Selected Growth Fallacies

by Herman E. Daly

If you have eaten poison, you must get rid of the substances that are making you ill. Let us, then, apply the stomach pump to the doctrines of economic growth that we have been force-fed for decades. The best way to do that is to consider critically some growth arguments.

The verb "to grow" has become so overlaid with positive connotations that we have forgotten its first literal dictionary denotation, namely, "to spring up and develop to *maturity*." Thus the very notion of growth includes some concept of maturity or sufficiency, beyond which point physical accumulation gives way to physical maintenance; that is, growth gives way to a steady state. It is important to remember that "growth" is not synonymous with "betterment."

Can't Get Enough of that Wonderful Stuff

Americans have been told by no less an authority than the President's Council of Economic Advisors that, "If it is agreed that economic output is a good thing, it follows by definition that there is not enough of it." (Economic Report of the President, 1971, p. 92). It is evidently impossible to have too much of a good thing. If rain is good, a torrential downpour is, by definition, better! Has the council forgotten about diminishing marginal benefit and increasing marginal costs? The council admits that "growth of GNP has its costs, and beyond some point they are not worth paying" (p. 88). However, instead of raising the obvious question n What determines the optimal point and how do we know when we have reached it? n the council pontificates: "The existing propensities of the population and policies of the government constitute claims upon GNP itself that can only be satisfied by rapid economic growth" (p. 88). Apparently, "existing propensities and policies" are beyond discussion. This is growthmania.

The theoretical answer to the avoided question is clear to any economist. GNP growth should cease when decreasing marginal benefits equal increasing marginal costs. But there is no statistical series that measures the cost of GNP. This is growthmania, literally not counting the costs of growth. But the situation is even worse. We take the real costs of increasing GNP as measured by the expenditures incurred to protect ourselves from the *unwanted* side effects of production and *add* these expenditures to GNP rather than subtract them. We count costs as benefits. This is hyper-growthmania. Obviously, we should keep separate accounts of costs and benefits. But to do this would make it clear that beyond some point zero growth would be optimal, at least in the short run.

The Hair of the Dog that Bit You

One of the most popular arguments against limiting growth is that we need more growth in order to be rich enough to afford the costs of cleaning up pollution. Economist Neil Jacoby says, "A rising GNP will enable the nation more easily to bear the costs of eliminating pollution" (1970, p. 42). Yale economist Henry Wallich makes a similar point:

> *The environment will also be better taken care of if the economy grows. Nothing could cut more dangerously into the resources that must be devoted to the Great Cleanup than an attempt to limit resources available for consumption. By…allowing everybody to have more, we shall also have more resources to do the environmental job* (Wallich, 1972, p. 62).

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No one can deny that if we were truly richer, our economic problems would be more easily solved. The question is whether further growth in GNP will *in fact* make us richer. It may well make us poorer. How do we know that it will not, since we do not bother to measure the costs and even count many real costs as benefits? These critics simply assume that a rising per capita GNP is making us better off, when that is the very question at issue!

"Environmental degradation is an iatrogenic disease induced by the economic physicians who attempt to treat the sickness of unlimited wants by prescribing unlimited production. We do not cure a treatment-induced disease by increasing the treatment dosage!"

If marginal benefits of physical growth decline while marginal costs rise (as economic theory would indicate), there will be an intersection beyond which further growth is uneconomic. The richer the society (the more it has grown in the past), the more likely it is that marginal benefits are below marginal costs and that further growth is uneconomic. That marginal benefits fall follows from the simple fact that sensible people satisfy their most pressing wants first, whether in alternative uses of a single commodity or in alternative uses of income. That marginal costs rise follows from the fact that sensible people first exploit the most accessible land and minerals known to them, and that when sacrifices are imposed by the increase of any one activity, sensible people will sacrifice the least important alternative activities first. Thus marginal benefits of economic activity fall while marginal costs rise.

The best attack on this argument is to argue that the cost and benefit curves continually shift apart so that the intersection always stays ahead of us, and thus growth remains economic. But there are physical limits to efficiency (how far down cost curves can be shifted), and our rush toward exotic growth-permitting technologies, such as fission power and breeder reactors, is more likely to push the cost curve up than down, once all costs are counted. Moreover, our efforts to push the benefit curve up by creating new wants too rapidly and too artificially are more likely to pull the curve down than to push it up. But even ignoring the possibility that the curves could shift in perverse directions, and assuming *very unrealistically* that the benefit curve will forever shift upward and the cost curve downward, there is *still* the question of timing. Why must the curves always shift *before* we reach the intersection? Might not technical progress occasionally be delayed?

