Men, Machines, and Modern Times

ELTING E. MORISON

The M.I.T. Press
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS, AND LONDON, ENGLAND

Library of Congress Catalog Card Number 66–22145
Printed in the United States of America

Men, Machines, and Modern Times

To the other members

Preface

In February 1950 I gave some lectures in the Athenaeum of the California Institute of Technology. I did so at the invitation of Hallett Smith, Chairman of the Division of Humanities, and Paul C. Eaton, Dean of Students. One of these lectures, which had to do with the disorder created in the United States Navy when an officer discovered a new way to fire a gun at sea, is now the first chapter of this book. It is also the source of all that follows for it started me out on the line of inquiry that is developed throughout these pages. For several years thereafter this inquiry was pursued until it seemed to me that I was reaching the point of diminishing returns, indeed the point of flat and stale repetition of earlier findings. So the subject was put aside.

In February 1963 I was invited again by the Chairman of the Division of Humanities and the Dean of Students to give three talks at the Athenaeum. In working up one of these talks I had some reflections that seemed to get me off the dead center of repetition I had been stuck on and to open up the possibility of a refreshing new direction for my earlier line of inquiry. Some of the things I said then have become the fifth chapter of this book.

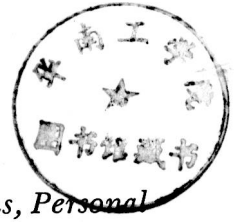
Now, in February 1966, once again at the invitation of my previous hosts, I have returned for a visit to the California Institute of Technology. In writing these words in a room at the Athenaeum it appears, as they say at institutes of technology, that I am closing the loop, or in other words, that I've gone about as far as I can usefully go on this particular line of inquiry. It appears also that this is the right time and place to give my thanks to the two prime movers of this venture. In responding to their first invitation I came upon my subject. By their thought and effort, long continued, I have ever since been supplied with opportunity, means, and delightful occasions to pursue it.

I am as deep in debt to some others, too. For the last fifteen years I have been a member of a group of fourteen men who have met regularly one Friday evening a month to eat and talk together. Of the fourteen three were trained in physics, three in history, two in economics, and one each in mechanical engineering, chemistry, sociology, political sciences, psychology, and the law. More than half of them have held responsible positions in government, industry, or higher education. Collectively they have been, therefore, in fairly close touch with both the intellectual underpinnings and actual operations of an industrial society. More often than not the conversations on Friday evening have turned on subjects dealt with in these pages. This book is not to be taken as even the palest reflection of these conversations, but it would have been different, in many ways it would not have been at all, had I not known the other members.

ELTING E. MORISON

The Athenaeum
California Institute of Technology
February 1966

Contents



1

Introductory Observations, Personal and Otherwise

I was first introduced to the subject of this book thirty-four years ago in the spring of my last year in college. I had at that time gone off to my family's house in the country to complete the writing of my senior thesis. The house had been built by my great-uncle forty years earlier. He had been a civil engineer who had spent much of his professional life designing and building the bridges that carried the railroads across the Western rivers. In this house, which was itself a very complete expression of his view of things, there were still many evidences of his powerful mind and personality: a file room of his blueprints, pictures of his bridges on the walls, and, in the bookcases, copies of his engineering reports including the study he had made for the federal government (just before his death in 1901) of the feasibility of the various isthmian canal routes.

From one of these bookcases one spring evening I took down in idle curiosity a little volume he had written called

The New Epoch. It consisted of a series of papers he had delivered at various times and places in the last decade of the last century. These papers were all an elaboration of a central idea suggested to him, so he said in his preface, while reading his classmate John Fiske's *The Discovery of America.* Fiske began his work with a description of what he called the "ethnical periods among prehistoric man," epochs representing the various conditions of savagery and barbarism that led to civilization. The character of these ethnical periods was determined in large part by the tools available to the men living in the period: fire, bows and arrows, pottery, domesticated animals, ironworking, and the alphabet.

From such considerations my uncle had been led to think that he and his generation had entered a new epoch. All earlier history had been determined by the fact that the capacity of man had always been limited to his own strength and that of the men and animals he could control. But, beginning with the nineteenth century, the situation had changed. "His capacity is no longer so limited; man has now learned to *manufacture power* and with the manufacture of power a new epoch began." In this little book, in a series of essays on different subjects, the author put down his speculations on the changes — social, economic, political, and intellectual — that would be produced by man's discovery of the means to manufacture power and to distribute it to do work wherever needed. On these matters he was invariably sensible and often prescient. If in supplying possible solutions for the large problems he foresaw he betrayed, at times, the oversimplifying optimism of the nineteenth-century engineers who had solved so many problems in their own field, nevertheless his sense of the important issues was virtually unerring. The paths of inquiry he laid out in this little book were in many cases

those which in later years attracted the attention of such dissimilar intelligences as Veblen, Whitehead, Schumpeter, and Wiener.

