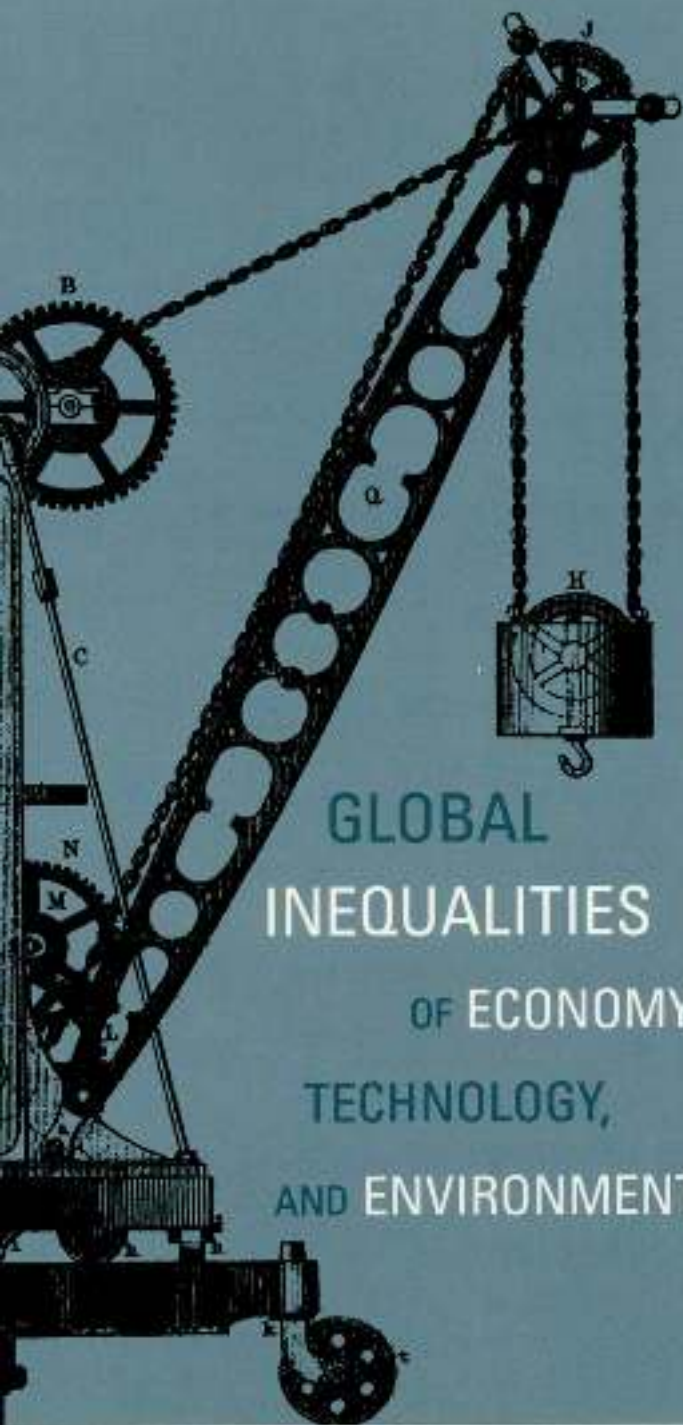


THE POWER OF THE



GLOBAL  
INEQUALITIES  
OF ECONOMY,  
TECHNOLOGY,  
AND ENVIRONMENT

ALF HORNBERG

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# The Power of the Machine

1911

1912

*For Sara and Christoffer*

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# The Power of the Machine

Global Inequalities of Economy,  
Technology, and Environment

Alf Hornborg



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## Preface

The chapters of this book were written over a period of ten years and in very diverse contexts, but they all pursue a basic set of intuitions about power and human-environmental relations that have preoccupied me since the early 1970s. It is never an easy task to argue for an interpretation of the world that goes against the grain of the everyday discourse of the people around you. To see reality in a new way means adopting an unfamiliar language for talking about it. It also means identifying "problems" other than those defined by conventional debate. Such new understandings will thus be frustrating to most people: by being "difficult" to read and by not being immediately useful in solving the seemingly self-evident "problems" at hand. There is also the risk that a reconceptualization of power structures and global inequality—even if explicitly not aiming to demonize the individual inhabitants of the affluent North—for many people would imply wedging an onus of guilt into their everyday lifestyle. All in all, it is not hard to understand the kinds of factors that select for pragmatic "knowledge" in the sense of perspectives that are *easy to live with*. But pragmatism is socially defined, and societies change. Globalized media now provide the rich and the poor with increasingly vivid images of each other's everyday lives. The social and psychological costs of denying or rationalizing the polarizations and tensions of world society are mounting. There is a chance that we are approaching a point where significant numbers of people on both sides of the North-South divide will be demanding more credible narratives than neoclassical economic theory and the rhetoric on "sustainable development."

The research on which this book is based has been supported by the Swedish Council for Research in the Humanities and Social Sciences (HSFR) and the Swedish Council for Planning and Coordination of Research (FRN). The case study presented in chapter 12 was funded by The Bank of Sweden Centenary Foundation.

