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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

REFLECTIONS

THE MEGAMACHINE~IV

MEGATECHNIC
CONTRADICTIONS

UNTIL the twentieth century, the spread of machine industry was retarded by customs and institutions that belonged to an earlier era of scarcity—an age chronically threatened in many regions by an insufficiency of extra-human energy, of material goods, and even of daily food. The small margin of surplus under which the most thriving agriculture operated could always be wiped out by a succession of dry years, a plague of insects, or a virulent disease. The thrifty habits needed to insure survival had been artificially reinforced from the very beginning of civilization by manufactured scarcity—the deliberate expropriation of the farmers' surplus for the benefit of the ruling minority. Natural scarcity and backward agricultural practices, plus socially enforced penury and deprivation, were the incentives to daily work.

To impose the regimentation of labor demanded by the power system in England, common agricultural land was seized from the peasants, rural wages were driven down, the jobless were rounded up and imprisoned in "workhouses" or factories, their wives and children were sent into mills and mines to work from fourteen to sixteen hours a day to earn a pittance. As if to caricature both his own philosophy and current practices, Jeremy

Bentham, the fountainhead of utilitarian pragmatism, actually proposed an "ideal" structure, half factory, half prison, with both wings under surveillance. Incredibly, something like two centuries passed before capitalist industry at last realized that this systematic restriction of wages and buying power was curtailing the market that new inventions and mass production had opened up.

Yet the capitalist economy, for all its labor-sweating, had introduced a contradictory aim. Though it preached contented penury to the poor, it sought to further industrial expansion by propounding the dogma of "increasing wants" as an indispensable basis for further industrial progress. This worked in the opposite direction, for the expanding economy was justified not merely by its insurance against want or its fuller satisfaction of long-established needs but by multiplying the number and variety of putative needs and by raising the "standard of living"—or, more accurately, by raising the standard of expenditure—throughout the population. That standard had once been fixed at different levels according to caste, occupation, and family status. But in keeping with this new principle, even the lowliest worker might hope in time to achieve a modicum of middle-class comforts, while the middle classes, with their increased incomes, could afford some of the luxuries and thoughtless extravagances

that the aristocracy had once claimed as their exclusive privilege—not least, the privilege of never counting the cost. (What is today's buying on unlimited credit but the "democratization" of this well-established aristocratic vice?)

Despite fitful improvements, the income of the working classes remained insufficient over the long run, either to pay for decent housing or to buy back the surplus of machine production and large-scale agriculture; thus there were periodic gluts in the market, corrected by devaluation or "valorization" (artificially contrived scarcity), with its attendant losses to both investors and workers. Such crises recurred often enough to be characterized as the "business cycle," and though the manic-depressive curves were in time smoothed out a little by unemployment insurance, social security, and old-age pensions, the system remained unworkable until its leaders belatedly accepted the fact that the old canons of a parsimony must be cast aside if the economy of abundance that mass production made possible was to achieve sufficient stability to continue its expansion. This change of outlook was too profound to take place overnight. By a series of tentative initiatives and accommodations, gradually amalgamating into a general policy, the older scarcity economy has turned in "advanced" countries, after many recesses and depressions, into an economy of abundance, or, as it might be more correctly styled, of maldistributed affluence.

Because of the staggering output of mechanized industry, a multitude of products once reserved for the uppermost income groups are now available in quantity at the middle level, and this process of raising the standard and widening the market might, theoretically, go on until the market system is undermined once more by its own excesses.

Perhaps the salient breakthrough in passing from the old economy to the new came in the motorcar industry—a classic case in every respect. To achieve a mass market for mass production of



Dana Frader

REFLECTIONS

THE MEGAMACHINE—II

ROAD TO ABSOLUTISM

THE transformation of the world picture begun by the theorizing of Copernicus, Kepler, and Galileo was carried further by Descartes, for he coupled the new world picture to two new phenomena that gave it immense authority: the behavior of clockwork automatons and the claims of monarchical absolutism. He proved to his own satisfaction that all the manifestations of life could be explained on a purely mechanical basis, and that, except in the case of man, organism and mechanism were interchangeable terms.

