PURPOSE IN NATURE

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ABSTRACT. My purpose here is to naturalize human purpose. This I do by constructing it as an evolved refinement of "purposes" found more generally in Nature, all of which subsume it. As a project in Natural Philosophy, this involves first generalizing human purpose, and then reconstructing it as a more highly specified example of a fundamental natural tendency.

KEY WORDS. Nature, purpose, teleomaty, causation, human agency, function, hierarchy, thermodynamical equilibrium, efficiency, efficacy, sustainability.

I begin with the problem of teleology. As graduate students in biology in the 1960's, we were warned not to think teleologically—suggesting how seductive such thinking must be! Examples we might have been seduced by could be, e.g.,: 'the purpose of the heart is to pump blood', or 'migrating to the tropics in winter motivates and is advantageous for some species of birds', or 'organisms produce more offspring than would be needed to maintain their populations so as to ensure their persistence in the face of heavy juvenile mortality'.

The general inspiration for this stricture against teleological thinking was / is the modernist idea that Nature is neither good nor bad; it just *is.* (And so only humans might be granted purposes.) Well, our first statement above got redone as 'the *function* of the heart is to pump blood.' Here we see the modernist tendency to view natural systems as machines. Hearts, kidneys, lungs are taken to be instrumental 'parts' of the body / machine. It seems clear that a deeper source of this imagery is our language. Nouns isolate objects and entities; verbs individuate tasks. Machine parts are isolated objects, and their tasks would be separately allocated. Logic itself is a linguistic machine (seen fully revealed in propositional calculus and predicate logic), and science discourse is, of course, first and foremost logical.

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Looking at the second proposition above, we needed to reconstruct 'is advantageous for' as just 'is'. First, species are dubious as functional parts of Nature. The biological species is a theoretical object rather than a concrete one. There are several species concepts, each conceived around different properties of organisms, viewed either as emblematic representatives of a species, or as its parts. Going to the tropics might, then, more plausibly be good for individual birds, who are the actual travelers. Well, do some birds travel to the tropics in winter because they intuit benefits from doing so? No. Darwinian evolutionary biologists tell us they do this because they've inherited genetic instructions compelling them to do so from ancestors who just happened by chance to have come to do that, while their fellows who did not travel failed to leave competitively many enough numbers of offspring. So organisms became viewed as programmed machines, the programs being encoded in their genes, the programming having been carried out by the happenstance of differential reproduction—an effect known as 'natural selection'—in the past.

And what of the proposition that organisms might spend energy making extra offspring in order to counter prospective mortality? NeoDarwinians tell us that this—which would be like throwing good money after bad!—is looking at things backward. According to them, the proper view would be that heavy mortality in the past was a force that selected individuals that happened by chance to produce more offspring than needed for replacement to be the parents of the next generations. What survives from one generation to the next is just what happens to work. A natural property doesn't function "in order to" achieve anything. A biological property is conceptually taken to be no different than the property of any abiotic dissipative structure. And, as well, any trait is there in the first place because it just happened to get produced during the development of some mutated individuals in the past—and mark well—*before* it could be useful. The Darwinian interpretation of biological evolution (which has currently outcompeted all others) avoids purpose by seeing innovations, successful or not, as coming into being by chance, to be preserved, it may be, by selection on the basis of their consequences for improving survival or reproductive rate. What worked just happened to happen, but then prospered and was preserved because it did. The key point is that new forms and behaviors are here ideologically viewed to occur prior to any possibility of their being useful. This puts the focus on genes, because genetic information can be present without being useful, while phenotypic properties cannot. This view is ideological because it was incorporated into Darwinian evolutionary biology in order to forestall possible external influences on the evolutionary process, as by a deity.

So, in order to avoid teleology, Darwinians constructed organisms as machines that exist because they happen to have the properties allowing for that in a given setting. Some kinds of natural things—say, tornadoes—come into existence spontaneously when the conditions required happen to be realized somewhere. Others, like organisms, come to exist because, in addition to appearing only in supportive conditions, they also happen to have pre-tested instructions, built into them by a past process of selecting the most successful from among potential ancestors. These instructions allow them as well to actively seek supportive conditions, and to skate across temporarily unfavorable ones as well. So much for teleology—that is to say, the influence of purpose—in the recent past of biology discourse!