Several of the chapters in this book have previously appeared in journals or edited collections of articles. Revised versions are reproduced here with permission of the following journals and publishers: chapter 1: *Knowledge and Policy* 6:37–45 (1993); chapter 3: *Ecological Economics* 25:1:127–136 (1998); chapter 4: *Journal of World-Systems Research* 4(2):169–177 (1998); chapter 5: Routledge (R. Denemark et al., eds., *World System History: The Social Science of Long-term Change*, pp. 235–252, 2000); chapter 6: *Man* (N.S.) 27:1–18 (1992); chapter 8: *Anthropological Theory* 1:4 (2001); chapter 9: *Journal of Material Culture* 4(2):143–162 (1999); chapter 10: Routledge (P. Descola & G. Pálsson, eds., *Nature and Society: Anthropological Perspectives*, pp. 45–62, 1996); chapter 11: Lund University Press (A. Hornborg & G. Pálsson, eds., *Negotiating Nature: Culture, Power, and Environmental Argument*, pp. 133–152, 2000); chapter 12: *Canadian Review of Sociology and Anthropology* 31:245–267 (1994). My thanks to these journals and publishers, and also to Dorothy Smith, Erin McKindley, A. J. Sabczak, and Rosalie Robertson for competently and efficiently turning my manuscript into a book.

A very large number of people have, in various discussions over the years, helped me to refine the arguments I present in this book. Most of them—students, lecture audiences, anonymous reviewers—must go unmentioned. Although inevitably far from complete, the list of colleagues to whom I feel indebted for productive discussions on topics discussed in this book includes Kaj Århem, Zygmunt Bauman, Hugh Beach, Sing Chew, Gunnar Dahl, Philippe Descola, Kajsa Björklm-Friedman, Karl Erik Eriksson, Gunder Frank, Jonathan Friedman, Maurice Godelier, Stephen Gudeman, Thomas Häkansson, Ulf Hannerz, Tim Ingold, Mikael Kurkiala, William McNeill, Robert Paine, Gisli Pálsson, Bryan Pfaffenberger, the late Skip Rappaport, Andrew Sherratt, and Mathis Wackernagel. None of them, however, has read more than fragments of this book, and few have been in complete agreement with me about the little they have read. I thus assure the reader that the responsibility for any remaining shortcomings is entirely my own.

My thoughts also go to friends and neighbors in several communities in different parts of the world who, for longer or shorter periods, have shared their homes with me and helped me begin to fathom the variety of perspectives on the world as well as the fundamental commonalities of human existence. For this I am indebted to the villagers of Huahuapucio and their relatives in Lima; to residents of the Mi'kmaq communities of Eskasoni, Memberton, and Whyteconmagh, and to longtime friends in the Swedish parish of Västana.

Finally, I continue to be grateful to my wife, Anne-Christine, and my children, Sara and Christoffer, for providing me with a meaningful context and the requisite peace of mind with which to dare my excursions into the abstract and the global.

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## Introduction



# The Machine As Emperor

**T**he last quarter of the second millennium a.d. saw the rise to power of the machine. Like all power structures, the machine will continue to reign only as long as it is not unmasked as a species of power. This book is intended as a contribution to such an unmasking.