I wish I could say that all this had been clear to me at my first reading of these essays. But I was ill prepared for such speculations at the time. My reading of history in school and college had led me to believe that shape and meaning were given to society primarily by the blunders or adroit maneuvers of men who appeared in public life as generals, senators, prime ministers, foreign secretaries, kings, and ambassadors. The senior thesis on which I was working at the time was a canvass of the intricate ineptitudes both at home and abroad of the Emperor Napoleon III. One of the principal recorders of the imperial difficulties, and one of my primary sources, was Philip Guedalla, whose views of the Industrial Revolution, or the new epoch, paralleled, if they did not determine, my own. Once when he could not avoid taking railroads into account, he had said that "the change was one of those queer achievements of the nineteenth century when little men in black coats produced astonishing results whilst thinking hard all the time about something else." In the history that I had learned, from the sacking of Rome by Alaric to Bethmann-Hollweg's piece of paper, there had been small place for little men in black coats.

So the concerns of *The New Epoch* went largely unattended in the year 1932. Indeed, for some time all I retained from its pages was a statement to the effect that the power generated in a modern steamship in a single voyage across the Atlantic was more than enough to raise from the Nile and set in place every stone of the great Egyptian pyramid.

When I next read it, some seventeen or eighteen years later, I had a considerably greater interest in its sub-

ject. In the interval I had done several things that took me somewhat closer to the work of the little men in black coats when they were thinking hard. First, I had written the life of a naval officer whose whole career had been determined by the shift from sail to steam and more particularly by the increasing mechanization of the naval gunnery system. I cannot say that in the writing of this book I had been fully aware of how much that remarkable personal career had been produced simply by a change in the tools the officer used. My interest at the time had been to get at the nature and effect of a particular personality. But, at least unconsciously, I could not avoid taking in some of the more obvious implications of the influence exerted by the changes in the mechanical systems he worked with.

Following this I spent four years editing the letters of Theodore Roosevelt. I came to this task accepting the views of many in my generation that the twenty-sixth President was something of a snake-oil salesman whose hold over the citizens came from the fact that like most of them he tended, as Lincoln Steffens said, to think with his hips. Four years of labor among his papers produced an increase of understanding and a quite astonishing change of judgement. Roosevelt had a matchless sense of the nature of the democratic process as it works out in this republic, and his awareness of the place of the Presidency in that process has been equalled by only two or three of the others who have held this office. In addition, he possessed a very clear insight into the nature of the times. He was the first President to discern the meaning of what he called "the wonderful new conditions of industrial growth" and to state directly the issue of what the society would do with itself in these conditions. In the course of his years in the Presidency he put all the hard questions that were accumulating as the country steadily increased its capacity to

manufacture power. He also offered interesting answers and gave it as his opinion again and again that if these answers or better alternatives were not supplied in time, the society would be shaken to pieces by the jolts and shocks produced by the continuous introduction of new energy. He was neither morbid nor depressive, but confronted by the rapid acceleration of the wonderful new conditions in his time, he had left many of the complacent assumptions of the nineteenth century — that things would proceed in good order along the whirring grooves of change — somewhat behind. He believed, in fact, that if great care were not taken in the ordering of the new energies, things would jump the rails.

Work with the letters and papers of this man was a further education. In a time when the number of little men in black coats was steadily increasing, the world was not to be held together simply by things like the Ems Dispatch or the Ostend Manifesto or the renewal of the Re-insurance Treaty. When "the strength of materials, the chemical composition of substances [and] the laws of heat and dynamic energy enter into almost every operation of modern life," some more informed and solidly based arrangements for the ordering of affairs were necessary. Education in this kind of necessity was extended when I became a member of the faculty of the Massachusetts Institute of Technology in 1946. It was at that time well on the way to becoming what it now is, one of the great intellectual centers of the new epoch. Virtually all the work done in its buildings — investigation, experiment, and the elaboration of theoretical systems — is directly related to the extended application of old forms of power and the development of means to produce new forms of power. Simply to live and work as an historian in such a place was a liberal education in the nature of the new dispensation.

Many of the people there were lineal descendants of the fellows in the black coats who produced astonishing results while thinking hard all the time about something else. But some of them were thinking, too, about the results — it was, after all, shortly after Hiroshima — and it was becoming more natural to consider not only the kind of design that would produce a mechanical system that would do more work but something of the effect of the mechanical system on the conditions of the time. Some of these people — Hawthorne, Soderberg, and Wiesner in engineering, Deutsch, Stratton, and Weisskopf in physics, Maclaurin and Millikan in economics, Bavelas in psychology, Wiener in mathematics and everything else — I got to know early on, worked and talked and, in a way, grew up with. Over the years I obtained from them at least a feeling for some of the conditions of an age that lives by the manufacture of power and some of the contemporary social implications and consequences of such manufacture. This may be an overstatement of the case, or an exaggeration of the dimension of the subject of this book. Perhaps it is fairer to say that from them I at the least began to look at the old materials in my field of history in what was for me a new way and let it go at that.

