

The Demostat

If the Old Testament preacher Koheleth could justly complain that “of the making of many books there is no end,”¹ then how much more reason do we have to complain now, some twenty-two centuries later! There are times when we fear that the snowballing “information overload” may be the downfall of civilization.

Fortunately there is a counterforce to information overload: *theory construction*. A good theory compacts a vast body of facts into a few words or equations. For example, before Gregor Mendel published his theory of heredity, some 8,000 pages of scholarly discussion had been produced on the subject. All these documents became useless upon the publication of Mendel’s forty-page paper. Today, more than a century later, we can condense Mendel’s findings into a single page.

The literature on human population growth is enormous. Blessedly, most of it can be safely ignored. A handful of principles enable us to incorporate the meaning of a great mass of data in a few images. The most important of these derive from “control theory,” a development of the middle of the twentieth century. A careful reading of Malthus’s *Essay* shows that control theory is implicit in his exposition.

Cybernetics

In 1948 the mathematician Norbert Wiener published *Cybernetics: or, Control and Communication in the Animal and the Machine*. This book briefly summarized and greatly extended a diffuse literature on the subject, introducing language that made it possible to talk more effectively about change and resistance to change. Wiener, the son of a classics scholar, derived the name of the science from a Greek word for “governor.” Cybernetics deals with the logic of the mechanisms that govern the equilibrating functions of complex machines and animals. The thermostat is a convenient example.

In *A* of Figure 11-1 we see the graph of the temperature of a thermostated room: an irregular line fluctuating about the *set point*, the temperature reading at which someone has set the thermostat. As usual, time is oriented on the horizontal axis. Part *B* displays a *collapsed time diagram* of the same data: both possible excursions away from the set point are shown as alternate possibilities of the same moment in time. The “closed” nature of the resulting figure symbolizes the restriction of temperature within limits when a thermostat is in control. The material components of the control system—a bimetallic strip, electric wires, a furnace, and so on—have

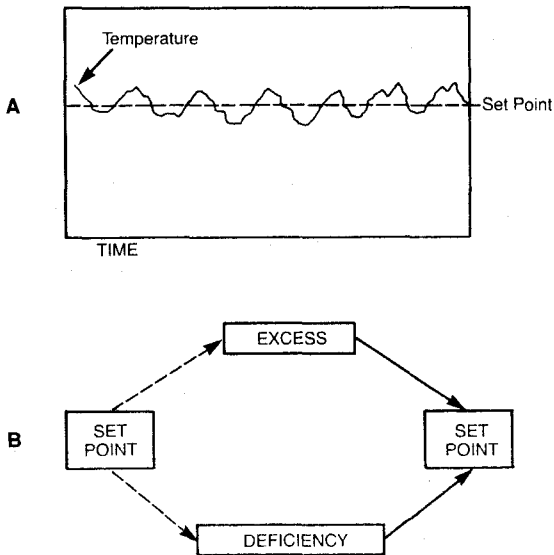


Figure 11-1. Records of the temperature of a thermostated room. Graph A is a "real time" record of the fluctuations about the set point of the temperature. Diagram B is a "collapsed time" representation of the same system, showing the logical elements of a negative feedback system. Dashed lines represent random or impressed changes, solid lines represent the inherent response changes.

been omitted from the diagram so as to focus our attention on the logical elements of cybernetic control.

Suppose the chosen set point is 68 degrees Fahrenheit. Dotted lines indicate changes that are impressed on the system by temperature changes in the room. What happens in response is determined by the construction of the thermostat. If the impressed change is an increase (note the rising, dotted arrow), the response of the system is to decrease the temperature by turning off the furnace (solid arrow). If a decrease is imposed on the room's temperature, the thermostat's response is to turn up the furnace. In each case the *response change is the negative of the impressed change*: hence the term *negative feedback*. Negative feedback is essential to produce stability in a self-adjusting system.

