obsolescence is an increased long-term cost with little or no short-

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[55] Christian Siefkes, *From Exchange to Contributions: Generalizing Peer Production into the Physical World* Version 1.01 (Berlin, October 2007), pp. 104-105

term savings. Solidly built, durable and human-friendly furniture can be manufactured at a lower cost in small shops than the push-marketed crap sold in chains.

B. The Transition to Decentralized Manufacturing

The building, bottom-up, of local economies based on small-scale production with multiple-purpose machinery might well take place piecemeal, beginning with the kinds of recycling and repair operations mentioned above. In a post-Peak Oil world, following a collapse or severe degradation of the national transportation system and the centralized economy dependent on it, facilities to keep existing appliances and machinery running might well be the first step toward local industrial self-reliance. Small machine shops, even the backyard shops of hobbyists, out of sheer necessity might begin to custom-machine the spare parts needed to keep aging machinery in operation. From this, the natural progression would be to farming out the production of components among a number of such small shops, and perhaps designing and producing simple machinery from scratch. This would also, by the way, be an ideal bottom-up model for industrializing village-based economies in the Third World.

And this model is based on more than theoretical speculation: it is almost exactly the way the Japanese bicycle industry developed at the turn of the 20th century, as described by Jane Jacobs, starting with the production in bicycle shops of replacement parts for Western bikes:

> To replace these imports with locally made bicycles, the Japanese could have invited a big American or European bicycle manufacturer to establish a factory in Japan... Or the Japanese could have built a factory that was a slavish imitation of a European or American bicycle factory. They would have had to import most or all of the factory's machinery, as well as hiring foreign production managers or having Japanese production managers trained abroad....
>
> [Instead], shops to repair [imported bicycles] had sprung up in the big cities.... Imported spare parts were expensive and broken bicycles were too valuable to cannibalize the parts. Many repair shops thus found it worthwhile to make replacement parts themselves--not difficult if a man specialized in one kind of part, as many repairmen did. In this way, groups of bicycle repair shops were almost doing the work of manufacturing entire bicycles. That step was taken by bicycle assemblers, who bought parts, on contract, from repairmen: the repairmen had become "light manufacturers."[56]

A couple of observations here. First, the alternative in Jacobs' first blockquoted paragraph is not only the model of development promoted by neoliberal technocrats in the Third World (with World Bank loans, interest courtesy of the taxpayers, to build the road and utility structure to support the factories, of course); it's also the typical model of

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[56] *The Economy of Cities*, pp. 63-64.

"economic development" pursued by states and localities in the U.S., building industrial parks, offering special corporate welfare subsidies to bribe giant corporations to come in from outside to colonize a community. Second, the Japanese model of ground-up industrialization by custom manufacturing spare parts would almost certainly be criminalized today by the WTO as "piracy," a violation of the so-called "intellectual property" rights of the Western bicycle manufacturers.

C. Desktop Manufacturing Technology

Another revolutionary development, in recent years, is the invention of multiple-purpose machine tools in a price range suitable for the home workshop. As Johan Soderberg describes it:

> What is gradually taking shape within the hacker movement at this moment is an extension of the dream that was pioneered by the members of the Homebrew Computer Club [i.e., a cheap computer able to run on the kitchen table]. It is the vision of a universal factory able to run on the kitchen table. The idea is not as far-fetched as it first might seem. Development trends towards flexible production within industry are pushing in the same direction. Researchers at the MIT laboratory, for instance, have experimented with computer-aided manufacturing facilities small enough to fit into a single room and easy enough to operate by lay people after a short, introductory course. The facility can be used to cut, solder, cast, compress, etc., almost any material into a finished product. Likewise, a group of engineers in Brighton try to construct a 'self-replicating rapid prototyper' that can mould everyday items out of plastic. The machine is meant to be able to make the parts out of which a second copy of the machine can be assembled. In a nod to the hacker movement, the blueprints... have been licensed under GPL.... [T]he desire for a 'desktop factory' amounts to the same thing as the reappropriation of the means of production.[57]

A good example is the multimachine, which "is an accurate all-purpose machine tool that can be used as a metal or wood lathe, end mill, horizontal mill, drill press, wood or metal saw or sander, surface grinder and sheet metal 'spinner'."[58] According to the Open Source Ecology design community, it "could be the central tool piece of a flexible workshop... eliminating thousands of dollars of expenditure requirement for similar abilities" and serving as "the centerpieces enabling the fabrication of electric motor, CEB, sawmill, OSCar, microcombine and all other items that require processes from milling to drilling to lathing."[59]

> It can be built by a semi-skilled mechanic using just common hand tools. For machine construction, electricity can be replaced with "elbow grease" and all the necessary material can come from discarded vehicle parts. It can be built in a closet size version or one that

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[57] Soderberg, pp. 185-186.
[58] <http://groups.yahoo.com/group/multimachine/?yguid=234361452>
[59] "Multimachine & Flex Fab--Open Source Ecology" <http://openfarmtech.org/index.php?title=Multimachine_%26_Flex_Fab>.

would weigh 4 or 5 tons.[60]

....What can the MultiMachine be used for in developing countries?

AGRICULTURE:
Building and repairing irrigation pumps and farm implements.

WATER SUPPLIES:
Making and repairing water pumps and water-well drilling rigs.

FOOD SUPPLIES:
Building steel-rolling-and-bending machines for making fuel efficient cook stoves and other cooking equipment.

TRANSPORTATION:
Anything from making cart axles to rebuilding vehicle clutch, brake, and other parts.

EDUCATION:
Building simple pipe-and-bar-bending machines to make school furniture, providing "hands on" training on student-built MultiMachines that they take with them when they leave school.

JOB CREATION:
A group of specialized but easily built MultiMachines can be combined to form a small, very low cost, metal working factory which could also serve as a trade school. Students could be taught a single skill on a specialized machine and be paid as a worker while learning other skills that they could take elsewhere. [61]

The possibility of a "small, very low cost, metal working factory" (even if it doesn't quite "fit on a kitchen table") is especially suggestive, in light of our earlier discussion of networked production by small shops, and of Jane Jacobs' treatment of the Japanese bicycle industry.

In addition, a number of firms have appeared recently which offer production of custom parts to the customer's digital design specifications, at a modest price, using small-scale, multipurpose desktop machinery. Two of the most prominent are Big Blue Saw[62] and eMachineShop.[63] The way the latter works, in particular, is described in a *Wired* article:

The concept is simple: Boot up your computer and design whatever object you can imagine, press a button to send the CAD file to Lewis' headquarters in New Jersey, and two or three weeks later he'll FedEx you the physical object. Lewis launched eMachineShop a year and a

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[60] <http://groups.yahoo.com/group/multimachine/?yguid=234361452>
[61] <http://opensourcemachine.org/node/2>
[62] <http://www.bigbluesaw.com/saw/>
[63] <http://www.emachineshop.com/> (see also <www.barebonespcb.com/!BB1.asp>).

half ago, and customers are using his service to create engine-block parts for hot rods, gears for home-brew robots, telescope mounts - even special soles for tap dance shoes.[64]

Two other promising developments are mobile manufacturing (Factory in a Box),[65] and the microfactory and micro machine tools.[66]

Building on our earlier speculation about small machine shops and hobbyist workshops, new desktop manufacturing technology offers an order of magnitude increase in the quality of work that can be done for the most modest expense.

