an empirical question whether technical progress offsets the diminishing returns inherent in nature.

Caught in a web of arbitrary assumptions describing the technology of scientific inquiry, Rescher does not perceive that his argument for the deceleration of science is ultimately dependent on the cessation of economic growth. He is surely correct in recognizing that there is a connection between scientific and material progress, but it is ironic that the principal conclusion of a closely reasoned argument about the future of science rests on an unexamined premise about the future of the economy.

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# Pressures Toward Bigness

**The Visible Hand**. The Managerial Revolution in American Business. ALFRED D. CHANDLER, JR. Belknap Press of Harvard University Press, Cambridge, Mass., 1977. xvi, 608 pp., illus. $18.50.

The view that the large, multiunit corporation is one of the most influential institutions in American society would doubtless command instant and widespread agreement. There is, to be sure, disagreement whether the influence has on balance been benign or malignant, but those at both ends of the political spectrum agree on the capacity of the large corporations to shape our lives and perhaps the destinies of our children. And yet, if one defines the role of social science as that of explaining our present situation, it has to be admitted that its accomplishments with respect to these central institutions have been distinctly modest. Although the corporation has been intensively studied from many specialized perspectives, our understanding of why it has taken its precise present forms and what factors account for its size and its explosive growth in the 20th century is still notably deficient. Far too much energy, for example, has been expended on painting business leaders as robber barons or industrial statesmen and far too little on analyzing the genuine but somewhat elusive functions of administrative coordination. For clearly such coordination is an important aspect of enterprises consisting of increasingly numerous and more and more highly specialized activities.

In *The Visible Hand* Alfred Chandler, who is perhaps the closest and most careful student of American corporate history, offers what must be regarded as the most ambitious attempt to date to explain large-scale corporate enterprise in light of the historical forces that have given it life and shape.

The title of the book serves to announce its central theme. Adam Smith's *Wealth of Nations*, published in 1776, presented an analysis of how the market mechanism in a capitalist society could be relied upon to bring about an efficient allocation of the society's scarce resources. So long as individual households and firms were free to pursue their own interest without impediment or restraint, and so long as the marketplace was permitted to register accurately, through changes in price, the ever-altering conditions of supply and demand, individual self-seeking could be relied upon to serve the public interest as well as the private. Adam Smith's invisible hand represents, thus, the guidance to resource use offered by the forces of the marketplace. Such a system of market-regulated allocation was adequate so long as small-scale enterprise remained economically efficient. But these conditions, Chandler believes, began to be rendered obsolete around the middle of the 19th century by the emergence of forces favoring growth in the size of the business unit. With such growth the marketplace was more and more displaced as a mediating force by managerial decisions inside the firm, or rather the boundaries of the firm gradually expanded to internalize flows and transactions that had formerly been mediated through the marketplace. In this manner, administrative and allocative decisions by the visible hand of management substituted for the invisible hand of the marketplace in coordinating supply and demand. Such coordination made possible a more efficient utilization of capital and reduced the transaction and information costs of business operations.

What accounted for the increasing advantages of bigness that inexorably enlarged the role of a specialized managerial class? It is difficult to do justice to Chandler's answer to this central question, for in providing it he spends 600 pages marshaling and analyzing historical evidence. The essence of the matter lies in a combination of rapidly expanding markets and technological innovations. The introduction of new coal-using technologies and the unique opportunities offered by the railroad and telegraph made possible vast improvements in economic efficiency, but the improvements were attainable only through unprecedentedly high volumes of production and high-speed processing of materials.

> The new sources of energy and new speed and regularity of transportation and communication caused entrepreneurs to integrate and subdivide their business activities and to hire salaried managers to monitor and coordinate the flow of goods through their enlarged enterprises. The almost simultaneous availability of an abundant new form of energy and revolutionary new means of transportation and communication led to the rise of modern business enterprise in American commerce and industry [pp. 77–78].

There was another essential element to the speed of growth of large-scale business enterprises, with their hierarchies of full-time salaried managers, in the years between the Civil War and the First World War. The immense increase in scale of operations—typified by the case of the railroads themselves—meant a huge investment in capital and a consequent high ratio of fixed to variable costs. Such conditions quickly proved to be incompatible with atomistic competition of the kind celebrated by Adam Smith a hundred years earlier. The relentless pressure of fixed costs and the evident unworkability of uncontrolled competition led to extensive experimentation with new organizational forms in the last 20 years of the 19th century. As Chandler's analysis of the experience of the railroads makes abundantly clear, decisions to combine large bureaucratic corporations into even larger units, and thus to internalize their activities and transactions, did not reflect further opportunities for cost reduction through administrative coordination but rather were desperate responses to competitive pressures.