The logical nature of cybernetic control was first worked out for such man-made control systems as the governor of a steam engine. Then physiologists showed that the mammalian body is maintained in a nearly constant condition by myriads of cybernetic mechanisms. Body temperature is controlled by its own thermostat. The level of sugar in the blood is kept within very narrow limits by negative feedback. The concentration of many different salts in the blood is similarly stabilized. The plasma that surrounds the cells is derived from the blood; it plays the role of an "internal environment" for the cells. The normal functioning of "warm-blooded" animals depends on minimizing the fluctuations of this environment. The relative constancy of this internal environment permits warm-blooded animals to flourish over a wider range of external environments than is possible for "cold-

blooded” creatures like reptiles and amphibians. This ability gives warm-blooded animals greater freedom in choosing their environments. The French physiologist Claude Bernard made this point in 1878, when he said: “The constancy of the internal environment is the necessary condition of the free life.” Paradoxically, *control increases freedom*.

The Malthusian Demostat

For a few years after an animal species expands into a favorable new territory the population may increase explosively—that is, by exponential growth. The explosion comes to an end when the population stabilizes around a set point called the *carrying capacity* of the territory. Climatic variations (and other factors) cause this capacity to vary from year to year, but over a long period of time the carrying capacity is essentially stable. For populations of animals other than man this description is patently true. What about the human species?

For the past three centuries the human population has been growing rapidly. People assume that whatever has been true for the past three generations will be true forever. The phrase “from time immemorial” usually means “for three generations.” Three hundred years is about twelve human generations—an infinity of time to many people.

Contemporary Americans find it difficult to imagine a world with zero population growth. Some find the thought not only difficult, but even immoral to entertain. An enormous body of rhetoric supports this position: “Grow or die” and “You can’t stop progress” are examples in point. Nevertheless, during most of human existence, the average rate of population growth has been very, very close to zero. If “normal” means *most common*, then over the long time span of human existence zero population growth must be judged normal.

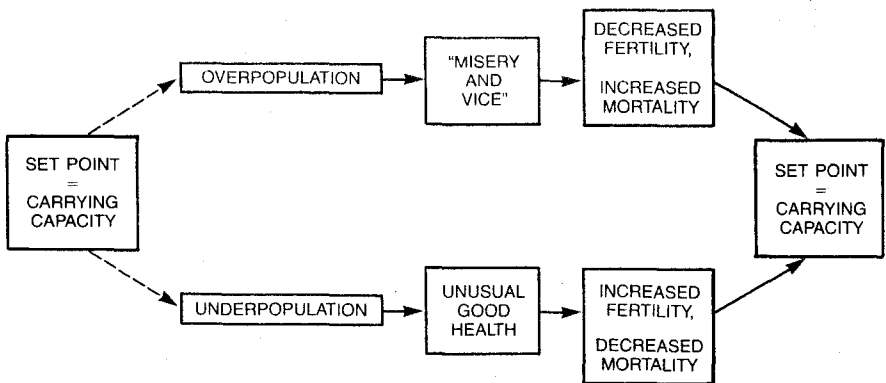


Figure 11-2. The Malthusian demostat, the heart of Malthus’s theory. In this “collapsed time” diagram the dashed arrows stand for random changes imposed by the environment; solid arrows stand for necessary changes inherent in the cybernetic system and made in response to imposed changes.

Malthus was both lucky and unlucky in living at the interface of two eras. Enough of the old era persisted so that it was natural for him to think in terms of static conditions; but a new era was developing rapidly, an era that (unluckily for his reputation) undermined his static theory, instigating (luckily for his memory) a controversy that attracted an enduring audience. Had he published his essay two hundred years earlier, the name Malthus might be unknown today.

Unaware of social and technological changes that were picking up speed in his time, Malthus described a cybernetic control system that would have elicited no excitement whatever during most of the millennia of human history. What Malthus proposed, we now realize, was an analog of the thermostat that controls the temperature of our rooms. This mechanism is called the *Malthusian demostat*. Of this mechanism Malthus gave only a verbal description in which the details are more implicit than explicit. The demostat balances the inherent tendency of every population to increase against factors that tend to reduce its numbers.

The human demostat is shown in the collapsed-time diagram of Figure 11-2, the elements of which should be compared with Malthus's rhetoric (given in Box 11-1). As before, impressed change (dotted arrows) leads to the negative feedback of response change (solid arrows). Whenever the population falls significantly below the set point, the increased prosperity (leading to better nutrition among women) causes a rise in fertility, which soon brings the population back up to the carrying capacity of the environment.² On the other hand, when the population moves beyond the carrying capacity, "misery and vice" diminish fertility and survival, thus driving the population down. "Misery and vice" are Malthus's terms for such negative feedbacks as premature death caused by famine, epidemics, infant neglect, criminal violence and the mortality of war. Such is the way the Malthusian demostat works, given a stable set point. (The consequences of a moving set point are the subject of the next chapter.)

