

Producing: Production

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A man named Adrian Bowyer is building a machine, which is building a machine, which is building a machine...

It could be the first line from a SF story (and perhaps it will), but in this case the story is true. Adrian Bowyer (and many others across the Internet in conjunction) is/are building the RepRap – a replicating rapid prototyper. It is an exploration of rapid prototype technology, with the purpose of building a prototyper capable of building the same prototyper: in other words, *capable of building replications of itself*. It is a very interesting project, and frightening, in some ways. I'm writing about it for two reasons: first, because Bowyer takes on a certain amount of philosophy in his exegesis of the project, which I'd like to engage (I'm using as my source [Adrian Bowyer's Keynote Address](#) on the RepRap project given to the Seventh National Conference on Rapid Design, Prototyping & Manufacturing, at the Centre for Rapid Design and Manufacture in High Wycombe in June 2006). Second, the project takes on a certain amount of philosophy itself by its purpose, despite intentions. The RepRap experiment is a project in practical and physical philosophy: it is the manifestation of philosophy in the form of an attempt to solve a problem in the real world. Naturally, the first question is: is it even possible to build this machine: what von Neumann called a "universal constructor"? But whether or not it yet it exists, many philosophical, economical, biological and technological questions blossom from the sheer potential existence of such a machine.

But these many questions are perhaps united: the philosophical, economical, biological, and technological questions are not anything like separate problems. Devices like the RepRap, capable of evolving our standard understanding of production (person operates machine,

machine makes product) are coming into existence and wide-spread use almost daily (for example, a computer user can now make, record, produce, distribute, and sell music all in one sitting) we are slowly (or in some cases, quickly) forming a new understanding of what these changes mean to us—a new technological ecology, embracing and often subsuming everything from the classically divergent *techne* and *episteme*, to the only recently labeled *environmentally-sustainable*, and *conscious-design* fields. I'm not going to attempt to coin a new term (yet). But, I will install and utilize a heavy Marxian, materialist framework for the philosophical exploration of these ideas—and in doing so, will come back against Marx's concept of production as the activity linking us to nature—the plain from which we produce objects—thereby forming our subjective, material world around us. It is a heavily phenomenological reading of Marx, and one not often voiced or accepted. But despite the readings of his economic and political philosophy in the past, this reading may have the benefit of helping us reach an understanding of technology as an ecological process, and give us the analytical tools to shape our world beneficially for now, and the future. In such a present as when supposedly “time-proven” models of transcendental economic and productive truths are crashing and burning all around us, it might be wise to begin considering alternate strategies. Perhaps a new material analysis drawn from the interactions between our productions and our nature, as part of our nature, both biological and rational, can be the path outward into the future.

Bowyer's machine is quite remarkable—I'm not sure how much of it has been developed by whom among his globally networked open-source community, but his brief introduction to the machine in the above-cited essay shows a very apt example of what individual researchers are able to accomplish using share and share-alike ethics of the Internet despite limited resources. He and his colleagues have put a lot of thought into how it would work, and how its function might change in the future. For my purposes, both highly speculative and philosophical, I'm going to begin by approaching his introduction to the concept of a “universal constructor”, and leave the technical elements of the machine's design to the experts, who are doing a fine job.

The concept of universal constructor was a theoretical invention of John von Neumann consisting of a computer and a robot which could make a copy of themselves (taking this description from Bowyer). It was so-named because the machine was not simply meant to self-replicate; it was meant to be complex enough to allow an iterative process through which evolution of the algorithm could occur during reproduction—in other words, to grow in complexity and form “life” ([more on that here](#)). This is all in the hypothetical, conceptual sense of course, not meant to intend a self-replicating machine will become sentient, or correspond to any other particular definition of life.

Bowyer takes his inspiration from this logic project, converting it into a technological proposal: what would be necessary to make a machine capable of building itself? The difficulty, he says,

is the “need for it to be able to self-assemble as well as self-replicate.” He therefore takes the biological model of symbiosis as his solution, suggesting it might be more feasible and simpler for humans and the machine to work together for the benefit of each other: “to make a universal constructor that could manufacture its component parts, but that left assembly to people.” This is an important and under-utilized fact of the “biomimetic” model which has been a part of design throughout history—no organism is a unit, unto itself. The very name “organism” lends itself to discussion of systematic approaches, schematic models, and functional compartmentability, but its real existence is much more dynamic.