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Consistent Inconsistencies and Avoiding the Main Issues

Growthmen claim that no economist worth his salt confuses GNP with welfare. Consider, however, the following four statements from the same article (Nordhaus and Tobin, 1970):

(1) *Gross National Product is not a measure of economic welfare … maximization of GNP is not a proper objective of economic policy … Economists all know that …* [p. 6].

(2) *Although GNP and other national income aggregates are imperfect measures of welfare, the broad picture of secular progress which they convey remains after correction of their most obvious deficiencies* [p. 25].

(3) *But for all its shortcomings, national output is about the only broadly based index of economic welfare that has been constructed* [p. 1, Appendix A].

(4) *There is no evidence to*

support the claim that welfare has grown less rapidly than NNP (Net National Product). Rather NNP seems to underestimate the gain in welfare, chiefly because of the omission of leisure from consumption. Subject to the limitations of the estimates we conclude that the economic welfare of the average American has been growing at a rate which doubles every thirty years

[p. 12].

It is asking too much of context and qualification to reconcile statement 1 with 2, 3, and 4. Either GNP (or NNP) *is* an index of welfare, or it is *not*. The authors clearly believe that it *is*. They offer sensible adjustments to make GNP a better measure of welfare. But all of this avoids the fundamental objection that GNP-flow is largely a *cost*. Wants are satisfied by the services of the *stock* of wealth. The annual production flow is the *cost* of maintaining the stock and, though necessary, should be minimized for any given stock level. If we want the stock to grow, we must pay the added cost of a greater production flow (more depletion, more labor, and ultimately more pollution). Depletion, labor, and pollution are real costs that vary directly with the GNP-throughput. If we must have some indices of welfare, why not take total stock per capita and the ratio of total stock to throughput flow? Welfare varies directly with the stock, inversely with the flow. Beyond some point, the benefits of additions to the stock will not be worth the costs in terms of additional maintenance throughput.

Kenneth Boulding has long argued that Gross National Product is largely Gross National Cost and has never been taken seriously. If this way of looking at things is wrong, why doesn't some economist refute it instead of avoiding it?

The source of this flow fetishism of orthodox economics is twofold. First, it is a natural concomitant of early stages of ecological succession (Odum, 1969). Young ecosystems (and cowboy economies) tend to maximize production efficiency, that is, the ratio of annual flow of biomass produced to the preexisting biomass stock that produced it. Mature ecosystems (and spaceman economies) tend to maximize the inverse ratio of existing biomass stock to annual biomass flow that maintains it. The latter ratio increases as maintenance efficiency increases. Economic theory is lagging behind ecological succession. Second, concentrating on flows takes attention away from the very unequally distributed stock of wealth that is the real source of economic power. The income flow is unequally distributed also, but at least everyone gets some part of it, and marginal productivity theory makes it appear rather fair. Redistribution of income is liberal. Redistribution of wealth is radical. Politically, it is safer to keep income at the center of analysis, because not everyone owns a piece of the productive stock, and there is no theory explaining wealth distribution. Putting stocks at the center of analysis might raise impolite questions.

Misplaced Concreteness and Technological Salvation

Technology is the rock upon which the Growthmen built their church. Since rocks are concrete entities, it is natural that Growthmen should begin to endow technology with a certain metaphorical concreteness, speaking of it as a *thing* that grows in *quantity*. From there, it is but a short step to ask whether this thing has grown exponentially, and to consult econometrics and discover that indeed it has! Next, we can conceive of technology as a sort of antibody to the pollution and depletion germs. Ultimately, we conclude that depleting and polluting activities (production and consumption) can continue to grow exponentially, because we have a problem-solving antiparticle, technology, which can also grow exponentially!