The Malthusian demostat is *the* central concept of population theory. The demostat necessarily follows from the two primitive assumptions of (1) exponential growth, (2) operating in a world of real limits. Did no one have an inkling of the demostat before Malthus?

Tertullian's "Blessing"

"What's new is not true, and what's true is not new" is a time-honored way of wittily damning views one refuses to consider. Damning views dams discussion. Some critics have disposed of Malthus's theory with the first excuse, others with the second. We can best reopen the dialogue by admitting the truth of the second objection, namely that Malthus was not entirely original. (But who is?)

That misery can act as a negative feedback to population growth was recognized by Tertullian, a lawyer who shaped much of the theology of the Roman Catholic church. Writing in the third century A.D., he said: "The strongest witness is the vast population of the earth to which we are a burden and she scarcely can provide for our needs; as our demands grow greater, our complaints against nature's inadequacy are heard by all. The scourges of pestilence, famine, wars, and earthquakes

Box 11-1. Intimations of the Demostat in Malthus.

We will suppose the means of subsistence in any country just equal to the easy support of its inhabitants. The constant effort towards population, which is found to act even in the most vicious societies, increases the number of people before the means of subsistence are increased. The food therefore which before supported seven millions must now be divided among seven millions and a half or eight millions. The poor consequently must live much worse, and many of them be reduced to severe distress. The number of labourers also being above the proportion of the work in the market, the price of labour must tend toward a decrease, while the price of provisions would at the same time tend to rise. The labourer therefore must work harder to earn the same as he did before. During this season of distress, the discouragements to marriage, and the difficulty of rearing a family are so great that population is at a stand. In the mean time the cheapness of labour, the plenty of labourers, and the necessity of an increased industry amongst them, encourage cultivators to employ more labour upon their land, to turn up fresh soil, and to manure and improve more completely what is already in tillage, till ultimately the means of subsistence become in the same proportion to the population as at the period from which we set out. The situation of the labourer being then again tolerably comfortable, the restraints to population are in some degree loosened, and the same retrograde and progressive movements with respect to happiness are repeated. [Chapter 2]

... it would appear, that the population of France and England has accommodated itself very nearly to the average produce of each country. The discouragements to marriage, the consequent vicious habits, war, luxury, the silent though certain depopulation of large towns, and the close habitations, and insufficient food of many of the poor, prevent population from increasing beyond the means of subsistence; and, if I may use an expression which certainly at first appears strange, supercede the necessity of great and ravaging epidemics to repress what is redundant. Were a wasting plague to sweep off two millions in England and six millions in France, there can be no doubt whatever, that after the inhabitants had recovered from the dreadful shock, the proportion of births to burials would be much above what it is in either country at present. [Chapter 7]

Famine seems to be the last, the most dreadful resource of nature. The power of population is so superior to the power in the earth to produce subsistence for man, that premature death must in some shape or other visit the human race. The vices of mankind are active and able ministers of depopulation. They are the precursors in the great army of destruction; and often finish the dreadful work themselves. But should they fail in this war of extermination, sickly seasons, epidemics, pestilence, and plague, advance in terrific array, and sweep off their thousands and ten thousands. Should success be still incomplete, gigantic inevitable famine stalks in the rear, and with one mighty blow, levels the population with the food of the world. [Chapter 7]

An Essay on the Principle of Population, 1798.

have come to be regarded as a blessing to overcrowded nations, since they serve to prune away the luxuriant growth of the human race.”³

In our time not many people are willing to call such negative feedbacks a “blessing,” cybernetic or otherwise: but Tertullian’s phrase, “have come to be regarded,” implies that in his time many people appreciated the benefits of timely death and elimination. Why then do we not more often hear of Tertullian’s early statement of the demostatic point of view? Several issues are involved.