D. Polytechnic

Another key concept is that of the "polytechnic," a term coined by Lewis Mumford to describe the coexistence of different "phases" of technology in a single "technological pool."

> Similarly [to a gene pool], one may talk of a technological pool: an accumulation of tools, machines, materials, processes, interacting with soils, climates, plants, animals, human populations, institutions, cultures. The capacity of this technological reservoir, until the third quarter of the nineteenth century, was immensely greater than ever before: what is more, it was more diversified--and possibly quantitatively larger, as well as qualitatively richer--than that which exists today. Not the least important part of this technological pool were the skilled craftsmen and work teams that transmitted the colossal accumulation of knowledge and skill. When they were eliminated from the system of production, that vast cultural resource was wiped out.
>
> This diversified technological assemblage not merely contributed to economic security: it permitted a continuous interplay between different phases of technology; and for a time this actually happened.

As an example, he mentions incorporation of new scientific advances into old technology, like "the altered cut of mainsail and jibs in modern sailing vessels: a change resulting from the closer analysis of air flow for the purpose of improving airplanes."[67]

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[64] Clive Thompson, "The Dream Factory," *Wired*, September 2005 <http://www.wired.com/wired/archive/13.09/fablab_pr.html>

[65] Carin Stillstrom and Mats Jackson, "The Concept of Mobile Manufacturing," *Journal of Manufacturing Systems* 26:3-4 (July 2007) <http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VJD-4TK3FG8-6&_user=108429&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_version=1&_urlVersion=0&_userid=108429&md5=bf6e603b5de29cdfd026d5d00379877c>.

[66] Yuichi OKAZAKI, Nozomu MISHIMA and Kiwamu ASHIDA, "Microfactory and Micro Machine Tools," Fine Manufacturing System Group, Institute of Mechanical Engineering Systems, National Institute of Advanced Industrial Science and Technology. Reported in The 1st Korea-Japan Conference on Positioning Technology, Daejeon, Korea, 2002.

[67] *The Myth of the Machine: The Pentagon of Power*, pp. 154-55.

The sea-going technology of Poul Anderson's Maurai is an excellent fictional example of the same thing. A real-world example is 20th (and 21st) century organic farming, as developed by the Rodales, Louis Bromfield and John Jeavons, which involves the recovery and preservation of older technique (much of it, like raised-bed technique and crop-rotation, itself a highly refined art of the eotechnic period--about which see below), and its synthesis with the latest findings of soil science, botany and bacteriology.

> There was no reason whatever to make a wholesale choice between handicraft and machine production: between a single contemporary part of the technological pool and all the other past accumulations. But there was a genuine reason to maintain as many diverse units in this pool as possible, in order to increase the range of both human choices and technological inventiveness. Many of the machines of the nineteenth century, as Kropotkin pointed out, were admirable auxiliaries to handicraft processes, once they could be scaled, like the efficient electric motor, to the small workshop and the personally controlled operation.[68]

Ivan Illich, in *Vernacular Values*, speculated on the possibility of integrating new technology into a subsistence society: "modern tools make it possible to subsist on activities which permit a variety of evolving life styles, and relieve much of the drudgery of old time subsistence."[69]

Mumford's conception of the polytechnic, with multiple "phases" of technology existing side-by-side, was echoed by E.F. Schumacher:

> It is a strange fact that some people say that there are no technological choices. I read an article by a well-known economist from the U.S.A. who asserts that there is only one way of producing any particular commodity: the way of 1971. Had these commodities never been produced before? The basic things of life have been needed and produced since Adam left Paradise. He says that the only machinery that can be procured is the very latest. Now that is a different point and it may well be that the only machinery that can be procured *easily* is the latest. It is true that at any one time there is only one kind of machinery that tends to dominate the market and this creates the impression as if we had no choice and as if the amount of capital in a society determined the amount of employment it could have. Of course this is absurd. The author whom I am quoting also knows that it is absurd, and then he corrects himself and points to examples of Japan, Korea, Taiwan, etc., where people achieve a high level of employment and production with very modest capital equipment.
>
> ....It is a fixation in the mind, that unless you can have the latest you can't do anything at all....
>
> ....We are told there is no choice of technology, as if production had started in the year 1971. We are told that it cannot be economic to use anything but the latest methods, as if anything could be more uneconomic than having people doing absolutely nothing.[70]

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[68] Ibid., pp. 154-55.
[69] Ivan Illich, *Vernacular* Values, p. ?.
[70] Schumacher, *Small is Beautiful*, pp. 213-14, 218-19.

Mumford's polytechnic overlaps to a considerable extent with Schumacher's concept of "intermediate technology":

> I have named it *intermediate technology* to signify that it is vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the super-technology of the rich.[71]

> Such an intermediate technology would be immensely more productive than the indigenous technology (which is often in a state of decay), but it would also be immensely cheaper than the sophisticated, highly capital-intensive technology of modern industry.[72]

The same author provided another example of polytechnic in *Good Work*: the adaptation of modern metallurgical knowledge to the traditional techniques of manufacturing metal rims for oxcart wheels:

> In order to have efficient oxcarts, the wheels ought to have steel rims. We've forgotten how to bend steel accurately except with big machines in Pittsburgh or Sheffield. How do you do it in a small rural community? Is it beyond the wit of man to do this on a small scale? No, we remember that our forefathers knew how to do it before James Watt, and they had a most ingenious tool. We found one of those tools in a French village, more than two hundred years old--brilliantly conceived, clumsily made. We took this to the National College of Agricultural Engineering in England and said, "Come on boys, you can do better than that. Upgrade it, use your best mathematics to work out the required curvature and what have you." The upshot of it is that while hitherto in the modern world the smallest instrument to do this bending job would cost on the order of £700, and require outside power and electricity to operate, this tool upgraded to the level of knowledge of 1974 can be made by the village blacksmith. It costs £7, it doesn't require electricity, and anyone can do it. Now this is something quite different from going back into the preindustrial era. It is using our knowledge in a different way, and we know it can be done.[73]

This is a common pattern. Generally speaking, the refinement of older, small-scale technology has been abandoned in favor of a focus on further developing large-scale production technology. When the modern engineer turns his attention back to the old tools of small-scale production, he quickly finds a host of cheap and easy minor changes that promise to greatly increase their productivity. Intermediate technology often embodies the polytechnic idea of resurrecting near-lost techniques hastily abandoned (or crowded out, rather, with state help) during the industrial era, and refining them by the application of modern engineering principles. For example, Borsodi found that the small manual looms commonly available were commonly designed from an impractical "artsy-craftsy" standpoint, rather than from an engineer's sensibility of maximizing the efficiency of hand production. As a result, the manual loom functioned as inefficiently as

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[71] Ibid., pp. 153-54.
[72] Ibid., p. 180.
[73] Ibid., pp. 135-36.