The combination of cheap power and the new opportunities offered by technological revolutions in transportation and communication led not only to the spread of a mass-production factory technology but to a system of mass dis-

tribution as well. Chandler examines with care the distinctive conditions and requirements of each sector of the economy to which this system spread. His examination takes full account of the complexities of the individual situations, and he never succumbs to the temptation to oversimplify or to force the frustrating diversities of the real world onto some Procrustean bed. Processors of such perishables as meat and beer confronted different organizational problems in marketing their products from those confronted by, say, makers of complex machines that required specialized marketing efforts such as demonstration, installation, or after-sale servicing. Sales to final consumers involved a very different organization of marketing activities from those involved in sales to business units. Thus the experience with sewing machines was very different from that with heavy electrical equipment. Products undergoing rapid improvement required strategies and organizations very different from those required by products with, say, a high degree of stability and heavy reliance upon advertising—such as cigarettes. Each case called for a managerial strategy that would provide for the coordination, scheduling, monitoring, and planning of a large number of separate operating units, and in a manner adapted to its specialized production and distribution needs.

Within this framework, Chandler presents a coherent account of the wave of industrial growth and merger that swept over the American economy in the early years of the 20th century and established patterns of industrial concentration whose broad features persist to this day. The analysis is judicious and balanced, taking into account both the subtle interaction between the requirements of the production technology on the one hand and a nationwide (or increasingly even worldwide) marketing network on the other and the manner in which continually shifting variables within these categories altered the competitive balance among firms.

Thus Chandler's book provides an interpretation of the historic rise of big business that contains novel elements, and he offers an analytical framework that makes it possible to discern a variety of issues more clearly. These include not only the determinants of firm size and the causes and effects of vertical and horizontal integration but also the movement toward diversification and the impulses giving rise to scientific research. He demonstrates convincingly the power of his explanatory framework empha-

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sizing technology and markets in accounting for size and concentration, as compared to alternative explanations emphasizing the quality of entrepreneurship, access to capital, or public policy. As he points out,

> Entrepreneurial ability can hardly account for the clustering of giant enterprises in some industries and not in others. The most brilliant industrial statesmen or the most ruthless robber barons were unable to create giant multinational companies in the furniture, apparel, leather, or textile industries. Yet, in other industries the first to try often succeeded [p. 373].

Antitrust legislation is shown to have been less important in its effect on size and industrial concentration than were technology and market requirements. The Sherman Anti-Trust Act of 1890 was ostensibly directed at the control of size, but its main effects in this respect were at best ambiguous. It did effectively discourage cartel-like controls over price and output by separate firms, but precisely in so doing it unquestionably accelerated the growth of large-scale enterprise. It did encourage the formation of oligopolies where monopolies already existed and discourage oligopolistic firms from merging into monopolies, but

> in these formative years of modern industry, federal action under the Sherman Act never transformed an oligopolistic industry back into a traditionally competitive one. Nor did it prevent the rise of the giant integrated firm where markets and technology made administrative coordination profitable [p. 376].

There are problems with Chandler's book. It is too long and too repetitious and occasionally burdens the reader with excessive detail. More seriously, it is not nearly as clear as it should be on the central issue of the benefits flowing from administrative coordination within the large firm. Before the analysis can be regarded as fully persuasive it will be necessary not only to identify but to quantify, at least crudely, the reductions in information and transaction costs that are achieved in substituting the coordinating activities of large firms for the role of the marketplace. Moreover, the book gives no attention to the larger questions of the social costs of bigness in business. With respect to the last point it may perhaps be legitimately rejoined that the benefits of specialization, so obvious and so widespread in the business world, should not be peremptorily denied in scholarly research. There is, in any case, no imminent danger of a shortage of academic treatises on the social costs of large-scale enterprise. If Chandler has ignored, for example, the impact of the increasing speed of industrial operations upon the well-being of the worker, the subject is currently receiving extensive treatment by other scholars. Chandler's book, although not covering all aspects of the large corporation, constitutes a major contribution on a surprisingly neglected subject: the role of organizational innovation in the growth of industrial societies.