Is this an unfair caricature? Consider the following statement from a review of *Limits to Growth* (Meadows et al, 1972) by two economists and a lawyer:

> *While the team's world model hypothesizes exponential growth for industrial and agricultural needs, it places arbitrary, nonexponential limits on the technical progress that might accommodate these needs.*
>
> *…It is true that exponential growth cannot go on forever if technology does not keep up, and if that is the case we might save ourselves much misery by stopping before we*

reach the limits. But there is no particular criterion beyond myopia on which to base that speculation. Malthus was wrong; food capacity has kept up with population. While no one knows for certain, technical progress shows no signs of slowing down. The best econometric estimates suggest that it is indeed growing exponentially (Passell et al., 1972, p. 12).

These few sentences unite in one short space so many of the misconceptions of orthodox Growthmen. Note that technology has become an exponentially growing *quantity* of some *thing* that solves problems but does not create any. Note the clear implication that exponential growth could go on forever if technology (that problem-solving antiparticle) can keep up. Can it in fact keep up? Consult a nameless econometrician and behold! It has in the past, so it probably will in the future. Most econometricians are more cautious in view of the fact that technological change cannot be directly measured but it is merely the unexplained residual in their regressions after they have included as many measurable factors and dummy variables as they can think of. Sometimes the residual technology component even includes the effect of increased raw material inputs! Note also the blind assertion that Malthus was wrong, when in fact his predictions have been painfully verified by the majority of mankind.

That technology accounts for half or more of the observed increase in output in recent times is a finding about which econometricians themselves disagree. For example, D. W. Jorgenson and Z. Grilliches found that "if real product and real factor input are accurately accounted for, the observed growth in total factor productivity is negligible" (1967). In other words, the increment in real output from 1945 to 1965 is almost totally explained (96.7 percent) by increments in real inputs, with very little residual (3.3 percent) left to impute to technical change. After taking account of critical reviews of their study, Jorgenson and Grilliches admitted the likelihood that a greater role was played by technological change but reaffirmed their basic conclusion "that total factor input, not productivity change, predominates in the explanation of the growth of output" (Jorgenson and Grilliches, 1972, p. 111). Such findings cast doubt on the notion that technology, unaided by increased resource flows, can give us enormous increases in output. In fact, the law of conservation of matter and energy by itself should make us skeptical of the claim that real output can increase continuously with no increase in real inputs.

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Two-Factor Models with Free Resources and Funds that are Nearly Perfect Substitutes for Flows

Economists routinely measure the productivity of the fund factors, labor and capital (and Ricardian land). But the productivity of the flow factors, natural raw materials and inanimate energy is seldom spoken of, much less calculated. This reflects an assumption that they are not scarce, that they are the free and inexhaustible gifts of nature. The only limit to the flow of product is assumed to be the capacity of the fund factors to process the inputs into products. Nordhaus and Tobin are explicit on this point:

> *The prevailing standard model of growth assumes that there are no limits on the feasibility of expanding the supplies of nonhuman agents of production. It is basically a two-factor model in which production depends only on labor and reproducible capital. Land and resources, the third member of the classical triad, have generally been dropped* (Nordhaus and Tobin, 1970, p. 14).

How is this neglect of resource flows justified? According to Nordhaus and Tobin, "the tacit justification has been that reproducible capital is a near perfect substitute for land and other exhaustible resources." (p. 15) If factors are near perfect substitutes, then there is, of course, no point in considering them separate factors. From the point of view of economic analysis they are identical. But it is very odd to have such an identity between factors whose very dimensionality is different. Capital is a fund, material and energy resources are flows. The fund processes the flow and is the instrument for transforming the flow from raw materials to commodities. The two are obviously complements in any given technology. But allowing for technological change does not alter the relationship. The usual reason for expanding (or redesigning) the capital fund is to process a larger, not a smaller, flow of resources, which we would expect if capital and resources were substitutes. New technology embodied in new capital may also permit processing different materials, but this is the substitution of one resource flow for another not the substitution of a capital fund for a resource flow.