if it were deliberately designed to be slow and laborious. By modifying a manual loom with his own homemade flying shuttle, the work of three or four hours, Borsodi was able to achieve production costs lower than those of the factory.[74]

David Dickson describes two complementary approaches, from opposite poles, toward developing intermediate technology:

> The first is the development of traditional indigenous production and servicing techniques. Productivity is increased through the application of scientific and technical knowledge often derived from elsewhere, but continuity with prevailing social and cultural conditions is maintained. The second source, at the other end of the spectrum, is the adaptation of technologies currently in use in the advanced industrial nations, but in a way that greatly reduces the scale of activity involved. It should also make technology suitable for a different capital/labour ratio, as well as for the use of local materials and other resources. Occasionally included in this category are technologies which have been developed and subsequently outgrown by the advanced countries during the course of industrialization, but which may now be considered appropriate to the economic and social conditions prevailing in the developing countries.[75]

Schumacher's Intermediate Technology Development Group has made a wide range of innovations along the lines of Borsodi's loom: greatly improved and more efficient tools, designed to be operated by human labor in the context of a village economy. They include economical, small-scale brick and tile production; improved cisterns made from cheap local materials; entire catalogs of human- and horse-powered farming tools; pedal-powered vehicles with efficient transmissions for light hauling; and small windmills with improved sail design and transmission, designed for manufacture in small local shops, to power irrigation pumps. Water turbine generators, for use in small streams, operate at greatly reduced cost because they are specifically designed for maximum efficiency on a small scale, and are capable of powering village industry like a small sawmill or workshop.[76]

Mumford's "gene pool" analogy above is an apt one, by the way. Evolutionary economist Michael Shermer made a similar analogy between evolutionary preadaptation in the biological and technological realms. Since so much of technological innovation results from the adaptation of technologies developed for one purpose to another purpose completely unforeseen, it makes sense to have as diverse a technlogical pool as possible.[77]

If we cross-pollinate Mumford's polytechnic with Jane Jacobs' Japanese bicycle model of ground-up industrialization, and with Kirk Sale's neighborhood

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[74] *Flight from the City*, pp. 52-53.
[75] *The Politics of Alternative Technology*, p. 154.
[76] George McRobie, *Small is Possible*, pp. 39-71.
[77] Michael Shermer, *The Mind of the Market: Compassionate Apes, Competitive Humans, and Other Tales from Evolutionary Economics* (New York: Henry Holt and Company, 2008), pp. 57-60.

repair/recycling/remanufacturing shops, we get still further intriguing possibilities. We're so used to an entire "production stream" being managed by a single, vertically-integrated corporation that we forget the process really involves a whole series of discrete subprocesses. And these subprocesses, individually, are amenable to being adapted to a wide variety of levels of technology. The post-WWII analysis of the effects of strategic bombing in Germany, in the Strategic Bombing Survey, and the analysis of industrial responses to strategic bombing in the Soviet civil defense literature, are full of anecdotes about factory production adapting to damage from strategic bombing (e.g., the substitution of human and other unconventional sources of power to fill specific gaps in the production process). Mumford draws similar conclusions from the resilience of North Vietnamese production in the face of American strategic bombing.[78] And if even workers in such totalitarian regimes were this adaptable and capable of initiative to keep production going, then, *a fortiori*, that should say a lot about the kind of worker-initiated innovations we might expect from Barry Stein's worker-managed plants in a free society (which we will discuss in the next chapter).

E. Eotechnic, Paleotechnic, and Neotechnic.

The idea of resurrecting old technologies in a modern context is also suggested by Mumford's periodization of technological history in *Technics and Civilization*. Mumford divided late medieval and modern technological development into three considerably overlapping periods: the eotechnic, the paleotechnic, and the neotechnic.

The original technological revolution of the late Middle Ages, the eotechnic, was associated with the skilled craftsmen of the free towns, and eventually incorporated the fruits of investigation by the early scientists. It began with agricultural innovations like the horse collar and horseshoe, and crop rotation. In mechanics, its greatest achievements were the invention of clockwork machinery, and the intensive development of water and wind power. It achieved great advances in the use of wood and glass, masonry, and paper (the latter including the printing press). The agricultural advances of the early second millennium were further built on by the innovations of the sixteenth and seventeenth centuries, like raised bed horticulture and greenhouses.

The eotechnic phase stagnated in the early modern period, mainly a result of its being supplanted or crowded out by the paleotechnic revolution. Paleotechnic was associated with the new centralized state and its privileged economic clients, and centered on mining, iron, coal, and steam power. It culminated in the "dark satanic mills" of the nineteenth century and the giant corporations of the late nineteenth and early twentieth. Although the paleotechnic incorporated some contributions from the eotechnic period, it was a fundamental departure in direction, and involved the abandonment of a rival path of development. To a large extent, technology was developed in the interests of the new

[78] *The Myth of the Machine: The Pentagon of Power*, p. 144.

royal absolutists, mercantilist industry and the factory system that grew out of it, and the new capitalist agriculturists (especially the Whig oligarchy of England); it incorporated only those eotechnic contributions that were compatible with the new tyrannies, and abandoned the rest.

The beginning of the neotechnic period was associated, among other things, with the invention of the prerequisites for electrical power--the dynamo, the alternator, the storage cell, the electric motor--along with the development of small-scale electric production machinery suitable for the small shop and power tools suitable for household production. Electricity made possible the use of virtually any form of energy, indirectly, as a prime mover for production: combustibles of all kinds, sun, wind, water, even temperature differentials.[79]

The typical factory, through the early 20th century (and afterward, in Sloanist American factories governed by batch production), had machines lined up in long rows, "a forest of leather belts one arising from each machine, looping around a long metal shaft running the length of the shop," all dependent on the factory's central power plant. The neotechnic revolution made it possible to run free-standing machines off of small electric motors.[80]

The decentralizing potential of small-scale machinery, powered by electric motors, was the central theme of Kropotkin's *Fields, Factories and Workshops*. Even before the introduction of electrical power, Kropotkin wrote, petty industry in small, wheel-powered workshops coexisted with large-scale industry. But with electricity "distributed in the houses for bringing into motion small motors of from one-quarter to twelve horse-power," workers were able to leave the small workshops to work in their houses.[81] More important, by freeing machinery up from a single prime mover, it ended all limits on where the small workshops themselves could be located. The primary basis for economy of scale, as it existed in the nineteenth century, was the need to economize on horsepower--a justification that vanished when the distribution of electrical power eliminated reliance on a single source of power.[82]

William Morris anticipated the decentralization of production, as a result of electrical power, in the future communist society of *News From Nowhere*:

> "What building is that?" said I, eagerly.... "It seems to be a factory."
>
> "Yes," he said, "I think I know what you mean, and that's what it is; but we don't call

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[79] *Technics and Civilization*, pp. 214, 221.
[80] William H. Waddell and Norman Bodek, *Rebirth of American Industry: A Study of Lean Management* (Vancouver, WA: PCS Press, 2005), pp. 119-121.
[81] Peter Kropotkin, *Fields, Factories and Workshops: or Industry Combined with Agriculture and Brain Work with Manual Work* (New York: Greenwood Press, Publishers, 1968 [1898]), p. 154.
[82] Ibid., pp. 179-180.

them factories now, but Banded-workshops; that is, places where people collect who want to work together."