These overly complex words aside, we know life will not exist to its own. It’s very “nature”, and I use that word here knowingly, is anti-transcendental. In other words, it eats, shits, and dies. It must subsist on a diet of chemicals, found in its immediate environment. It must re-supply chemicals back to the environment, and take the consequences of this change upon the environment. Most organisms require a number of its species in a localized area, if not for purely chemical reasons, than for some sort of “social,” iterative behavior—though I cringe while I use that last phrase because of its irritating complexity, it will be important later. But in other, simpler words: “survival of the fittest,” doesn’t work if you’re on your own.

So symbiotic, altruistic, or parasitic and manipulative relationships between organisms are part of nature’s daily work, but it doesn’t end there. Any ecosystem is made up of thousands of intensity barriers and pathways, the ebb and flow of which are crucial to the cycles of life within it. Temperature regulation, for example, or concentration and access of resources are clearly important, but salinity, light frequency, or even geology and astronomy can make or break an environment for an organism. Organism behavior is so complex, and the interactions between them are so complex, we don’t even know where to begin when describe these networks. We simply call it ecology.

But if these economies of biology are so all-encompassing, isn’t it a bit redundant to speak of “biomimetics”? How could a cuckoo, in pushing another bird’s eggs out the nest and replacing them with its own, be said to be mimicking or perverting nature? Isn’t that nature itself? What about a human using an oar—is it more like a flipper, or our own human hand? We now know we are hardly the only species to use tools—so if we take our inspiration for our tools from nature, are we “aping” nature, according to the archaic term, or simply being humans at our most natural?

Indeed, as Bowyer notes, even self-replication is not exactly a new idea for us or for our relationships with nature: “agriculture [clearly he is referring to husbandry as well]—is entirely founded on self-copying machines: the animals, plants, and micro-organisms that are its products.” If self-replication is not new, it seems there is not much about this idea to be called

strictly “break-through”; it seems the real breakthrough for these quite natural concepts is, thanks to the work of Bowyer and crew, we seem to finally have a technology ready to apply self-replicating natural patterns to manufacturing three dimensional objects. It’s exciting, but also mundane, in the history of the world.

Or is it mundane? This is precisely the level at which the “frightening” speculative possibilities come into play. Forgive me if I shoot towards the more speculative side of things immediately, and then bring it back towards the more immediate and less apocalyptic possibilities. There is a flow, I assure you.

For a long time the act of mechanical reproduction has been a boundary; on one side stood humanity, and on the other side its objects. Nature was not included in this duality, rather taking the form of the surrounding arena of this particular drama. The conflict between “man and material” has taken several forms, and acquired and traded many vectors back and forth over the years. “Body and mind” is one you may remember, or “idealism and materialism”. “Workers and commodities” is another, though less familiar to some. And certainly, these boundaries have been the site of bloody battles and vengeful betrayals, but also the scene of great love affairs.

But more and more frequently, this boundary is breaking down in different ways. Sometimes the person who was previously required to form an object becomes superfluous. Other times the object is produced in a new form, or the old form becomes obsolete, making the object seem less objective than it once was, and it itself becomes superfluous. And in certain situations, humans become objectified, and objects can take on aspects of humanity itself, miming our own nature, as we perceive it.

All of these are unappreciated by humanity, a species very much enjoying deliberate, full control of its objects at all times. But the third barrier is invested with uncanny apprehension—when humans are treated like manufactured objects (that is, fully and un-restrictedly exchangeable), and even more so, when objects are treated like humans. Robots are fine with us, as long as they have some plug which can be yanked out of the wall at any time, or some innate logic separating their violent productive/destructive power from humans’ own power of the same by some sort of metaphysical spark gap. But when machines start doing *our* stuff—when they think, love, murder out of emotion, or exhibit any sort of *desiring, creative urge*—then it’s time for the torches and the pitchforks.

Personally, I’m not afraid of this. Human emotions in everyday humans scare me about as much as any automaton I can imagine. Robots with guns don’t kill people; the senselessness of uninhibited, totally enabled human emotion flowing through a human’s bare hands around his/her lover’s neck is what kills people.

Nor do I think the RepRap is even close to any definition of “sentient”, “emotional”, or “capable of stabbing one’s mate”. What it is close to is the ability to make things, and an interface to a computer telling it what to make, and perhaps via these, being told to make the components of itself. This is the breakthrough: fully autonomous re-production. The universal constructor can build whatever it needs, and scale production in order to do so. Robots free to make, and to make what they see fit. To increase the market supply where it is needed, and to design new solutions to everyday problems: cost effectively! In short, it will do the things human producers do, and do it by itself.