Descartes's "Discourse on Method" stands as a landmark in the history of Western thought. Through its elegant style and its fusion of mathematical and mechanical modes of reasoning, it left a permanent imprint on later scientific formulations. This work, as short and readable as Rousseau's later "Social Contract," was Descartes's substitute for a more comprehensive book that he suppressed when he saw what trouble his contemporary Galileo had got into with the Holy Inquisition. As such, it serves almost as a prefatory "Summa" to modern thought—a neatly articulated skeleton that contrasts with the corpulent, overdetailed synthesis of Thomas Aquinas. At the time Descartes wrote, as much of the world as was then known seemed open to adequate scientific investigation by a single mind. Alone, like a royal despot, he ventured to lay the ideological foundations for a new age. In that sense, Descartes was still in the older Aristotelian tradition and had not yet made the great submission his older contemporary Francis Bacon had prophesied, for the latter realized that science, to become more productive and immediately serviceable, must accept a specialized division of labor and a standardized, piecemeal mode of investigation. From Descartes, nevertheless, one gets a clear account of the underlying motives for scientific investigation apart from its oldest and noblest impulse—the sheer delight of using the mind to discover ordered relationships and to create intelligible symbolic structures that reveal the underlying causal sequences or the emergent pattern of seemingly haphazard events. Without that bottomless curiosity and wonder, man could hardly have

advanced beyond the animal state of muscular exercise and mindless enjoyment. What Thorstein Veblen used ironically to call "idle curiosity" once served to attach the best minds to the passionate pursuit of science, often to the exclusion of more tangible rewards. That disinterested commitment to universally sharable truth was perhaps science's most enduring bequest.

But, in addition, more egoistic ambitions and utilitarian lures played a part from the beginning in the development of science, as earlier with magic, and these concerns come out even in the austere statements of Descartes. "I perceived it to be possible," he observed, "to arrive at knowledge highly useful in life, and instead of the speculative philosophy usually taught in the schools, to discover a practical [method] by means of which, knowing the force and action of fire, water, air, the stars, the heavens, and all the other bodies that surround us, as distinctly as we know the various crafts of our artisans, we might also apply them in the same way to all the uses to which they are adapted, and thus render ourselves the *lords and possessors of nature.*" (Italics mine.)

The language of this last sentence is obviously not the language of the disinterested speculative scientist. It is related, rather, to the social motives that from the sixteenth century on had been playing an ever more active part in the whole development of Western civilization—in exploration and colonization, in military conquest and mechanical industry. To become the "lords and possessors of nature" was the ambition that secretly united the conquistador, the merchant adventurer and banker, the industrialist, and the scientist, radically different though their vocations and their purposes might seem. Even at the beginning, science and technics played a part in furthering this extravagant ambition. Without the magnetic compass, astro-

nomical observations, and cartography, the circumnavigation of the globe would have been long delayed, if not impossible. From the nineteenth century on, science's preoccupation with man's one-sided mastery over nature took another turn—that of seeking artificial substitutes for every natural process, replacing organic products with manufactured ones, and eventually turning man himself into an obedient creature of the forces he had discovered or created. Ironically, the synthesis of urea, an animal waste product, was the first great triumph of such research. But many other substitutes—fibres, plastics, pharmaceuticals—followed, some excellent in their own right, some merely producing larger profits for bigger organizations.

Descartes could not, of course, foresee that this one-sided effort to "conquer nature" would bring a special danger the closer it approached realization—that of dispossessing and displacing man himself. But though we must now confront this threat, I mention it here only to exonerate Descartes and proclaim his relative innocence. Like Galileo, he could have had no notion of what would happen when the control of external phenomena and the increase of physical energies available for altering the environment and commanding time and space should take precedence over the effort to humanize man himself, to discipline and direct his own development, and to explore the exuberant potentialities of his culture and personality. In Descartes's time, the physical and mathematical sciences had not yet achieved anything like their present position of superiority. Descartes himself, though he was a gifted mathematician, was not exclusively immersed in mathematical problems or physical phenomena, for he made a close physiological study of the motion of the blood in the heart and arteries, of the kind that Harvey carried to a more successful conclusion. Though

Descartes conceived of man's becoming a lord of nature, that overlordship remained for him, despite his experience as a soldier, chiefly in the mind. His best hopes for this accomplishment lay not in increased physical power or productivity but in achieving knowledge of the human organism, which he hoped would provide a rational foundation for a more healthy regimen. Thus, while Descartes,