Power is here understood as a social relation built on an asymmetrical distribution of resources and risks. Power relations are culturally constructed but masquerade—to the powerful and powerless alike—as inevitable and natural. To reveal their arbitrary foundation is thus an epistemologically arduous task. It involves not only exposing conventional perspectives as mystifying but necessarily also presenting an alternative and more credible interpretation of social reality. This has become increasingly difficult in the intellectual climate of postmodern social science. Deconstruction becomes toothless when all it finally adds up to is a philosophy of “anything goes.”

To unmask the power of the machine, we need to be as open to thermodynamics as to semiotics. It is one thing to say that the machine is culturally constituted, that is, that our perception of it is symbolically mediated. It is something else to say that, beyond this cultural lens, the *actual* machine contradicts our everyday image of it—that there is something

outside our conventional representation of it that we now need to acknowledge. To make both kinds of arguments in the same book is not very common these days. Researchers in the human sciences tend to be either constructivists or objectivists, and the two discourses usually are kept separate if not antagonistic. But to expose the special character of machine power requires that the two kinds of discourse can be articulated, for machines rely for their very existence as much on symbols as on thermodynamics.

The title of this book is intentionally ambiguous. The book's central argument is that three possible meanings of machine "power" that we conventionally would distinguish—power to conduct work, power over other people, and power over our minds—are really aspects of a single, social phenomenon. It seeks to show that the foundation of machine technology is not primarily know-how but unequal exchange in the world system, which generates an increasing, global polarization of wealth and impoverishment. The main challenge has been to achieve a distanced view of the everyday, cultural categories and assumptions which continue to reproduce this asymmetric, global power structure. One of the strategies that I use is to juxtapose the modern power of the machine with premodern power structures such as that embodied in the Inca emperor.

When I argue in chapter 8 that the machine and the emperor are comparable (as instances of Marxian fetishism), I mean it in all the three senses of "power" referred to above. Both imply power over other people and power over their minds, but also, simultaneously and concomitantly, power that actually works. It is precisely the illusory distinction between symbolic communication and technical efficacy that prevents us from recognizing the machine as a social institution no less culturally constituted than Inca ritual. In both cases, the efficacy hinges on the symbolic codes that mobilize the masses. As I argue in chapter 9, we cannot hope to understand the material agency of humans in the biosphere if we are not prepared to juxtapose materialist perspectives, on one hand, with symbolic analysis and phenomenology, on the other. Chapter 9 focuses on the semiotics of money and modernity, phenomena without which the machine would not be possible.

Although the chapters in this book range widely in terms of theoretical perspectives and empirical case material, they all pursue the fundamental intuition that the environmental crisis of modern society is a problem of power, culture, and epistemology. The underlying concern is to show that the objective and the subjective dimensions of human environmental relations are inseparable. In particular, I hope to reveal how the material existence of modern, industrial infrastructure (i.e., "development") ultimately relies on certain cultural notions about production and exchange, and on the unequal flows of resources that these notions mask and repre-

duce. My main thesis is that we are caught in a collective illusion about the nature of modern technology. We do not recognize that what ultimately keep our machines running are global terms of trade. The power of the machine is not *of* the machine, but of the asymmetric structures of exchange of which it is an expression.

This work could perhaps be viewed as an additional chapter in the critical, cultural analysis of capitalism inaugurated by Karl Marx. Throughout part 1, I try to show that the most central "fetish" of capitalism is nothing less than the industrial machine. To make this clear, it is necessary to uncover the material asymmetries implied in contemporary patterns of global trade. I argue that these asymmetries are systematically concealed from view by the hegemonic, economic vocabulary. It is only in making these material dimensions of exchange transparent that it becomes possible for us to assess the *moral* dimensions of the global market economy. A cultural critique of industrial capitalism might begin by recognizing that economic exchange (and the vocabulary and institutions that orchestrate it) is a part of the technology.