The first concept we need in order to reinstate purpose into Nature is Aristotle's analysis of causation. This is the most complex causal analysis yet contrived in the West, and so recommends itself, it seems to me, in the context of complexity studies. It involves four categories of causes—the synchronic pair, material cause paired with formal cause, and the diachronic pair, efficient cause / final cause. Material cause is that which makes something possible, while formal cause, as a framework, mediates some possibilities into effects. Moisture in the air is among the conditions making rain possible, while the relative arrangement of contiguous bodies of air fosters its precipitation. Efficient cause is the trigger or push that gets something going, while final cause is that *for which* something occurs—a 'pull' rather than a push, answering the question "why?". Initiation of an updraft may trigger rain in the right conditions, while the dissipation of a temperature gradient between different bodies of air can be said to be the "reason why" this occurs. (This answer depends on the fact that our Universe is far from thermodynamic equilibrium, and is tending to return to that state by eliminating energy gradients whenever possible—see below.) To illustrate the possibility of problematizing causality, we can take an example from a cartoon. If, while aliens landed on Earth, their spaceship ignited a fire, they might (picking out a material cause of importance to them) think something like "This fire was caused by the presence of oxygen," thereby taking for granted the unavoidable efficient cause of their landing itself, which would be the same wherever they landed, and so not marked as an event for them. So they choose a formal cause as their explanation rather than an efficient cause, which would be the way we who are already on the planet would see the causality in the event.

Historically, efficient cause—the push or forcing of things—was taken up by physics as its sole causal category after Francis Bacon banned the others as unnecessary for practical purposes. In particular, final cause was assimilated only to human interests. Later, chemistry and biology found it necessary to revive material cause. And it can be said that scientific theorists have implicitly been using formal cause all along in their models of natural phenomena—for example, in the forms of their equations. Formality sums up the 'set-up'. Final cause (the "why" of things), however, has been explicitly banned from modern science. We can see, anyhow, taking a broad view of it as in this essay, that it has been covertly present in what are called "variational principles". Here a solution to the behavior of a modeled system can be calculated only after we assume that one of the variables in a descriptive equation has had its value maximized or minimized. It's obvious that maximizing a variable is making a change 'in order to' achieve a solution. Furthermore—and most importantly—there are some variables that are supposed to always be tending toward a maximum, or a minimum. Here we find 'entropy' (disorder) in thermodynamically isolated systems, or 'population fitness' in a biological population being affected by natural selection. My attempts to suggest that the universal tendency toward entropy increase can be seen as a final cause have, unsurprisingly then, met with scorn among several scientists. Yet some ecologists are explicitly using finality in their analyses—for examples, Bernard Patten of the University of Georgia, and Robert Ulanowicz of the Chesapeake Biological Laboratory. These scientists feel the need for a full causal analysis like Aristotle's in the face of complex systems. In any case, we may note here that teleology is a kind of finality. Purpose is a final cause, and it has been restricted in natural science to human agency alone.

Next we should consider more directly the now important idea of complexity. One view is that it refers to a situation needing more than one approach to understand it, as suggested by the late biology theorist, Robert Rosen. Consider that you might be examined as just a physical system, perhaps by measuring some internal diffusion rates or blood pressure. Or you could be considered to be a kind of chemical system, examining changes in metabolic products. Alternatively, you might be considered as a biological system, looking at growth or some aspect of aging. A good tool for projecting this sort of complexity is the specification hierarchy of integrative levels. This can be displayed as the relationship between a class and its subclasses, as in:

{class of birds {subclass of song birds {sub-subclass of warblers {yellow warbler}}}}.

The properties of a class continue to hold in its subclasses, while each new distinction, requiring a new bracket, adds some further information within that class, marking the emergence of another, more highly specified integrative level, nested within the others. Class properties subsume those of all of its members, and their properties each imply the properties that define the class.

For present purposes, we can consider:

{physical realm {material / chemical realm {biological realm {human sociocultural realm}}}}.

More generally present levels give rise to the next level above them (to the right in this example) by providing necessary conditions (material causes), making possible the emergence of a more deeply nested level. So, biology depends directly on chemistry and physics, and could even be said to be a more highly specified kind of chemistry. But, as well, biology harnesses chemistry and physics to its ends by organizing their dynamics and interactions in particular ways—by 'integrating' them under its rules, which establish formal causes governing them. So, we have {material causes → ← {formal causes}}.

Reconsidering teleology in this context, as 'purpose' it is clearly a property of the human sociocultural realm and does not seem to most scientists to be present in lower levels. So we can understand the objection to using it as a category in lower levels purely on logical grounds. That would be making a category mistake, since a property emerging in a higher level in a specification hierarchy could not be present in lower levels. However, we need to consider more closely the notion of "giving rise to," used above. "Biology gives rise to socioculture" means that socioculture is a further development of potentials (material causes) present in biological systems. Among these must have been some precursor of purpose as well. In the 1950's, when teleology was being actively worried about in biology, Colin Pittendrigh in the UK suggested that functionality in biology, which he dubbed 'teleonomy', is a property of biological systems of the same general kind as teleology / purpose. Like purpose, function provides a 'why'. Hearts exist because they are key components of circulatory systems. So Pittendrigh generalized teleology, suggesting, in effect: {{teleology} implies teleonomy}. This amounts to suggesting that purpose emerged out of some biological function, as in: {function → {purpose}}.