Nordhaus and Tobin state that the "tacit assumption of environmentalists is that no substitutes are available for natural resources" (p.15). They consider this an extreme position, but what substitute is there for natural resources? They offer "reproducible capital;" however, in addition to requiring natural resources for their very reproduction, capital funds are clearly complements to resource flows, not substitutes. The fact that one resource flow may substitute for another, if the capital fund is redesigned to allow it, is no basis for saying that the generic factor of capital is a substitute for the generic factor of natural resource! After we deplete one resource, we redesign our machines and set about depleting another. The assumption is that in the aggregate resources are infinite, that when one flow dries up there will always be another, and that technology will always find cheap ways to exploit the next resource. When the whales are gone, we will hunt dolphins, and so on until we are farming plankton. The ecologists tell us that it will not work, that there are other limits involved, and even if it would work, who wants it? But Nordhaus and Tobin see little connection between economic growth and ecological catastrophe: "As for the danger of global ecological catastrophe, there is probably very little that economics can say." (1970, p. 20) As long as economic growth models continue to assume away the absolute dimension of scarcity, this is quite true and is simply another way of saying that current growth economics has uncoupled itself from the world and has become irrelevant. Worse, it has become a blind guide.

Present Value and Positive Feedback

It is sometimes argued that the market provides for conservation by offering high profits to farsighted speculators who buy up materials and resell them later at a high price. There are at least two flaws in this argument:

First, exponentially growing extraction leads to "unexpectedly" sudden exhaustion. Suppose the doubling time of the cumulative total amount extracted is on the order of 30 years, as it apparently is for many resources, and that there is enough of the resource to last for 300 years at present growth rates. At the end of 270 years the resource would only be half depleted. Yet in the final 30 years it would go from half to total depletion. Most resource owners probably find that surprising. For linear trends, the past is a good guide to the future. For exponential growth, the past is a deceptive guide to the future.

Second, the future profit must be discounted to its present value. The investor has the alternative in an expanding economy of depleting now and investing the short-term profits in another line that will earn the expected going rate, which will be close to the growth rate of the economy. The discount rate he applies to future profit is the same as the rate at which he would expect his reinvested short-term profits to grow. This expected rate is determined largely by the current rate and by recent changes in it. The result is that high and increasing current growth rates, based on high and increasing current depletion rates, lead to high and increasing discount rates applied to future values. The last condition in turn leads to a low incentive to conserve, which feeds back to high current depletion and growth rates, high discount rates, and so forth. Present value calculations thus have an element of positive feedback that is destabilizing from the point of view of conservation. Financial prudence usually advises depleting now and investing short-term earnings in depleting some other resource. The presumption again is infinite resources. There will always be more resources available to feed the march of compound interest. This tacit assumption sometimes becomes explicit, as in the following statement from the president of a great oil company:

> *The fact seems to be that the first [resource] storehouse in which man found himself was only one of a series. As he used up what was piled in that first room, he found he could fashion a key to open a door into a much larger room. And as he used up the contents of this larger room, he discovered there was another room beyond, larger still. The room in which we stand at the middle of the twentieth century is so vast that its walls are beyond sight. Yet it is probably still quite near the beginning of the whole series of storehouses. It is not inconceivable that the entire globe — earth, ocean and air — represents raw material for mankind to utilize with more and more ingenuity and skill* (Quoted in Ordway, 1953, p. 28).

Even if this were correct, we should add that eventually we must *live* in the same rooms we work in. Living in intimate contact with garbage and noxious wastes is a by-product of growth. But optimists will argue that there is another infinite series of ever larger garbage dumps! The conceptual basis of the growth faith is a generalization of the chain-letter swindle.

Pascal's Wager Revisited

Growthmania rests on the hypothesis that technological change can become entirely problem solving and not at all problem creating and can continually perform successively more impressive encores as resources are depleted. There is sufficient evidence to make reasonable people quite doubtful about this hypothesis. Yet it cannot be definitely disproved. There is a certain amount of faith involved, and faith is risky. Let us then take a completely agnostic position and apply the logic of Pascal's wager and statistical decision theory. We can err in two ways: we can accept the omnipotent technology hypothesis and then discover that it is false, or we can reject it and later discover that it is true. Which error do we most wish to avoid? If we accept the false hypothesis, the result will be catastrophic. If we reject the true hypothesis, we will forgo marginal satisfactions and will have to learn to share, which, though difficult, might well be good for us. If we later discover that the hypothesis is true, we could always resume growth. Thus even in the agnostic case, it would seem prudent to reject the omnipotent technology hypothesis, along with its corollary that reproducible capital is a near-perfect substitute for resources.