I am trained in cultural anthropology, and many of my theoretical and empirical reference points indeed derive from anthropology. In struggling with the transdisciplinary field of human ecology, however, I have ventured into the literature of neighboring disciplines such as sociology, archaeology, economic history, geography, and development studies. My argument represents a conjunction of perspectives from the humanities, social sciences, and natural sciences. It is polemical in relation to most conventional discourse on "sustainable development," ecological economics, and similar topics in suggesting that solutions to our ecological predicament will have to be much more profound and radical than is usually envisioned in the environmental debate. I argue for a *defamiliarization* of our conventional conceptions of technology and development, that is, a fundamental distancing from the cultural categories through which the modern economic system operates, and in terms of which most policy negotiations are conducted. Above all, I argue that we must recognize the global, *distributional* aspects of development, technology, and environmental issues. The intellectual ancestry of these ideas can be traced to the underexplored interfaces between world system theory, political ecology, ecological economics, economic anthropology, fetishism theory, and semiotics. An important aspect is to connect political ecology and political economy with the anthropological concern with culture.

In part 2, I thus relate the phenomenon of machine fetishism to the wider, cultural and existential context of modernity, focusing on processes of semiotic abstraction. If I confuse readers by juxtaposing arguments from thermodynamics and semiotics in one and the same book, it is because both are part of the world we live in, and both are of

significance for the problems of sustainability which confront us as we enter the third millennium. If the phenomenology of modern personhood seems totally unrelated to questions of natural resource management, it is only because our Cartesian compartmentalization of knowledge produces such illusions. It is in fact deluding to separate scientific discourses on the "reality" of environmental problems from humanistic discourses on the *representations* of such realities, simply because the representations (including all our discourse) tend to be active ingredients *in* reality. This condition is powerfully evoked in much post-structuralist thought as well as in the Marxist concept of fetishism, which is a central point of departure for this study.

This book, in short, is about the epistemology of exchange. I believe that many of the intuitions that have guided it ultimately derive from my previous struggles with anthropological theories of kinship and marriage (Hörnberg 1988, 1993, 1998b). Fundamental to both inquiries has been a concern with "underlying" structures of exchange masked or veiled by the cultural constructions of the participants. The difference between what Lévi-Strauss (1969) referred to as elementary and complex structures of kinship is coguate to the difference between primitive and modern money. The transformation in both cases is in the semiotics of reciprocity. Direct marriage exchange resembles the exchange of primitive valuables such as the Melanesian *iviv* or the ancient Andean *mulla* (*Spondylus* shell), discussed in chapter 5, in that both represent a culturally *restricted* interchangeability. The transitions to complex structures of marriage and to general-purpose money entailed a successive *generalization* of exchange in time and space.

Whereas Malinowski's "pure gift" tolerated delayed reciprocity only within a restricted social space (cf. Sahlin's 1972), money purchases (fictitiously) present themselves as immediate reciprocation and are thus able to extend the social range of exchange beyond the reach of personal, face-to-face relations. Money capital is an institution for delaying and extending the archaic, gravitational pull of reciprocity. It is the conceptual and institutional transmutations of this "pull" that make possible increasingly asymmetric exchanges between distant populations and ecosystems. The extension in time and space of such gravitational fields is achieved through a process of semiotic abstraction that is at the heart of what we know as modernity. My use of the metaphor of "gravitation" here is not fortuitous, for it refers to the capacity of money signs to *make matter move*. These processes clearly interlace the semiotic and the material, culture and nature, the subjective and the objective. In fact, as I show in chapter 11, their very fulcrum is the phenomenology of the modern person.

The connection between money and modern personhood constitutes a fulcrum in an epistemological sense as well. Parts 1 and 2 in this book



illustrate two diametrically opposite ways of transcending the kind of conventional, Western dualism that regards nature as *material* and society as *communicative*, and the two as mutually exclusive domains of reality. Conventional ecological science approaches nature as flows of matter and energy, whereas economic science approaches society as flows of money signs. This book consistently tries to transcend this dichotomy, part 1 by arguing that society is also material (involving flows of matter and energy), part 2 by arguing that nature is also communicative (involving flows of signs). The anthropological study of money—and the modern persons whose configurations it shapes—must bring these putatively separate domains together, because money simultaneously organizes material and semiotic flows in nature and society. An anthropological study of money should help us overcome the illusory abyss between studies of the social construction of nature and studies suggesting a natural science of society.