"I suppose," said I, "power of some sort is used there?"

"No, no," said he. "Why should people collect together to use power, when they can have it at the places where they live, or hard by, any two or three of them; or any one, for the matter of that?..."[83]

As Ralph Borsodi showed, with electricity most goods could be produced in small shops and households with an efficiency at least competitive with that of the great factories, once the greatly reduced distribution costs of small-scale production were taken into account.[84] The modest increases in unit cost of production are offset not only by greatly reduced distribution costs, but by the possibility of timing production to need instead of attempting to engineer mass-consumption to the requirements of production:

> if the domestic grain grinder is less efficient, from a purely mechanical standpoint, than the huge flour mills of Minneapolis, it permits a nicer timing of production to need, so that it is no longer necessary to consume bolted white flours because whole wheat flours deteriorate more quickly and spoil if they are ground too long before they are sold and used.[85]

Again, this illustrates the principle that overall flow is more important to cost-cutting than maximizing the efficiency of any particular stage in isolation.

In any case, if the object is to have the highest quality flour with bran and germ intact, at a reasonable cost, as opposed to nutritionally dead wallpaper paste, the small mill is the *most* efficient means available. The larger mills are only more "efficient" if the consumer is subordinated to the needs of large-scale production.

It was primarily the decentralizing potential of electricity that inspired Kropotkin's vision of the merging of village and town in *Fields, Factories and Workshops*. As Colin Ward commented, in his edition of that work:

> The very technological developments which, in the hands of people with statist, centralising, authoritarian habits of mind, as well as in the hands of mere exploiters, demand greater concentration of industry, are also those which could make possible a local, intimate, decentralised society. When tractors were first made, they were giants, suitable only for prairie-farming. Now you can get them scaled down to a Rotivator for a small-holding. Power tools, which were going to make all industry one big Dagenham, are commonplace for every do-it-yourself enthusiast.[86]

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[83] William Morris, *News From Nowhere*, in *Three Works by William Morris*, with an introduction by A. L. Morton (New York: International Publishers, 1968), p. 226.
[84] *Flight from the City*.
[85] *Technics and Civilization*, p. 225.
[86] Colin Ward, in *Fields, Factories and Workshops Tomorrow* p. 164.

Paul Goodman, likewise, remarked on the change from the time when "the sewing machine was the only widely distributed productive machine..."

> but now... the idea of thousands of small machine shops, powered by electricity, has become familiar; and small power-tools are a best-selling commodity. In general, the change from coal and steam to electricity and oil has relaxed one of the greatest causes for concentration of machinery around a single driving-shaft.[87]

The neotechnic, in a sense, is a resumption of the lines of development of the original eotechnic revolution, following the paleotechnic interruption. The neotechnic

> differs from the paleotechnic phase almost as white differs from black. But on the other hand, it bears the same relation to the eotechnic phase as the adult form does to the baby.
>
> ....[T]he conceptions, the anticipations, the imperious visions of Roger Bacon, Leonardo, Lord Verulam, Porta, Glanvil, and the other philosophers and technicians of the day at last found a local habitation. The first hasty sketches of the fifteenth century were now turned into working drawings: the first guesses were now re-enforced with a technique of verification: the first crude machines were at last carried to perfection in the exquisite mechanical technology of the new age, which gave to motors and turbines properties that had but a century earlier belonged almost exclusively to the clock. The superb animal audacity of Cellini, about to cast his difficult Perseus, or the scarcely less daring work of Michelangelo, constructing the dome of St. Peter's, was replaced by a patient co-operative experimentalism: a whole society was now prepared to do what had heretofore been the burden of solitary individuals.[88]

It would be "poetic justice," as Borsodi put it, "if electricity drawn from the myriads of long neglected small streams of the country should provide the power for an industrial counter-revolution."[89]

Mumford suggested that, absent the dislocations imposed from above by the new states and their clients, the eotechnic might have evolved directly into the neotechnic without any disruption. A full-scale modern industrial revolution would likely have come about through such decentralized technology, as Mumford put it, "had not a ton of coal been dug in England, and had not a new iron mine been opened."[90]

The amount of work actually accomplished by wind and water power compared quite favorably with that of the steam-powered industrial revolution. Indeed, the great advances in textile output of the eighteenth century were made with water-powered factories; steam power was adopted only later. The Fourneyron water-turbine, perfected in 1832, was the first prime-mover to exceed the poor 5% or 10% efficiencies of the early

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[87] *Communitas* p. 156.
[88] *Technics and Civilization*, p. 212.
[89] *This Ugly Civilization*, p. 65.
[90] *Technics and Civilization*, p. 118.

steam engine, and was a logical development of earlier water-power technology that would likely have followed much earlier in due course, had not the evolution of water-power been interrupted by the paleotechnic revolution.[91]

> Had the spoonwheel of the seventeenth century developed more rapidly into Fourneyron's efficient water-turbine, water might have remained the backbone of the power system until electricity had developed sufficiently to give it a wider area of use.[92]

In *The City in History*, Mumford mentions abortive applications of eotechnic means to decentralized organization, unfortunately forestalled by the paleotechnic revolution, and speculates at greater length on the Kropotkinian direction social evolution might have taken had the eotechnic passed directly into the neotechnic. Of the seventeenth century villages of New England and New Netherlands, he writes:

> This eotechnic culture was incorporated in a multitude of small towns and villages, connected by a network of canals and dirt roads, supplemented after the middle of the nineteenth century by short line railroads, not yet connected up into a few trunk systems meant only to augment the power of the big cities. With wind and water power for local production needs, this was a balanced economy; and had its balance been maintained, had balance indeed been consciously sought, a new general pattern of urban development might have emerged. But this possibility was blocked by the prevailing ideology, which favored intensive specialization and the centralization of economic power in a few big centers, to which small urban units would be subservient.
>
> In 'Technics and Civilization' I pointed out how the earlier invention of more efficient prime movers, Fourneyron's water turbine and the turbine windmill, could perhaps have provided the coal mine and the iron mine with serious technical competitors that might have kept this decentralized regime long enough in existence to take advantage of the discovery of electricity and the production of the light metals. With the coordinate development of science, this might have led directly into the more humane integration of 'Fields, Factories, and Workshops' that Peter Kropotkin was to outline, once more, in the eighteen-nineties.[93]

It's important to remember that there is no such thing as generic "superiority" of one technology over another. One technology can only be said to be superior to another with reference to some purpose. The transition to paleotechnics, instead of further development of eotechnics, reflected a given set of interests. Paleotechnics were more "efficient" at serving the interests of the absolute state and its privileged clients, the great landowners and mercantilists.

Ralph Borsodi speculated, along lines similar to Mumford's, on the different direction things might have taken:

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[91] Ibid., p. 118.
[92] Ibid., p. 143.
[93] *The City in* History, pp. 333-34.