At this point, in order to continue generalizing still further we need a property entailing both function and purpose. Webster's has "an object or end to be attained" for 'purpose', and for 'function': "the action for which a ... thing is specially fitted or used, or for which it exists." Well, just grammatically, a function might be used to attain a purpose, so we are sound in that way. And it could be said, following Kant, that natural systems have the "purpose" of nothing more than to continue existing. In order to attain this they need to have certain properties, some of which could be viewed as functions enabling them to persist in particular locales. But function, as mentioned earlier, has mechanistic connotations. Hearts could be viewed as pumps—and are, within our mechanistic science. So

Pittendrigh shifted the richness of purpose over to the simpler notion of mechanical function in order to get rid of the teleology problem in biology. But here I am embracing teleo-thinking, and in order to do so must shed the mechanistic stance of classical science. This can be done by noting that, while a heart does indeed 'function' as a pump, that would be only *one* of its functions, of which there are certainly many, maybe even untold many, some of them likely only transient during development. To point out the many connections and interactions, actual and potential, that anything natural would have, easily deconstructs the illusion that it might be a machine part, which would have at most only a few well-defined functions.

Well, what would be a more general category including both purpose and function? Possibly 'tendencies'? A purpose is certainly a tendency to achieve something, a propensity. And a function strongly tends to enact its role. If a kind of system requires some tendency to underwrite it, it could appear only where that tendency occurred. And if a system could internalize certain tendencies the way biological systems do, then it could evolve the ability to generate them for itself. Richard O'Grady of the American Institute of Biological Sciences and Daniel Brooks of the University of Toronto, following a proposal of evolutionary biologist Ernst Mayr, extended teleo-talk further by promoting "teleomaty" to signify physical tendencies, like the spontaneous and ineluctable production of entropy from energy gradients. So, then we would have

{{{teleological} teleonomic} teleomatic}
or
{{{purposeful} functional} tending physically}

That is, functions would have been materially caused by—and emerged from—physical propensities, while purpose evolved as a later refinement of some biological function. The justification here is the materialist, and evolutionary, one that all properties must have had precursors—in effect, material causes. In biological evolution, inherited traits must have had some ancestral precursors. Nothing comes from nothing. This formulation allows us to understand human purpose, or any other property, as a refinement of more generally occurring tendencies in nature.

Now we must note that Nature's 'purposes' have implications for our own. Let us look again at a universal tendency noted earlier without naming it—the Second Law of thermodynamics. This refers to the fact that eventually an isolated system, with no energy input will lose whatever organization it has and become ever more disorderly, gradually decomposing into only the most physically likely configurations of its materials—eventually just a random dispersion of its finest elements. This 'disorderly' end point is the condition of thermodynamic equilibrium. Equivalently, energy gradients (any material aggregations and objects) contained within an isolated system will dissipate until there's no further usable energy left in them. One school of ecologists, led by the late James Kay of the University of Waterloo in Ontario, and long championed as well by Rod Swenson of Yale University, is based on the view that the local systems within the Universe act to dissipate energy gradients as fast as possible. This connects to the earliest thermodynamic observation, made by Sadi Carnot in France, that the faster any work is done, the more of an available energy tapped for that work will be wasted as entropy (disordered or "heat" energy, the kind remaining at equilibrium), making that work less energy efficient. Effective work of any kind is never much more than 50 per cent energy efficient. A basic observation here is that whenever a simple energy gradient builds up, like apposed air masses with different temperatures, an organized system will spontaneously appear—in this case a thunderstorm—that acts to dissipate it.

Well, if we take the Universe to be isolated from energy input, such internal dissolution seems to be its eventual fate. It is difficult to see how it could be expanding at accelerating rate (in the Big Bang) unless it is isolated. This seems a most reasonable postulate as well because of the fact that all energy gradients in the world *are* indeed demonstrably unstable, requiring work to be maintained. And this work must be afforded by other energy gradients, which get dissipated in the doing, such that more energy is used up than is re-embodied in whatever was made by the work. Here we have a Siva principle—nothing gets built or maintained without destroying something else. The late ecologist Howard Odum noted that, on average with typical workloads, about half the energy available for work in any gradient gets lost as entropy during the work. That is, natural, effective work tends to be energy inefficient. And so we cannot do it without contributing greatly to the Universe's {{{goal}}} of thermodynamic equilibration. Thus, something can be built (or build itself, as organisms do) only by paying a stiff entropy tax. This law of Nature is always present to us, requiring as we do, continual inputs of energy in foods, electricity and gas, all of which must be renewed as we use them up. That is, we—and all dynamic systems—are 'open systems', which exist, grow and act only given external sources of energy. Our isolated Universe, then, features a continually changing cast of open systems, each launched upon the destruction of others.