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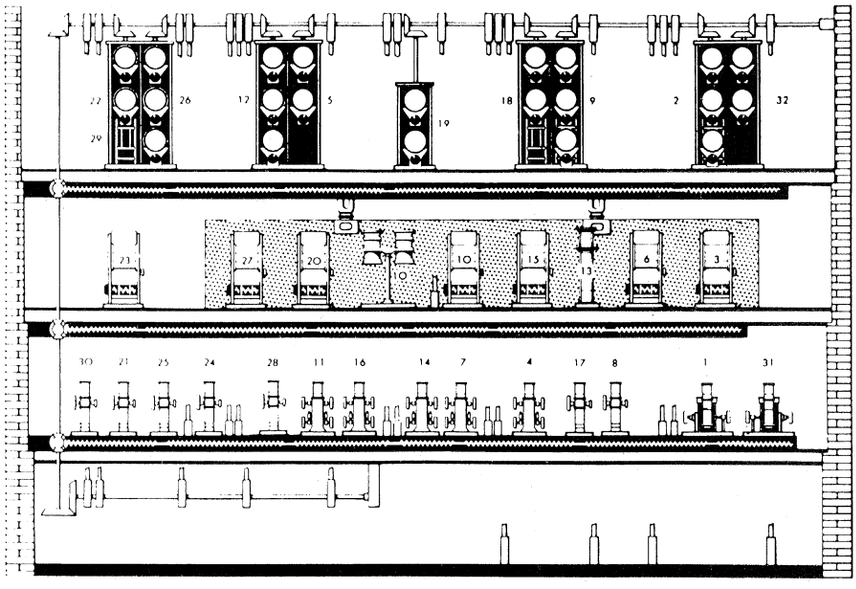

Plan of the Washburn automatic, all-roller, gradual-reduction mill, 1879. "The creation of a continuous-process or automatic factory . . . involved a number of inventions, . . . which had to be synchronized . . .; it also required perfection in plant design." One such factory was that represented here, used to process wheat and other grains. "Flour mills had used continuous-process machinery since . . . 1787 [but] only after the grain-growing regions had expanded and after the railroad and ancillary storage facilities permitted high-volume year-round operations did demand for the large automatic mill appear. The need to find more efficient ways to process the hard-grain wheat of the northern prairies intensified the search for processing innovations in the Minneapolis area. The result was a series of innovations [that] involved gradual reduction, multiple grinding, steel rollers to replace grindstones, purifiers and aspirators, and reels for scalping, grading, and dressing the flour. . . . The 'new process' mills . . . produced high-quality flour in high volume and at low unit cost. Theirs quickly became the standard processing technology." By the end of the 1880's the average daily output for the Minneapolis mills, which had been 274 barrels in 1874, was 1837 barrels. "Comparable developments occurred [with] other grains. In the milling of oats, the output was so high that the leading processors had to invent the modern breakfast cereal industry in order to dispose of their surpluses." [Reproduced in *The Visible Hand* from J. Storck and W. D. Teague, *Flour for Man's Bread*, University of Minnesota Press, 1952]

## Technology as Master

**Autonomous Technology**. Technics-out-of-Control as a Theme in Political Thought. LANGDON WINNER. MIT Press, Cambridge, Mass., 1977. x, 386 pp. $17.50.

This study of the idea of technology out of control makes an important contribution to our understanding of the problems of our industrial civilization. The basic argument is not that some persons or groups promote technologies against the public interest (true though that is), or even that our technology develops in its own way in spite of all our efforts to control it (also true in some respects). Rather, Winner is concerned with a more subtle effect: the artifacts that we have invented to satisfy our material wants have now developed, in size and complexity, to the point of delimiting or even determining our conception of the wants themselves. In that way, we as a civilization are losing mastery over our own tools.

Winner's starting point is a certain conventional wisdom, which although subject to widespread doubt has not been systematically scrutinized or replaced: (i) that men (sic) know best what they have made; (ii) that things men make are under their firm control; and (iii) that technology is essentially neutral, a means to an end; the benefit or harm it brings depends on how men use it (p. 25).

Against this Winner gives a set of propositions (to be found on p. 190) called "the master-slave paradox," asserting that we have a pathological de-