In any event, some years after I became a member of the faculty of the Institute, I thought it would be interesting to arrange some of these old materials in a new way to see what would come out of it. The thing that at the time was on many of my colleagues' minds as a new kind of inquiry — the kind of fashionable kick that so often appears to stimulate our intellectual life — was technological innovation, what Schumpeter called "the gale of creative destruction," or, more simply, what happens when you change the machinery. There are many parts of this process: why change, who changes, what design problems,

what capital requirements, what institutional modifications, who gets hurt, who profits? Among the parts there is room for many of the intellectual trainings: physical scientist, engineer, economist, sociologist, psychologist, and political scientist. There might also, it seemed to me, be some place for the historian.

So I took some data with which I was thoroughly familiar, the evidence bearing on the introduction of a new system of gunnery into the United States Navy at the turn of the last century. I had used this material ten years before as part of the biography of the naval officer William S. Sims. It had then been cast in a relatively simple narrative form. This time I tried to organize it to emphasize, without undue distortion, what happened when there were changes in the mechanical systems men worked with. When the evidence was put together in this way, it appeared that there was a rather clearly defined anatomy in the whole process and a set of rather interesting connections between certain causes and effects.

The study, as thus composed, is the first essay in this book. It is also the source or beginning of all the essays that follow. In working on it, I came upon enough matters I could not resolve to my own satisfaction to start me along on further investigations. The subject since that time has remained a sort of subsidiary intellectual concern, taken up now and then from different points of view during the last fifteen years.

Much of the ensuing research and reflection has been spent on four distinct parts of the process: the condition of things at the point of origin of any mechanical change, the character of the primary agents of change, the nature of the resistance to change, and the means to facilitate general accommodation to the changes introduced. Interesting or entertaining things can be found and said on all these matters.

For instance, no man ordinarily can get out very far ahead of the state of the art, or to put it another way, he can't rise very far above the thresholds of existing knowledge. No intellectual heroism or psychic leap will take you from the development of the wheel immediately to the internal-combustion engine and the automobile. On the other hand, if the state of one art permits a considerable advance, there is not much profit in it unless the state of other related arts supports a general forward movement. The Greeks, for example, had a steam engine which remained a toy and was then forgotten because there was no way for it to do work within the technological surround, no mechanical system to hook it to. Also in Greece, the work that was done was done cheaply by slaves. There is an interesting converse to this proposition: the conditions of the technological surround, if it can inhibit change in a single part, can also foster it in a single part. Years, centuries, of experiment with windmills and waterfalls had produced by the eighteenth century a very sophisticated technology to go with these sources of energy. In some countries impressive linkages to transmit power three and four miles from the water wheels had been developed. All the elaborate machinery needed was a more effective prime mover. Since there wasn't the steam engine, it became necessary to invent it.

There are a great many other attendant propositions or tentative generalizations. It is possible, for instance, that in any very strict sense there is no such thing as an inventor or an invention. To put it another and slightly more persuasive way, the act of invention may simply be making conscious, explicit, and regular what has been done for a considerable time unconsciously or by accident. Bessemer changed his society by discovering a system for making steel in a way it had been made by accident for generations.

Also for generations before Pasteur, European mothers had been pasteurizing when they heated the milk of cows in an effort to get it as warm as their own. Indeed, almost any study of a new invention indicates that for considerable periods of time before the inventor did his work other men were also doing much the same thing.

Whether or not there are inventions it is clear that there are inventors, or at least there is a syndrome, as clearly defined as any neurosis, possessed by men who are said to invent. I once collected evidence on the lives of about thirty of these men who flourished in the nineteenth century. A surprising number turned out to be people with little formal education, who drank a good deal, who were careless with money, and who had trouble with wives or other women. This is also, I suppose, what is now called a good stereotype of the painter or poet. And it is quite probable that the inventor who is also something of an engineer is, like all great engineers, an artist and therefore shares in what is assumed to be the artistic or creative temperament. But there may be a little more to it than that. It is possible, if one sets aside the long-run social benefits, to look upon invention as a hostile act — a dislocation of existing schemes, a way of disturbing the comfortable bourgeois routines and calculations, a means of discharging the restlessness with arrangements and standards that arbitrarily limit. An Englishman who some years ago made a canvass of the lives of a good many inventors was surprised to find how many of them had worked as telegraphers. He concluded that the nature of this calling — itinerant, odd hours, episodic work loads, essentially lonely, in touch with mechanisms — supplied a kind of *rive gauche* or revolutionary underground for men not at home with standard operating procedures.

The temptation in the study of these matters historically