The Fallacy of Exponentially Increasing Natural Resource Productivity

Robert Solow has defended growth by appealing to increasing resource productivity. Solow concludes "there is really no reason why we should not think of the productivity of natural resources as increasing more or less exponentially over time" (1973, p. 51). This remarkable conclusion, if true, would be a boon to those who advocate limiting the throughput of resources, because it would mean that such a limit is totally consistent with continued exponential growth in GNP and is therefore not such a radical proposal. The resource flow could be stabilized and GNP could continue to grow exponentially as resource productivity (i.e., GNP/resource flow) increased exponentially. Why, then, does limiting the resource flow provoke such strong opposition from growth economists?

Solow's arguments to support his conclusion are interesting. If the productivity of labor is measured by GNP/labor, he reasons, the productivity of iron is measured by GNP/iron output, that of aluminum by GNP/aluminum output, and so on. He calculates what has happened to the productivities of a number of resources between 1950 and 1970 and finds that some (iron, manganese, copper, lead, zinc, bituminous coal) have increased, while others (nickel, petroleum) have remained the same and still others (aluminum, natural gas, electric power, columbium) have fallen. On the face of it, the evidence supports no generalization about resource productivity at all, even accepting Solow's definitions. But even more damaging is a hard look at the facile analogy between labor productivity and coal productivity, columbium productivity, and so forth, insofar as particular resource productivities are supposed to add up to, or convey some notion of, aggregate resource productivity, which is what Solow's conclusion clearly requires that it should do.

If the amount of labor used goes up, *ceteris paribus,* the labor productivity goes down. If the quantity of all resources used goes up, then *ceteris paribus,* the productivity of aggregate resources likewise goes down. But the productivity of many *particular* resources will still increase if the GNP increased faster than the quantity of that resource used. Furthermore, the increase in GNP is in part made possible by the more rapid increase in quantity used of those particular resources whose productivities consequently fell.

The meaning of these "resource productivities" is further obscured: "Sooner or later, the productivity of oil will rise out of sight, because the production and consumption of oil will eventually dwindle toward zero, but real GNP will not" (p. 51). Presumably, when production and consumption of oil approach zero, oil productivity will become infinite! The conclusion to be drawn is certainly not that increasing productivity compensates for diminishing supply of resources – otherwise we would be better off with nearly zero output of petroleum, which is absurd.

In his Richard T. Ely Lecture to the American Economic Association, Solow went so far as to proclaim not only the conditional possibility, but the empirical likelihood that "the world can, in effect, get along without natural resources." Solow elaborates that this is so if we have a "backstop technology," such as breeder reactors, which will mean that "at some finite cost, production can be freed of dependence on exhaustible resources altogether" (1974, p. 11). Apparently, the world cannot get along without all natural resources, as he first suggested, but only without exhaustible ones. Just how to build and maintain a backstop technology of breeder reactors (the only example offered) without such exhaustible resources such as copper, zirconium, tungsten, and iron, not to mention initial stocks of enriched uranium or permanent depositories for radioactive wastes, is not explained. No doubt it is true that at "some finite cost" we could live on renewable resources, as mankind essentially did before the industrial revolution. But the finite cost is going to include a reduction in population and in per capita consumption levels, or, at the very least, a cessation of further growth.

The belief in the unlimited productivity of natural resources and the unlimited substitutability of other factors for natural resources has led Nicholas Georgescu-Roegen to the following verdict on Solow and the many other economists for whom he is the spokesman:

> *One must have a very erroneous view of the economic process as a whole not to see that there are no material factors other than natural resources. To maintain further that "the world can, in effect, get along without natural resources" is to ignore the difference between the actual world and the Garden of Eden* (Georgescu-Roegen, 1975, p. 361).

The Ever Expanding Service Sector and "Angelized GNP"

Advocates of growth frequently appeal to the increasing importance of services, which, it is assumed, can continue to grow indefinitely, since such activities are presumably nonpolluting and non-depleting. Thus while agriculture and industry will be limited by their necessary pollution and depletion flows, services are allegedly not so limited and will continue to grow. Therefore, an ever-larger fraction of total GNP will originate in the service sector, and consequently the pollution and depletion flows per average dollar of GNP will fall continuously. Presumably, we will approach a nonphysical "angelized GNP."