In the first place, in the work quoted, Tertullian was not primarily concerned with population: he was chasing another hare. The passage occurs in the treatise *De Anima*—“On the Soul,”—a queer place, one might suppose, to look for demo-

graphic theories. In this treatise Tertullian was intent on disproving the ancient theory of the "transmigration of souls." In one variant of this theory the world at its beginning was presumed to have been supplied with all the human souls it would ever need. Each time a person died his or her soul was stashed away in a celestial warehouse where it would remain until called for by a new birth. But, said Tertullian, this theory cannot be true: the original supply of souls would be insufficient for the much larger number of people now swarming over the earth. The greatness of population in his day was, Tertullian said, "the strongest witness" against the theory of transmigration.

The transmigration theory was Tertullian's interest at the moment and he did not follow up on the demographic implications of his position. Here we see one more instance of the truth of Whitehead's aphorism: "Everything of importance has been said before by somebody who did not discover it." What Tertullian *said* in the third century had to be *discovered* at the end of the eighteenth century.

Even before Malthus made his appearance another citizen of the Enlightenment showed that he understood the balance produced by the opposing forces of fecundity and mortality. This was the Comte de Buffon.⁴ It is hardly to be wondered at that his remarks were little noticed by later demographers, for they were buried at the end of the forty-four volumes of his *Natural History*, the last of which was published after his death in 1788. Buffon implied demographic control for human populations as well as for animal populations, but his treatise was used principally as a reference work by zoologists who had little interest in human populations.

If one had to put forward a single sentence that summarizes the heart of Malthusian theory, I think it would be this: *Exponential growth is kept under control by misery*. To speak, as Tertullian did, of the need to prune away the luxuriant growth of the human race, is to adopt the viewpoint of farmers. First farmers try to get something to grow. Then, finding they have encouraged life too much, they are faced with the necessity of destroying some of it. A farmer who was so unwise as never to thin, cull or prune away superfluous life would produce not greater, but smaller crops than neighbors who had no such compunction. Rural people know this to be true for their crops; consequently they have less difficulty than city folks in understanding that the same principle also applies at some stage to the growing crop of human beings. But anyone who utters such truth in the twentieth century is sure to be called heartless.

It is true first, that the inextinguishable drive toward exponential growth creates a need for some counteracting force; and second, that Tertullian's "pestilence, famine, wars, and earthquakes" *can* serve as the forces that quench exponential growth. But it is also true that the ingenuity of men and women is equal to the task of finding more gentle controllers of population than the ones Tertullian knew. Birth control pills are gentler than starvation. Only when gentler substitutes are in place throughout the world can we truly say that the post-Malthusian revolution has arrived.

Tertullian, though no doubt city bred, lived at a time when the experiential gap between city life and country life was not as great as it is today. Rural habits of thought still guided the thinking of city dwellers in the third century. Today, the very grossness of our multimillion-person metropolitan aggregations makes infection of urbanites by rural habits of thought unlikely. Many city dwellers are descended solely from urbanites three, four, or more generations back. They have

essentially lost their rural roots and with them they have lost the farmer's way of thinking. This defect is ludicrously apparent when, in response to some emergency, an urbanite takes up gardening. Then, when nature in her usual fashion produces too much life in the row of vegetables or the cluster of trees, the urbanite-turned-gardener has great difficulty mustering the moral courage to uproot superfluous seedlings, to knock down three-quarters of a too-exuberant "set" of tiny fruit, or to prune crowded branches off a tree. Similarly, after wolves have been removed as the controllers of deer populations, soft-hearted city dwellers often lack the courage to diminish the suffering of overcrowded deer herds by harvesting the excess animals. The sentimentality that urbanites are pleased to call "respect for life" corrupts those who have never farmed, fished, or hunted. True respect for life must include respect for the functions and necessity of death.

Though little literature on human population problems was produced until the nineteenth century, it is reasonable to assume that many of our ancestors (insofar as they thought about such matters at all) were Malthusians-before-Malthus. In a sense, Malthus had to rediscover what common folk had always known. This he did in a day when new and powerful contrary currents of thought had set the stage for controversy where there had been little before. His critics were right when they said of his theory, "what's true is not new." For some time, truths that bookish, urban people found unpleasant had been ignored or suppressed in polite literature.

Malthus made the world acutely aware that there is a puzzle to be solved. The puzzle is this: the coexistence of the potentially limitless exponential growth with the reality of essential stability in population size. *An "obvious" fact that is ubiquitous is hard to see.* As Einstein once asked: "What does a fish in the depths of the sea know of water?" Long-term demostatic stability was an unremarked reality for most of human history. It is only in modern times that continual population growth has been mistakenly perceived as a permanent truth.