> It is impossible to form a sound conclusion as to the value to mankind of this institution which the Arkwrights, the Watts, and the Stephensons had brought into being if we confine ourselves to a comparison of the efficiency of the factory system of production with the efficiency of the processes of production which prevailed before the factory appeared.
>
> A very different comparison must be made.
>
> We must suppose that the inventive and scientific discoveries of the past two centuries had not been used to destroy the methods of production which prevailed before the factory.
>
> We must suppose that an amount of thought and ingenuity precisely equal to that used in developing the factory had been devoted to the development of domestic, custom, and guild production.
>
> We must suppose that the primitive domestic spinning wheel had been gradually developed into more and more efficient domestic machines; that primitive looms, churns, cheese presses, candle molds, and primitive productive apparatus of all kinds had been perfected step by step without sacrifice of the characteristic "domesticity" which they possessed.
>
> In short, we must suppose that science and invention had devoted itself to making domestic and handicraft production efficient and economical, instead of devoting itself almost exclusively to the development of factory machines and factory production.
>
> The factory-dominated civilization of today would never have developed. Factories would not have invaded those fields of manufacture where other methods of production could be utilized. Only the essential factory would have been developed. Instead of great cities, lined with factories and tenements, we should have innumerable small towns filled with the homes and workshops of neighborhood craftsmen. Cities would be political, commercial, educational, and entertainment centers. The homestead would have developed in countless directions and would have continued the economic center of the family. Efficient domestic implements and machines developed by centuries of scientific improvement would have eliminated drudgery from the home and the farm....
>
> We must, in short, make a comparison between the factory economy which we have today and a hypothetical economy which I believe should have been developed.[94]

Likewise, as P. M. Lawrence has pointed out,[95] the proper comparison is not between agribusiness and subsistence farming as they exist, but between agribusiness and subsistence farming as it would exist had it been free to develop without enclosures, without rack-rents, and without the state's diversion of all resources for innovation into the channel of large-scale cash crop agriculture (about which more below).

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[94] *This Ugly Civilization*, pp. 60-61.

[95]

Conventional histories--written by the victors, of course--give the paleotechnic phase credit for many advances of the eotechnic: schoolchildren are taught a received version of the industrial revolution in which "gentleman farmers" like Jethro Tull and inventors like Watt, Whitney, Fulton et al are elevated into demigods, while the civilization of the free towns of the late Middle Ages is telescoped back into the "Dark Ages."

> For a whole century the second industrial revolution… has received credit for many of the advances that were made during the centuries that preceded it. In contrast to the supposedly sudden and inexplicable outburst of inventions after 1760 the previous seven hundred years have often been treated as a stagnant period of small-scale petty handicraft production, feeble in power resources and barren of any significant accomplishments.

One reason for this, Mumford suggests, is that the history of the paleotechnic industrial revolution is filtered largely through an English lens. England had been a backwater of the earlier eotechnic civilization compared to the great towns of the continent, and served mainly to supply raw materials for Dutch, north German and Italian industry. To English observers, the paleotechnic revolution was therefore perceived to be arising in a vacuum.[96]

But it was in equal part arrogant, willful blindness: the temporal provincialism of Nietzsche's Last Man, who smugly proclaimed that "we have invented happiness."

> At the very height of England's industrial squalor, when the houses for the working classes were frequently built beside open sewers and when rows of them were being built back to back--at that very moment complacent scholars writing in middle-class libraries could dwell upon the "filth" and "dirt" and "ignorance" of the Middle Ages, as compared with the enlightenment and cleanliness of their own.
>
> How was that belief possible?....
>
> The mechanism that produced the conceit and the self-complacence of the paleotechnic period was in fact beautifully simple. In the eighteenth century the notion of Progress had been elevated into a cardinal doctrine of the educated classes. Man... was climbing steadily out of the mire of superstition, ignorance, savagery, into a world that was to become ever more polished, humane, and rational....
>
> ....Assuming that progress was a reality, if the cities of the nineteenth century were dirty, the cities of the thirteenth century must have been six centuries dirtier.... If the hospitals of the early nineteenth century were overcrowded pest-houses, then those of the fifteenth century must have been even more deadly. If the workers of the new factory towns were ignorant and superstitious, then the workers who produced Chartres and Bamberg must have been more stupid and unenlightened. If the greater part of the population were still destitute despite the prosperity of the textile trades and the hardware trades, then the workers of the handicraft period must have been more impoverished.

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[96] *Technics and Civilization*, pp. 151-52.

In short, we're presented with a Monty Python parody of the Middle Ages in which a king is identified by the fact that "he's the only one who doesn't have shit all over him."

> The fact that the cities of the thirteenth century were far brighter and cleaner and better ordered than the new Victorian towns: the fact that medieval hospitals were more spacious and sanitary than their Victorian successors: the fact that in many parts of Europe the medieval worker had demonstrably a far higher standard of living than the paleotechnic drudge...--these facts did not even occur to the exponents of Progress as possibilities for investigation.[97]

If William Morris's vision of the colorful, airy and convivially designed 14th century English town, in *The Dream of John Ball*, was idealized, it was probably at least closer to the truth than were its detractors.

F. Decentralized Agriculture

There is an ironic parallel between the productivity of household gardens in the capitalist west, and the small private garden plots of collective farmers in the old USSR, compared to that of the large-scale mechanized operations in both countries. The court intellectuals who most eagerly defend the alleged superior productivity of agribusiness as against small-scale farming are often the same ones who drew the most attention to the large percentage of Soviet food production carried out on a tiny percentage of arable land. And their false scientism in cheerleading for the so-called "Green Revolution" resembles nothing so much as the fondness for gigantism expressed by the collectivist technocrats of Soviet agriculture. But in fact, the productive superiority of the intensively cultivated family vegetable plot over the giant agribusiness operation, in the West, is directly comparable to the superiority of the small plot over the *kolkhoz* and *sovkhoz* in the old USSR.

And in the area where relatively large-scale, mechanized production makes most sense--cereal grains--it's hard to see how the hired tractor-driver on a corporate agribusiness plantation would have any more "entrepreneurial spirit" than a member of a Soviet collective farm. If the *kolkhoz* had been the genuine common property of the peasants, rather than a plantation owned by the state, the collective farmers would have had if anything *more* of a "private," "entrepreneurial" interest in productivity than the agricultural wage-laborers of America.

As Colin Ward pointed out, in his commentary on Kropotkin's *Fields, Factories and Workshops*,

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[97] *Technics and Civilization*, pp. 181-83.