While some activities are more throughput-intensive than others, it is not clear that these activities are always services, nor is it clear that the differences are very great once indirect effects are incorporated. Eric Hirst found that "services associated with food used almost as much energy as did farming and processing" (1974, p. 135). It is likely that when we add all the indirect as well as the direct aspects of service activities (inputs to service sector, inputs to inputs of service sector, etc.), we will find that services do not pollute or deplete significantly less than many industrial activities. That most services require a substantial physical base is evident from casual observation of a university, a hospital, an insurance company, a barbershop, or even a symphony orchestra. Certainly the incomes earned by people in the service sector will not all be spent on services but on goods as well.

It is true that "In 1969 a dollar's worth of GNP was produced with one-half the materials used to produce a dollar's worth of 1900 GNP, in constant dollars" (National Commission on Materials Policy, 1973, p. 3-3). Nevertheless, over the same period total materials consumption increased by 400 percent. We must resist being carried away by the halving of the material content of a GNP dollar. Remember the man who bought a new stove that cut his fuel bill in half and then reasoned that he could cut his fuel bill to zero by buying another such stove! More significant than the halving of the materials per dollar of GNP is the quintupling of the absolute material throughput and the similar increase in energy throughput over the same period.

The idea of growth overcoming physical limits by angelizing GNP is equivalent to overcoming physical limits to population growth by reducing the throughput intensity or metabolism of human beings. First pygmies, then Tom Thumbs, then big molecules, then pure spirits. Indeed, it would be necessary for us to become angels in order to subsist on angelized GNP.

What Second Law?

Economists often disregard the second law of thermodynamics.

In an article defending growth, Harvard economist Richard Zeckhauser tells us "Recycling is not the solution for oil, because the alternate technology of nuclear power generation is cheaper" (1973, p. 117, n. 11). The clear meaning is that recycling oil as an energy source is possible but just happens to be uneconomical, because nuclear energy is cheaper. The real reason that energy from oil, or any other source, is not recycled is of course the entropy law, not the relative price of nuclear power. This nonsensical statement is not just a minor slip-up; it indicates a fundamental lack of appreciation of the physical facts of life. No wonder Zeckhauser is unconvinced by limits to growth arguments; if he is unaware of the entropy law he could not possibly feel the weight of the arguments against which he is reacting.

An article entitled "The Environment in Economics: A Survey" begins, "Man has probably always worried about his environment because he was once totally dependent on it" (Fisher and Peterson, 1976, p. 1). The implication is that man is no longer totally dependent on his environment, or at least has become less dependent. But, in fact, technology has merely substituted nonrenewable resources for renewables, which is more an increase than a decrease in dependence. How could man possibly become more independent of his environment without shutting off exchanges with the environment or reducing depletion and pollution, rather than increasing them? For man to exist as a closed system, making no exchanges with the environment, would require suspension of the second law. Man is an open system. What was man three months ago is now environment; what was environment yesterday is man today. Man and environment are so interdependent it is hard to say where one begins and the other ends. This interdependence has not diminished and will not, regardless of technology.

The statement by Barnett and Morse that "Nature imposes particular scarcities, not an inescapable general scarcity," is about as clear a denial of the second law as could be imagined. To drive the point home they add:

> *Science by making the resource base more homogeneous erases the restrictions once thought to reside in the lack of homogeneity. In a neo-Ricardian world, it seems, the particular resources with which one starts increasingly become a matter of indifference … Advances in fundamental science have made it possible to take advantage of the uniformity of energy/matter* **n** *a uniformity that makes it feasible without preassignable limit to escape the quantitative constraints*

imposed by the character of the earth's crust (Barnett and Morse, 1973, p. 11).

It is, however, not the uniformity of matter-energy that makes for usefulness, but precisely the opposite: differences in concentration and temperature. If all materials and energy were uniformly distributed in thermodynamic equilibrium, the resulting "homogeneous resource base" would be no resource at all.

There would be a complete absence of potential for any process, including life. The economist's notion of infinite substitutability bears some resemblance to the old alchemists' dream of converting base metals into precious metals. All you have to do is rearrange atoms! But the potential for rearranging atoms is itself scarce, so the mere fact that everything is made up of the same homogeneous building blocks does not abolish scarcity. Only Maxwell's Sorting-Demon could turn a pile of atoms into a resource, and the entropy law tells us that Maxwell's Demon does not exist. •