If the word “power” in the title is ambiguous, so also perhaps, ultimately, is the word “machine.” My concern with modernity and the social consequences of abstraction finally addresses modernist rationality as a *mechanism* in the widest sense. Although my primary argument is that the machine is social, it is embedded in reflections about the inverse observation that our modern social system functions like a machine. It has been observed that it was precisely this modernist rationality which made the atrocities of the Holocaust possible (Horkheimer and Adorno 1944 [1972]; Bauman 1989). We can only hope that humanity shall one day be able to look back with the same horror and indignation at the global inequalities of the present age.



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I

TECHNOLOGY AND  
UNEQUAL EXCHANGE



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# 1



## Technology and Economics: The Interfusion of the Social and the Material

After several decades of strong public awareness that industrial civilization is moving in an unsustainable direction, there is an uneasy feeling that all this talk is not going to help. The concerned scientists, the "green" politicians, the uncounted thousands of activists around the world: will all their awareness ever have a real impact on the grinding wheels of the world economy? Why do so many of us remain sceptical? Is it, perhaps, because the recipes themselves seem contradictory? How, for instance, can engineers be expected to come up with increasingly complex technologies that are simultaneously cleaner and less expensive? How can economists be expected to devise "green taxes" which will both discourage consumption and stimulate growth? How is it possible to organize "development aid" that will stimulate production for export and yet increase local self-sufficiency? These are some of the impossible tasks specialists are being confronted with, should they try to implement the dominant, contemporary doctrine, as codified, for instance, in the Brundtland Report (World Commission on Environment and Development [WCED] 1987). As long as the concept of development continues to hinge on growth, the notion of "sustainable development" remains an oxymoron.

In very general terms, I argue in this book, the problem is our way of conceptualizing the relationship between socio-cultural constructions and

material processes. We seem to have difficulties understanding exactly in which sense human ideas and social relations intervene in the material realities of the biosphere. Rather than continuing to approach "knowledge" from the Cartesian assumption of a separation of subject and object, we shall have to concede that our image-building actively participates in the constitution of the world. Our perception of our physical environment is inseparable from our involvement in it.

In this and the next seven chapters, I wish to challenge the fragmented worldview that treats "technology" and "economy" as if they were separate parts of reality. My argument is a plea for holistic perspectives on technology as a total social phenomenon, but it follows a somewhat different track from the "social constructivist" approach (cf. Bijker, Hughes, and Pinch 1987). It is not enough to say that the specific forms of technology are socially constructed; ultimately, the whole idea of a technological "realm," so to speak, rests on social relationships of exchange. This implies that what is technologically feasible cannot be distinguished from what is socially (i.e., economically) feasible. If, since Newton, the machine has served as a root metaphor for the universe, an advocate of a less mechanistic worldview might begin by demonstrating that even the machine is an organic phenomenon.

### TECHNO-ECONOMICS

Seen as a total phenomenon, industrial technology represents the conjunction of three different factors, or levels of reality: (1) thermodynamics and other properties of matter and energy, or *nature*, for short; (2) technical knowledge, or ideas about how to assemble various components and substances so as to exploit such material properties; and (3) economics, defined as sociocultural institutions for exchange between individuals and groups. In sum, machines are part nature, part knowledge, and part exchange.

I hope to show that the worldview of industrial society does not properly reckon with the interrelatedness of these three levels. If we were to recognize how nature, knowledge, and exchange interact to generate industrial technology, machines would assume a quite different appearance than as indices of "progress" and "development." We would see that technology is not just a matter of applying technical knowledge to nature, for in order for this knowledge to result in anything at all, the components and substances to which it refers must be socially accessible. For the machines to continue running, specific components have to be provided, and at specific rates. It could be argued that this is what the world market is really all about. Although it is theoretically conceivable to keep the ma-

chines supplied with fuels and raw materials through some other mode of extraction, such as keeping colonies of slaves, the market has proven a more successful institution because it requires fewer soldiers and has made the exploitative nature of the extractive process less obvious.