Plugging this information about a universal tendency into the specification hierarchy: {physical tendency {function {purpose}}}, we see that the functions we began by considering—the beating of hearts, migrations of animals, and their excess production of offspring, could all be viewed, inasmuch as they are not perfectly energy efficient, as means to aid the

Universe in its {{{project}}} of thermodynamic equilibration. And, of course, this would be the general "purpose" (as seen from the physical integrative level) of our own projects as well. Thermodynamic equilibration subsumes anything that transpires in our universe. That is, whatever happens in this universe contributes to its equilibration, by degrading energy gradients, and by using the energy obtained rather inefficiently as well, so that new gradients are of smaller amount than those dissipated to make them. Schemes invented to evade this law are known as 'perpetual motion machines', and they are just that—schemes.

Here we arrive at a dilemma facing our society. We certainly have been devoted to strenuous energy use; almost nothing is accomplished in our culture without its being done as rapidly as may be. That is, we have been, and are—in principle, one might say—extremely energy inefficient. In part we can understand this as coming from the fact of competition. If more than one system is using an energy gradient, the one using it fastest gets most of it. As well, that system will tend to outproduce others, given equal abilities. Competition, of course, is a major aspect of our Capitalist economic system, and this system is now spreading throughout the world. Therefore, with increasing numbers of competitors for a limited, and diminishing, endowment, it is likely that energy inefficiency will continue to characterize our economy—our watchword has been 'effectiveness', not 'efficiency'. Effectiveness is mediated by 'power' (energy flowing through a system), increase in which is associated with rapid dissipation of supporting energy gradients. And so those that do the Universe's {{{bidding}}} in this regard compete best, or, logically: {{strenuous competition} fast entropy production}.

Now we must turn to another watchword heard frequently today—sustainability. It has been pointed out that so-called "sustainable growth" is an oxymoron, an internally contradictory phrase. Maintenance might be sustainable, but not growth. But maintenance can never equal growth in entropy production. From this we can surmise that maintenance is not as good a way to fit into our Universe as growth is. And, indeed, natural systems do not maintain themselves for long—they all (from tornadoes to organisms) grow and then decline. Declining systems can best serve universal equilibration by getting recycled, which is indeed their—our—fate. In economics, repetition of this pattern is known as 'boom and bust'. One can conclude that what is meant in economics by "sustainable growth" must be preservation of the boom and bust economic cycle. Sustainable growth can only be renewable growth, which must be afforded by new energy gradients after each bust. It is not unlikely that unrest in the oil rich Middle East today has its most basic root in the grasping for energy gradient.

With this reference we have arrived at a basic emotional challenge for our society today. We must acknowledge that war is the most perfect way for humans to uphold the Second Law of thermodynamics. In war, huge amounts of entropy are produced with no material aim (leaving aside political aims) other than to produce them. Here the cycle appears as build → burn → rebuild → etc., all mediated by a strenuous (i.e., energy inefficient) war economy. Given what we know of human history, it must be concluded that war is an overwhelmingly attractive choice that is seldom, if ever, foregone when the opportunity for it arises. The most minimal form of this idea can be displayed as {weak forces {strong forces}}. That is, a physical tendency operates continually, and will become determinative when all the stronger forces closer to our consciousness tend to balance out. In our complex world it is seldom the case that all strong forces point unequivocally in one direction. Thus, faced with the question: "shall we go to war or not?", the Universe can "work its will" as we find ourselves once again marching to the front!

Lest we take the challenge to understand this too lightly, we should note how we ourselves as individuals continually serve the mighty Second Law. Here we need to attend to our frequent fidgeting, foot tapping, hair twirling, tongue twisting—restless activities that ought to be susceptible to control. An attempt to do that would feel odd indeed! These are testimonials to the power of the Second Law, endlessly declared by our own bodies. It could said that such continuous physical activity is actually beneficial to the organism, keeping it fit—and, we now learn, from becoming too obese. From an evolutionary point of view, this suggests that evolutionary success has been found only by systems striving their utmost to obey the Second Law.

Could we actually resist a natural law? The power of any purpose would be greatest when the 'purposes' of the integrative levels below it are consistent with it, as in: {entropy production {male aggression {warfare}}}. This hierarchy suggests the magnitude of the difficulty we face in trying to oppose the {{{purpose}}} of this particular law of Nature—the Second Law of thermodynamics.

FURTHER READING

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