> The actual or potential contribution to food production of ordinary domestic gardens is another illustration of the productivity of domestic horticulture. The advocates of high-density housing have always cited the "loss of agricultural land" as a factor supporting their point of view. Sir Frederic Osborn, with equal persistence, has always argued that the produce of the ordinary domestic garden, even though a small area of gardens is devoted to food production, more than equaled in value the produce of the land lost to commercial food production. Surveys conducted by the government and by university departments in the 1950s proved him right.
>
> One implication of Kropotkin's line of argument is that, at present assumptions of population growth, nobody need starve. Hunger in the world today is not because of the soil's insufficiency, nor will it be in the conceivable future.[98]

Ward, in *Talking Houses*, cites John Seymour's contrast of the two styles of agriculture:

> There is a man I know of who farms ten thousand acres with three men (and the use of some contractors). Of course he can only grow one crop--barley, and of course his production *per acre* is very low and his consumption of imported fertiliser very high. He burns all his straw, put no humus on the land (he boasts there isn't a four-footed animal on it--but I have seen a hare) and he knows perfectly well his land will suffer in the end. He doesn't care--it will see him out. He is already a millionaire several times over. He is the prime example of that darling of the agricultural economist--the successful agri-businessman....
>
> Cut that land (exhausted as it is) up into a thousand plots of ten acres each, giving each plot to a family trained to use it, and within ten years the production coming from it would be enormous.... The motorist with his *News of the World* wouldn't have the satisfaction of looking over a vast treeless, hedgeless prairie of indifferent barley--but he could get out of his car for a change and wander through a seemingly huge area of diverse countryside, orchards, young tree plantations, a myriad small plots of land growing a multiplicity of different crops, farm animals galore, and hundreds of happy and healthy children. Even the agricultural economist has convinced himself of one thing. He will tell you (if he is any good) that land farmed in big units has a low production of food per acre but a high production of food per man-hour, and that land farmed in small units has the opposite--a very poor production per man-hour but a high production per acre. He will then say that in a competitive world we must go for high production per man-hour and not per acre. I would disagree with him.[99]

No doubt the reader has heard, ad nauseam, the same arguments we have from the agricultural establishment (including well-meaning agriculture professors and extension agents): without large-scale, mechanized, chemical agribusiness, with only organic methods, "the world would starve." For the most part this is learned disability. When

[98] Ward Commentary, *Fields, Factories and Workshops Tomorrow* p. 116.
[99] John Seymour, quoted in Colin Ward, "The Do It Yourself New Town," *Talking Houses: Ten Lectures by Colin Ward* (London: Freedom Press, 1990), pp. 33-34.

pressed to think rather than regurgitate the received dogma, most such people quickly recognize such statements as nonsense on stilts. For example, I challenged a retired agriculture professor on his claim that the world would starve without chemical fertilizers. "Do you mean to say sufficient food could not be produced from available land with the intensive raised-bed techniques of Jeavons, and careful building of soil through composting and green manuring with leguminous cover crops?" "Ah, well, if the land were used that efficiently, it would be a different matter."

But that's just the point. These techniques of efficient land-use were developed long before Liebig (or at least his vulgar followers) reduced the issue of soil building to massive infusions of synthetic N, P and K. The intensive methods of Chinese horticulture, built upon and improved, formed the basis of Jeavons' biointensive raised bed techniques. And Kropotkin, writing in 1913 (indeed, as early as 1898), described the techniques of market gardeners in northwestern Europe and truck farmers in the United States, by which a family could support itself on a fraction of an acre. The new techniques, "created of late" (1898), were "as superior to modern farming as modern farming is to the old three-fields system of our ancestors."[100] The idea, according to Kropotkin, was "to cultivate a limited space well, to manure, to improve, to concentrate work, and to obtain the largest crop possible.... The annual consumption of a man is thus obtained from less than a quarter of an acre." Rather than "talk about good and bad soils," practitioners of the new technique "[made] the soils themselves...." Besides composting and intensive development of the soil, techniques included the combination of cold frames and other season extenders with carefully timed succession planting, intercropping, and the like, to get as many as nine crops a year from a given plot.

> Market gardeners of Paris, Troyes, Rouen, Scotch and English gardeners, Flemish and Lombardian farmers, peasants of Jersey, Guernsey, and farmers in the Scilly Isles have opened up such large horizons that the mind hesitates to grasp them. While up till lately a family of peasants needed at least seventeen to twenty acres to live on the produce of the soil... we can no longer say what is the minimum area on which all that is necessary to a family can be grown, even including articles of luxury, if the soil is worked by means of intensive culture.[101]

Perelman on output of market gardeners. Kropotkin's figures from America: 445-600 bushels of onions, 400 bushels tomatoes, 700 bushels sweet potatoes per acre, all in Florida. pp. 81-82.

As we have already seen in Chapter Twelve, many of the world's cities produce a majority of their own vetetables through rooftop and vacant lot gardening. The Netherlands, the most densely populated country in Europe, was reported in 1974 to have produced 25% more food (by value) than it consumed; Denmark was a net exporter by

[100] Kropotkin, *Fields, Factories and Workshops*, p.60.
[101] Peter Kropotkin, *The Conquest of Bread* (New York: Vanguard Press, 1926 [1913]), pp. 192-197; Kropotkin, *Fields, Factories and Workshops*, pp. 60-68, 81-82.

79%.[102]

Mechanized chemical agriculture was not designed to use land more efficiently, but to increase the productivity of agricultural wage labor. And modern organic techniques are far in advance of traditional farming methods. According to Bill McKibben,

> ...[O]rganic farming techniques have steadily improved in recent decades, especially in their use of cover crops, or "green manures," which enrich the soil without needing animal waste.
>
> The best data come from an English agronomist named Jules Pretty, who has studied two hundred "sustainable agriculture" projects in fifty-two countries around the world. They might not pass the U.S. standards for organic certification, but they're all low-input, using far less energy and chemicals than industrialized farming. "We calculate that almost nine million farmers were using sustainable practices on about 29 million hectares, more than 98 percent of which emerged in the past decade," he noted in 2002. "We found that sustainable agriculture has led to an average 93 percent increase in per hectare food production."
>
> ...This is not simple peasant agriculture; in fact, it's far more complex than just following the fertilizer or spraying schedule that the nice man from the company hands you when you fork over your cash. But farmer-run schools have sprung up in country after country to spread the new techniques, and the longer that small farmers experiment with the new ideas, the more improvements they find.

Sustainable methods led to a 150% increase in average output for fourteen projects employing 146,000 farmers growing potato, sweet potato, and cassava crops, and a 73% increase in yield for 4.5 million grain farmers. Indonesian rice farmers experienced only steady yields, but with a drastic reduction in costs. And on top of all that, the quality of soil and productivity of farms improved over time, as contrasted with the "eroding soil and dying up aquifers" associated with industrial agriculture. An experiment with raised bed horticulture, involving households in twenty-six Kenyan communities, found hunger almost entirely eliminated and the proportion that had to buy supplemental vegetables falling from 85% to 11%. The adoption of nitrogen-fixing cover crops in Central America has increased corn yields two or three times.[103]

And local seed varieties, combined with intensive techniques and the creative use of biological processes, result in levels of output comparable in many cases to Green Revolution varieties combined with heavy chemical use. Even setting aside the long-term costs of soil depletion, good husbandry with local varieties of seed produces almost as much corn and sorghum output per acre. An experiment in Bangladesh--ceasing pesticide use in order to raise fish in rice paddies--resulted in a 25% increase in rice production, along with the high quality protein from the fish. The fish controlled insects more

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[102] Ward Commentary, *Fields, Factories and Workshops Tomorrow* p. 111.