But—wait a minute... why am I getting images of robots making huge stocks of singing, animatronic fish? Robots imitating commercials with their look-alike mp3 players? Robots designing other robots who build robots to throw away all of last month’s computers? What if... (HORROR!) the robots are just like us?!?! They’re people! Robot workers ARE PEOPLE!

But we’ll leave the failures of our own economies to the side for now. Here is a much more basic problem—who hasn’t come back into the room after discovering they hit the print button twice, and now they have two copies of the fifty-page digital camera manual printed? Okay, maybe not—but who has ever made a mistake with a decimal point and had the calculator say “ERR”. What would ERR look like on the thousandth iteration of a thinking, fabricating robot, making other thousands of robots with that ERR included, expanding and increasing the ERR as more robots are created? I’m not saying SkyNet would become self-aware (though this is something to think about), but what about another Y2K-type issue? If a batch of computer parts becomes bad, it can be potentially crushing for the economy of an electronics company. What if on its tenth iteration, an error develops that goes un-seen? At a rate of production in Bowyer’s example of the comb (every day a RepRap can produce one RepRap and one comb), by the time a month goes by, you have half a trillion objects to debug, looking for the error! And you must take every machine out of production during the time you check, to keep the error from perpetuating. Even if you keep good lineage records, and are able to isolate the exact mutation generating the error, the blow to productive power is huge. Ask the FDA about tracking down tainted tomatoes.

This is not a reason against experimenting with iterative, self-replicating production. It is simply one possible stumbling point to think about as we suggest making our production more “natural”. After all, nature creates hurricanes, plagues, cancer, and the destructive potential of humanity. If you could turn back the clock and keep humanity from ever leaving the trees, or inventing guns, or the A-bomb, would you? This is not an important philosophical question, merely a game. But if we begin to automate the “decision” of producing, by making machines capable of doing so at will, we will be in the position of asking our descendants’ version of this hypothetical question ourselves, when we are in the position to do something about it.

But to treat production as only an action by asking these logic-tree questions, reducing philosophical analysis to a simple “yes/no”, is a minimal line of reasoning reduces thought to only a line of choice—just the sort of probability mongering which has brought us to the brink of nuclear war before. We’ve already discussed the idea that no one organism is alone in an ecosystem—so why should the individual choice by any one thing (person or machine) to make another thing be a stumbling block? There will always be failures at the individual level. This is the essence of prototyping! But what sorts of ecological strategies can increase the health of the productive ecosystem? We are in desperate need of some good strategies.

Bowyer takes on Marx in his speech, in order to refute Marx’s established view of technology; Bowyer does not state he is doing so, and may not be aware, but yet he does it in his use of the philosopher. Marx believed that any technological advance would only alienate the worker further from his/her product, allowing more possibilities for others to step in and extract surplus value. You can make twice as many combs per hour? Great! More combs for Mr. Business, same hourly rate for Mr. Machine Operator, formerly Mr. Comb Carver.

But Bowyer implements the new argument that digital technology brings to the materialist table, which of course, we can hardly blame Marx for missing. The replication power of digital technology allows scaling production to near infinity. This productive advance makes creative power the real asset rather than industrial power, and rendered the reproduction of a number of objects as easy as making one. So, whereas in the past a guitarist would have been at the mercy of the person “owning” the recording equipment, record press, and so forth, any person who can play a guitar can make a decent recording with a computer, and manufacture and sell recordings. [This is an argument I’ve made before](#) to note the historical dilemma of “intellectual property” in the days of digital production—then as now, it must also be noted that what becomes important in the age of digital production is the *means of distribution* of the objects into a market or other network, rather than the means of “production,” as formerly understood by Marx and other industrial philosophers. Luckily, it seems digital technology is in our corner, as regards the means of distribution (that is, we, as *workers*)—at least so far.

The RepRap is not digital production, but it establishes ability for scaling production in similar magnitude to the near infinite power of digital reproduction. As said before, if one RepRap can make one additional RepRap a day, in a month one might have half a trillion of them. Clearly there is little market in selling items capable of producing themselves.¹ The limit of our

¹ At least, until distribution schemes are developed, designed, and manipulated. What will be the one difficult component resource to find? (Call it the “Spacely’s Sprocket”, if you like.) What sorts of modifications and customizations will the open-source model of design make available in this future market? Distribution networks are often the production chains most susceptible to stagnancy and conservatism—allowing the distribution element of production to be perhaps the most important new market for innovative design in our current times. This is a good thing, if the development of the Internet is any indication of the innovations distribution will manifest. However, I can think of many caveats to solid potential outcomes, with cartels like the RIAA and the

productive power, (and what's more, the *worker's* productive power) is now reduced to the resources necessary, and Bowyer and his team have many good ideas in this category: bio-synthesizable plastics, fully recyclable materials, and an open-source design philosophy. The idea is a good one—by putting the means of production directly into the hands of the producer (interestingly enough via a physically tautological, though not logically tautological production process) production relations can be re-formed from the ground up on the digital model.