One might expect that the crowding that comes with an increase in urbanization would make city dwellers readily admit the reality of overpopulation. Not so. Permanent urbanites are more comfortable attributing the ills of city existence to politics, injustice, and other whipping boys of moralistic thinkers. Overpopulation is, for many people, simply *unthinkable*.⁵ And we must not forget that many people profit personally from the consequences of overpopulation, which causes real estate prices to rise, thus enriching speculators in land and buildings. Such beneficiaries of overpopulation are apt to deny the existence of the condition that makes them rich.

Individualism, Population, and Posterity

Tertullian is strong medicine. Were he alive today, I think he could defend himself well. He did not say that a painful death was a blessing to the *individual* who suffered it; the blessing of many such deaths accrues only to those who survive, particularly to later generations. The blessing is a group blessing. In terms of the standard cybernetic diagram (Fig. 11-1B), the blessing is to be found in the solid arrows of the response change, which corrects for the harm caused by the dotted arrows of impressed change.

The common conflict between individual-oriented and community-oriented value systems needs to be underlined. Tertullian's "blessing" is conferred on an overcrowded nation, that is, on the community. Concerned with its welfare *over a period of time*, Tertullian could easily see the blessing of reducing the numbers in an already overcrowded community. The immediate effect of such a reduction is greater misery for some individuals, but in the long run the total number of individuals made miserable is less when the needed corrective feedbacks are brought into play *at an early date*.

Community-oriented ethical thinking was no doubt commoner in the third century than it is today. Today the greatest honor is accorded to speakers who focus on individual interests to the exclusion of community interests. Demagogues derive their power by appealing to the selfish interests of many individuals. Individuals vote: this is the reality. The abstraction called "the community" cannot vote. But, in time, the abstraction called "community" becomes the reality of posterity, which must suffer for the lack of imagination and courage of its ancestors.

Malthus, an ordained minister, came on the scene more than a century after John Locke had persuaded intellectuals to couch moral questions in terms of the interests of the individual rather than in terms of community interest. Malthus's theory implicitly gives priority to community interests—and "the community" includes limitless posterity. Lockeans, focusing on the individual and having difficulty in seeing the community, accused the author of the *Essay on Population* of being a misanthrope. As was pointed out in Chapter 4, however, Malthus opposed population growth not because it generated more people but because it multiplied misery.⁶

The imputation of hard-heartedness continues to be leveled against Malthus and his followers by people who reckon morality only in an individualistic, community-blind mode. (Community-blind includes posterity-blind.) Stung by criticism Malthus said: "I must be prepared to hear unmoved all those accusations of 'hardness of heart' which appear to me to be the result of ignorance or malice."⁷ Thus was the critics' charge of misanthropy met with his countercharge of malice. The argument needs to be moved to a higher level than the *argumentum ad hominem*.

Is "Killing the Messenger" Ever a Solution?

An ancient story has it that a messenger bringing news of a military defeat to a Persian king was executed by the displeased monarch. In the mind of that king the battle evidently marked the end of a segment of time: killing the messenger created a happy ending. But if the end of the battle is perceived as the beginning of a segment of time that reaches far into the future, killing the messenger is foolish. Planning for the future demands the best possible assessment of where we are at present, regardless of who is to blame for the misfortune. Illusions are a treacherous foundation on which to lay plans. (But it's pleasanter to blame others than to reform oneself.)

Commercial interests, which penetrate to the farthest corners of our society, tremble at predictions of the ultimate exhaustion of our stores of fossil energy (oil,

coal, gas); at confirmation of the greenhouse effect; at speculations about the agricultural consequences of this effect; at news of massive deforestation and runaway soil erosion; and at the condemnation of unlimited "development" implied in the blunt truth that "asphalt is the land's last crop."⁸

Inspirational pundits like to say that our civilization will be saved only when we ascend to a higher moral level. They may well be right, but phrases like "a higher moral level" are too vague to be of much help. What we need most is a brief calendar of specific practices that must be given up if we are to survive. Ecologists suggest that the first item on the list should be this: *Stop killing the messengers.*