[103] Bill McKibben, *Deep Economy: The Wealth of Communities and the Durable Future* (New York: Times Books, Henry Holt and Company, LLC, 2007), pp. 68-69.

efficiently than chemical pesticides, and fertilized the rice.[104]

Many of the celebrated achievements of the Green Revolution, like genetically engineered "golden rice" with Vitamin A, are answers to artificial problems. Vitamin A deficiencies are much more likely to occur in the first place among growers of large monoculture rice crops, who don't grow anything else for household consumption because they need to maximize rice output to pay for the expensive seeds and chemical inputs. On the other hand, farmers who grow rice mainly for local consumption and can spare the expense of chemicals to protect vulnerable monoculture crops, can afford to grow more than enough leafy vegetables in their own kitchen gardens to supply their needs for Vitamin A.[105]

Cf. Borlaug idiocy, idiocy cited by Bailey and Schwenkler, on how switch to organic would take up more land.

Such critics assume an "organic" model that amounts to the presently predominating form of American agribusiness, in all particulars except the use of chemicals. But when it comes to food output per acre, the organic-chemical divide is far less significant than that between mechanized row-cropping and soil-intensive cultivation. "Organic" is a catchall term that includes an entire spectrum of techniques. At one end is organic tractor farming, "a system fairly close... to current large-scale farming using chemical outputs. The primary difference is that no fertilizers, pesticides, or herbicides are used."[106] Like other forms of conventional mechanized agribusiness, its business model is aimed at economizing on labor at the expense of efficient use of the land. At the other end of the spectrum is intensive raised bed techniques that are actually more productive in terms of food output per acre than mechanized farming (although they require higher labor inputs). And at the small-scale end of the spectrum, the difference between the traditional techniques of small peasant cultivators, and the ways in which people like John Jeavons have developed intensive techniques, is the difference between a Model-T and a Ferrari. Applying techniques like green manuring and companion planting to small peasant production in the Third World would result in a quantum increase in efficiency. In short, those who say that "the world would starve" if it switched from chemical to organic methods, or that such a switch would require an expansion of land under cultivation, are guilty of an intellectually lazy and dishonest comparison.

Intensive horticultural techniques are actually more productive, in terms of output per acre, as Barbara Ward and Rene Dubos point out:

> [T]he small farmer working with his own labour on a family holding, has been shown in a wide variety of developing countries... to produce more per acre than big estates. Some of

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[104] Hawken et al, Natural Capitalism, p. 211.
[105] McKibben, *Deep Economy*, pp. 205-206.
[106] Peter Gillingham, "Appropriate Agriculture," in Dorf and Hunter, eds., *Appropriate* Visions, p. 94. [92-105]

> the highest yields are to be found in countries where acre limitations are strictly enforced. This productivity is secured not by heavy machines which drink gasolene and can easily damage fragile soils, but by hard work with light equipment which is by definition less prone to generate ecological risks. Fertilizers and pesticides are less lavishly used, human and animal wastes are more carefully husbanded. Greater personal care keeps terraces in trim, shade trees planted, gullies forested. And earnings are not spent, as is often the case in semi-feudal economies, on acquiring more land for extensive use, thus pushing up land prices and driving working farmers away from the soil. Nor are they withdrawn altogether from the rural economy, by the development of 'Western' standards of consumption or an over-affection for numbered accounts in Swiss banks.[107]

And Peter Gillingham cites Sterling Wortman of the Rockefeller Foundation to the same effect:

> Most large-scale mechanized agriculture is less productive per unit area than small-scale farming can be. The farmer on a small holding can engage in intensive high-yield "gardening" systems such as intercropping, multiple cropping, relay planting or other techniques that require attention to individual plants. The point is that mechanized agriculture is very productive in terms of output per man-year, but it is not as productive per unit of land as the highly intensive systems are.[108]

Regarding chemicals in particular, rather than making a stacked comparison of chemical agribusiness to the most primitive traditional techniques, it would be more honest to say that chemical farming and the most advanced organic methods are two *alternative* ways of significantly increasing productivity, and that development of the former has tended to crowd out the latter.

Switching from monoculture farming to multiple cropping actually reduces losses to pests more than adding chemical pesticides to monoculture farming, for example. And it does so without the diminishing payoffs that result from insect resistance, and from killing off insects' natural enemies higher in the food chain.[109] Gillingham cites the example of one organic corn grower whose land yields 100-150 bushels per acre, with an average protein content of 12%--compared to the 1971 U.S. average of 87 bushels per acre and 9% protein.[110]

Consider the productivity of local farm economies in Africa that experiment with abandoning chemical herbicides and fertilizers. Instead of using herbicides to kill off the water hyacinths that grew out of control and choked the stagnant lakes polluted by nitrogen fertilizer runoff from large-scale chemical monoculture crops, farmers used the dried hyacinth in growing beds for highly nutritious mushrooms. The mushrooms broke the hyacinth down into a perfect medium for raising earthworms. The earthworms broke

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[107] Barbara Ward and Rene Dubos, *Only One Earth*, in *Radical Technology* p. 249.
[108] Gillingham, "Appropriate Agriculture," p. 96.
[109] Gillingham, "Appropriate Agriculture," p. 98.
[110] Gillingham, "Appropriate Agriculture," p. 105n.

the hyacinth down further into humus for the soil. They also served as food for chickens, who in turn produced eggs, and provided droppings for the methane digesters, which economized on firewood. The shift from a monoculture aimed at producing crops for export, and heavily reliant on purchased chemical inputs, to a diversified farm economy providing a wide range of crops for local consumption, greatly increased the efficiency of land use and improved the nutritional quality of the diet (hence reducing the need, mentioned above, for gimmicks like genetically engineered golden rice). Interestingly, though, it actually *reduces* "growth" as it is conventionally measured, since previously monetized outside inputs are now supplied within a closed-loop subsistence economy.[111]

John Jeavons, in developing successive versions of his biointensive farming techniques, has managed to reduce to four or five thousand square feet the space needed to meet the bare subsistence requirements of the average person. Of course, it is a very spare and monotonous diet, with the vast majority of the space devoted to high carbohydrate cereal grains, legumes or tubers that concentrate a great deal of caloric value on a small space. Only a small fraction of the space can be spared for fruits and vegetables to supplement the diet with vitamins. But 4000 square feet is about half the space available even on a standard suburban residential lot. Even for the cul-de-sac denizen, that leaves considerable space for some additional vegetable beds, a few dwarf fruit trees and berry bushes, and a patch of alfalfa or some extra corn for chickens and rabbits. The careful prevention of rainwater runoff, the saving of surplus rain in cisterns for dry season irrigation, the composting of kitchen scraps and human waste--all these things would make possible a nearly closed loop of food production.

In addition, the agribusiness apologists who talk about the tiny number of "farmers" who produce America's food are guilty of creating a false dichotomy between "farmers" and everybody else. A major part of the vegetables, and some of the poultry and other small livestock, that are consumed in this country are produced in the household sector, by a lot more than one percent of the population. In Great Britain, like the United States, there is widespread concern that urban sprawl is taking vitally needed farmland out of use. But in fact, studies have shown that the total food production in newly suburbanized areas actually increases over the production of the former rural land, as a result of household gardens.