Calling world trade exploitative, I insist, is more than a value judgment. It is an inference based on the Second Law of Thermodynamics. If production is a dissipative process (Georgescu-Roegen 1971), and a prerequisite for industrial production is the exchange of finished products for raw materials and fuels, then it follows that industrialism implies a social transfer of entropy. The sum of industrial products represents greater entropy than the sum of fuels and raw materials for which they are exchanged. The net transfer of "negative entropy" to industrial centers is the basis for techno-economic "growth" or "development." In other words, we must begin to understand machines as thoroughly social phenomena. They are the result of asymmetric, global transfers of resources. The knowledge employed to keep them running would be infertile if the world market did not see to it that the industrial sectors of world society maintain a net gain in "negative entropy" (or in energy; see chapter 3). Inversely, the non-industrial sectors experience a net increase in entropy as natural resources and traditional social structures are dismembered. The ecological and socioeconomic impoverishment of the periphery are two sides of the same coin, for both nature and human labor are underpaid sources of high quality energy for the industrial "technomass." Perhaps I should add that I use the concepts of center/periphery and industrial/non-industrial sectors in an abstract sense, to denote a structural relationship rather than discrete geographical areas or political units (cf. Frank 1966). The polarization of "developed" and "underdeveloped" countries is an expression of this structural relationship but does not exhaust it.

In not reckoning with the intimate connection between economics and technology—the social and the material aspects of industrialism—we tend to talk as if technology were primarily a matter of knowledge. We imagine that education and "technology transfer" might solve problems of "underdevelopment," forgetting, as it were, that new centers of industrial growth require new peripheries to exploit, and that peripheries are already in so high demand that, looking East, we are seeing former centers turn into peripheries rather than vice versa. The science of technology is not simply a matter of applying rational thought to nature, for the "natural" conditions for matter-energy conversions in privileged, so-called developed areas have been transformed by world trade. Technological science deals with the management of resources locally accumulated within such restricted areas through unequal, global exchange. It presupposes such accumulation, which implies that its own applicability is socially re-

stricted. Conventional economics, in recognizing no other concept of value than exchange value, tends to conceal this inequality.

If technology is nature plus knowledge plus exchange, we tend to forget the last part of the equation. The social processes through which its components are supplied are visualized as external to the definition of technology. Our machines fool us into thinking that they can exist without the socioeconomic premises that I have just outlined, and that they are simply revealed regularities of nature, to be approached as *non-social* phenomena. This illusion is related to our conception of the "material" world as natural, nonnegotiable, open to scientific revelation and manipulation, but in its fundamentals immune to contamination by human thought and society. We seem to have difficulties understanding that machines, being material structures, for their very existence depend on social relations. Machines occupy an ambiguous position in the Cartesian scheme: they are material, yet products of mind. This is probably why we have such a hard time grasping them as the social phenomena that they are.

The environmental debate increasingly focuses on ways in which economics and ecology do not harmonize. The argument in this book, however, is that industrial technology is a *product* of this disharmony. Its power to conduct work "in itself," as it were, is a cultural illusion. It is the productive potential of the fuels and other raw materials which is at work in our machines, not the machines "in themselves." The accessibility of such resources hinges on the socially constructed discrepancy, in world trade, between material qualities and price, ecology and economics; thus, social distribution is necessarily prior to production, and global terms of trade are a crucial "productive force" or "factor of production."

One way of grasping the nature of this illusion is to think in terms of how industrialism has shifted the boundary between negotiable and non-negotiable aspects of human production systems. If we exclude local barter of bulk goods, most pre-industrial trade was in items the primary value of which was symbolic, for instance as magic sources of fertility or indicators of social prestige. Because work generally was manual, the local exchange value of such items corresponded to their productive potential—the rate at which they could be converted into human labor. To say that the local exchange value of a long distance import was proportional to its productive potential would be tautologically true for such economic systems. Whenever an object of exchange carries an *intrinsic* (thermodynamic) productive potential, however, there is a chance that exchange value and productive potential are not proportional; that is, that a unit of productive potential is underpaid relative to the product into which it is transformed. As we shall see in chapters 4 and 5, such underpayment can occur in the context of several different kinds of production



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