But before dismissing Marx on the basis of his unfortunate historical contingency (that is, being long dead), as Bowyer is largely willing to do, despite his own similar enthusiasm for a technology with the possibility of improving the conditions of producers, perhaps we should consider what caused the philosopher-economist to come to these conclusions about technology. The key, for Marx, is the alienation of the worker from his/her labors. Rather than making ten combs, in the industrial age a laborer works for one hour. The ten combs are a by-product, and any value put into the wood, now turned into a comb, is seized immediately by the employer who employs the worker. At no time did the worker own the combs s/he made—the labor was bought by the capitalist for \$X/hour, and thereby, *abstracted* from labor into mere work. It is an unequal equation, with all the multipliers on the side of the employer.

But now we've given all the production to the laborer, freeing him or her from these chains of abstraction. The only place where abstraction or surplus value can occur in the digital model of production is in the distribution chain, when value is bought cheap and sold dear somewhere else, manipulating markets and distorting the natural distribution for profit. Natural distribution... but wait—this reminds me of something; only a few pages ago I was discussing how our current understandings of the relationships between humans and their objects are simplified linearizations of true, ecological production: the understanding of “human and object” as the essential relationship of the world is itself an abstraction. Weren't we going to strive for an ecosystem model, incorporating as many factors of production into our understanding as possible, whether they be biological, mechanical, economic, or otherwise?

But what exactly does this mean: an ecosystem model? It sounds nice, sure. Everybody likes ecosystems, and even if you don't, you still probably like systems. But what is it? Well, you may be surprised to hear that I believe a good ecology of production would involve a systemized view of as many networks as possible, in material terms, attempting to avoid abstraction whenever possible. Funny, you never would have seen this coming...

Abstraction is a fact of thought, as much as it is the political reality Marx described. The world is far too complicated to keep all systems in mind all of the time, and so we reduce elements of the systems to linearizations, logical steps, quantified units, and other such commodities of the

rational human mind. But when we begin to treat these abstractions as natural units—commodifying our abstractions into objects *for themselves* (get it, phenomenology crowd?)—we begin to suffer at the hands of our own simplicity. We shouldn't think of our production relations as simply "what we do". A worker should never think of his/her work in terms of hours. This leads to clock-punching, shoddy work, and numerous other problems as the worker tries maximize his/her work *by the hour*. The maximization should occur for the product: harder, better, faster, stronger, etc. What's the best way to do this? Put the value on the work, not the time—and not just the piece work, but the overall impact to the productive ecosystem as a whole. If you need to quantify it, profit sharing, for instance. Not too hard to figure out. The same thing goes for the rest of the productive environment: why outsource when you can collectivize; why pump and dump a resource when you can sustain and develop? Why? Because pump and dump creates the highest potential for abstract profit. The real estate market is exhibit A. It has *nothing* to do with building places to live, and everything to do with making "money"—even if it results in imploding the meta-economic system. Who could have seen that one coming? Creating a false demand to create a higher value to create more false demand? All it would have taken was to go knock on the door, and make sure someone was living in the house and paying for it. Oops. Well, they promise not to be only profit-focused again.

When we put production in the hands of the laborer with a remarkable feat of design such as the RepRap, our job has clearly only just begun. One abstraction has been re-materialized, and the power of that element of the productive system is now "living", building, and in the direct hands of the worker. So, what shall the worker produce? Half a trillion RepRaps? Just as many combs? Advancing mechanical production to the logic of digital production is a huge breakthrough, and as such, it must be carefully implemented. It is nothing less than a revolution (if it works, and is expanded) and must be treated as such.