Worldwide, cities produce about a third of the food they consume.[112] In China, rooftop and small lot production together supply 85% of urban vegetable consumption, along with significant amounts of tree crops and meat.[113] In Shanghai, specifically, 60% of vegetables and 90% of milk and eggs are produced on urban farms.[114]

A community-supported agriculture project of only 200 acres supplies 7 to 8% of the

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[111] McKibben, *Deep Economy*, p. 204.
[112] McKibben, *Deep Economy*, p. 82.
[113] Hawken et al, Natural Capitalism, p. 200.
[114] McKibben, *Deep Economy*, p. 82.

fresh food consumed in Burlington, Vt.[115]

All this is not to say that complete household sufficiency in food, or the elimination of division of labor between town and country, is either necessary or desirable. It only means that it is possible. A return to agriculture based on intensive work with the spade, u-bar and fork would not mean starvation. It would mean greater output per acre than is presently the case.

G. A Soft Development Path

Vinay Gupta proposes a "soft development path" for the Third World, based on integrating intermediate-scale technology into the village economy:

> Our goal is simple - to remake the “lifestyle niche” of the smallholder organic farmers who comprise half of the human population into something which is healthy, prosperous, stable, environmentally benign, and includes health care and health maintenance, access to energy and education, and many other improvements. The bedrock of this transformation is appropriate technology deployed as whole systems, not as the stand-alone stepwise improvements of the past which have had such mixed success.
>
> History is on our side. The development of new technologies like ever-more-affordable solar panels and ICT (information and communication technologies) extends our reach every single day. Our goal, then, is to work with these underlying trends to maximize progress in the regions where it is needed most: to go to where the poverty is deepest, and stabilize and improve life there.
>
> It is our hope and belief that by improving life for the smallholders and in the villages using applied basic science and appropriate technology that the destructive and unsustainable flight to the cities can be slowed, and the destructive transformation of agriculture which clears farming households off their land can be arrested. To make smallholders economically productive enough to retain their land during agricultural transformation requires use of relatively modern organic farming know-how, like green manures and integrated pest management, but there are pockets of expertise in these techniques all over the world. The challenge is spreading the knowledge to make the smallholder’s fields abundant. This is the bedrock and anchor of revolutionizing the lives of the poor, and stabilizing half of the population of the planet in their existing sustainable lifestyles.
>
> Then there is technology. Stoves which are five times as efficient as current stoves, adding as much as 15% to household income through reduced fuel spending. Simple electrical lights based on cheap LED lighting elements. Water purifiers which can end illness and death from water borne disease. Malaria nets and microfinance. The Hexayurt itself is a simple building designed for refugees, IDPs, and the very poor from any country who are unable to afford more traditional home. These systems together constitute a redefinition of the basic way of life of the very poorest in the same way that running water and sanitary

[115] Ibid., p. 80.

toilets transformed the way of life of Europeans and Americans over the past 200 years, but in a manner which does not require the poor to vastly increase their income or ecological footprint.

The poor cannot follow the development path that the current rich have taken without destroying the planet. It is not even clear that the rich can become sustainable, although new technology will help. The soft development path is an alternative approach to spreading results like those of the Kerala Miracle, in which an Indian region with an average income of $300 per year has attained quality of life as measured by lifespans, literacy and infant mortality very close to those of rich nations. Although not every area may enjoy Kerala's unique social advantages, Kerala proves that it is possible to live well on very little money or ecological impact. Kerala proves it can be done, and appropriate technology will lower the barriers to this kind of success in other regions.

The Hexayurt Project is dedicated to the development, under open intellectual property licenses, of the necessary technical and social solutions to the long term development needs of these smallholders and their urban cousins. To date we have developed an award-winning emergency shelter system and infrastructure package, and we are working with a variety of agencies from the US Department of Defense to the Netherlands Red Cross, as well as with private enterprise to develop and deploy a fielded solution for refugees. The next step is to move beyond disaster relief and into development aid.[116]

The "Kerala Miracle" Gupta refers to is indeed noteworthy. As Bill McKibben describes it, it is a textbook example of what E.F. Schumacher meant by intermediate technology:

> Instead of building huge factories, or lowering wages to grab jobs from elsewhere, or collectivizing farmers, the left has embarked on a series of "new democratic initiatives" that come as close as anything on the planet to actually incarnating "sustainable development," that buzzword beloved of environmentalists. The left has proposed, and on a small scale has begun, the People's Resource Mapping Program, an attempt to move beyond word literacy to "land literacy."
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> Residents of local villages have begun assembling detailed maps of their area, showing topography, soil type, depth to the water table, and depth to bedrock. Information in hand, local people could sit down and see, for instance, where planting a grove of trees would prevent erosion. And the mapmakers think about local human problems, too. In one village, for instance, residents were spending scarce cash during the dry season to buy vegetables imported from elsewhere in India. Paddy owners were asked to lease their land free of charge between rice crops for market gardens, which were sited by referring to the maps of soil types and the water table. Twenty-five hundred otherwise unemployed youth tended the gardens, and the vegetables were sold at the local market for less than the cost of the imports. This is the direct opposite of a global market. It is exquisitely local--it demands democracy, literacy, participation, cooperation. The new vegetables represent "economic growth" of a sort that does much

[116] Vinay Gupta, "Soft Development Paths," *The Bucky-Gandhi Design Institute*, April 10, 2008 <http://vinay.howtolivewiki.com/blog/hexayurt/soft-development-paths-520>.

> good and no harm. The number of rupees consumed, and hence the liters of oil spent packaging and shipping and advertising, go down, not up....
>
> ....One can imagine, easily, a state that manages to put more of its people to work for livable if low wages. They would manufacture items that they need, grow their own food, and participate in the world economy in a modest way, exporting workers and some high-value foods like spices, and attracting some tourists. "Instead of urbanization, ruralization," says K. Vishwanathan, a longtime Gandhian activist who runs an orphanage and job-training center where I spent several days. At his cooperative, near the silkworm pods used to produce high-quality fabric, women learn to repair small motors and transistor radios--to make things last, to build a small-scale economy of permanence. "We don't need to become commercial agents, to always be buying and selling this and that," says Vishwanathan. He talks on into the evening, spinning a future at once humble and exceedingly pleasant, much like the airy, tree-shaded community he has built on once-abandoned land--a future as close to the one envisioned by E. F. Schumacher or Thomas Jefferson or Gandhi as is currently imaginable.[117]

A good example of the cheap, human-scale technology Gupta described can be found in Guatemala, where a cooperative has begun producing farm machinery from old bicycles.

> ...[I]nstead of spending a week beating cobs with a stick to loosen the grains, then grinding them for meal in a hand-cranked mill, the average small farmer can now do the job in a day and a half, thanks to a machine that "resembles a primitive exercise bicycle" and is called a *bicimolino*, or bike mill. The company also has bike-driven irrigation pumps, a pedal-powered machine that produces cheap, strong roofing tiles, and bicycle trailers for taking crops to market.[118]

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[117] Bill McKibben, "What is True Development? The Kerala Model," *Utne Reader*, March 1998 <http://www.ashanet.org/library/articles/kerala.199803.html>.

[118] McKibben, *Deep Economy*, p. 206.