This is no doubt why Bowyer's assesses Marx's call for the seizure of the means of production by revolution as "a good candidate for the all-time worst-idea in human history." He is obviously thinking of the Soviet Union's poor human rights track record; and shows it when in the next sentence following this quoted passage he calls the communist revolution worse than Nazism. Of course, he is making the all-time stupidest mistake in the history of philosophical treatments of Marx—somehow implying that the *Communist Manifesto* was responsible for Stalin and the other totalitarian Soviets. The *Manifesto* was written in 1848, when joining a trade union was considered a revolutionary act. And yes, for those industrial workers, oppressed, persecuted, and killed for attempting to do something as brazen as to unionize and bargain with one's employers, revolutionary struggle meant a fight. It was a fight they won, winning human rights for workers everywhere, though it did not extend to the national level in the way

Marx envisioned, because the governments were smart enough to make concessions before it led to this point. Rather than let the army make the decision not to fire at the mob and lose sovereignty all together, they made the decision to call off the army, and keep the government. Violence, in this case, was an extension of politics—forcing abstraction of production relations (the production in this case being destruction) into different veins, to make a point and defend oneself. When violence extends into the arm of the power of the state it is the same thing, directed at new targets for new causes. Equally deplorable under certain moral abstractions, sure—but then again, there once was a man who said something about this topic while fighting against such violent governments.... Something about workers and police, and knowing which side he was on....

Revolution, it seems, is precisely what Bowyer is after despite his opposition to violence, and rightly so. His project would revolutionize manufacturing, and what's more, revolutionize our understanding of production by evolving our productive relations: in fact, our entire humanity as producing beings. It would give us a new glimpse at the big un-abstracted ecosystem of productive chains spanning our world via a new, digital model to work through. Violence is a potential outcome. Economic and environmental destruction are also real risks. But these always have been possibilities; we just like to forget about them, abstracting them in our minds to simple errors from "the way things are supposed to work." They would need to be considered in the vanguard if we are going to shake up our relations with production.

This new production system, which I have referred to varyingly as the digital production model, the ecological model and other technical adjectives, is *iterative analysis*. Note I am flying out on a limb here, inventing new terms as I go. What I mean when I say "iterative analysis" is not only a checking of abstract concepts to make sure they are useful and rational, but also a re-affirming of the overall structure under constantly evolving conditions. Under certain conditions it makes sense for all workers to share profits—but will it always? Using wood as a raw material is often a good choice because it is renewable—but will tree farms always be the most efficient process of renewal? And so on. Iterative analysis should conduct the sorts of judgments that will prevent species, our or others, from flat-lining. Pandas, for example, found a good renewable resource in bamboo, and evolved their diets to switch over their consumption to this source despite its inefficiencies. Now the land with bamboo is threatened by another species (yours and mine truly), and that inefficiency and specialty is coming back to haunt the species. They were perfectly evolved, until things changed faster than they could adapt. This is what we need to judge in our own species, and specifically, in the part of our existence we call production. Our methods of production have been evolving in fits and starts throughout our knowable history. Other aspects of our ecology had not always been in sync. Unfortunately, when our society has trouble catching up to our technology, people die. Not only through the

plague, influenza, AIDS, rising sea levels, carcinogenic chemicals, radiation, heart disease, and other “real” natural causes (there’s more?!?), but through the “other” natural causes: fires, car accidents, wars, and yes Mr. Bowyer, worker revolutions. Remarkably, we’re all still alive though we are constantly plugging ourselves into circuits, pumping our drinking water full of drugs, bashing each other over the head, and zipping through the air at accelerations our fragile forms are not even close to being able to accommodate. But it isn’t a miracle, either. We are pretty good at evolving, all things considered, even though our flat-line could be looming just behind any number of epochal corners. Ever wonder why we don’t have trench warfare anymore? Or heavy, sustained sieges (at least, in most of the world, embargoes aside)? We even try and limit our cruelty, reserving torture for special occasions the way we do profanity, and by creating such abstract ideals as morality, justice, and health, by which we seek to gain friends and pacify our enemies. In fact, it seems we already do some forms of iterative analysis, though perhaps only in the past, and not as directed towards the future as we should. We call it “culture”, and it is always already on—this constant interface between ourselves and our world which does not limit our objects to an abstract and simplistically-direct relationship between ourselves and others, like abstract concepts of “economies” and “means of production”. We don’t just make objects in culture; we love objects, we feel things about objects, we have desires for objects, and visualize them throughout our understanding of time-space, extending our objects into the past and the future, along with ourselves. What should I write about today? How will what I write today make me feel tomorrow? How will others feel reading my writing today, or tomorrow? This is iterative analysis, and humans are masters of it. Mostly we just call it thinking.

So why don’t we start thinking about something we have only just been doing for a very long time? Let’s think about production. Rather than just making things and selling them for whatever they are worth, why don’t we actually think about it? What should we make? Is what we make today the same thing we should make tomorrow? How will we make it today, versus tomorrow? How can we change the way we think about what we make to help us make whatever it is we will need to make in the future?

Adrian Bowyer is thinking about it—and what’s more, he and his network are making it. They are making machines, which are making machines, which are making machines... just like we all are.