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Unchained

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RESCUING PROMETHEUS

By Thomas P. Hughes.

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Pathbreaking mega-engineering and technology projects have been hallmarks of our history. The Erie Canal, the transcontinental railroad, the Tennessee Valley Authority complex, the Manhattan Project -- these are just a few of the achievements reflecting America's genius for inventing and building. In "Rescuing Prometheus," Thomas P. Hughes, a professor of the history and sociology of science at the University of Pennsylvania, focuses on the cold war years, a particularly exciting era when rivalry with Moscow caused Washington to finance vast technological innovation, when collaboration between the Pentagon and companies like IBM and universities like the Massachusetts Institute of Technology reached its zenith and when the country's finest talent opted for careers in science and engineering rather than banking and marketing. Writing simply and directly, if a bit dryly, Hughes makes an important contribution to an understanding of the history, politics and culture of big science-based projects in that era.

Hughes begins by discussing the early development of air defense systems, which led to the first computers that could assimilate and analyze astronomical amounts of information in order to monitor and control complex military operations. He then turns to the building of the Atlas intercontinental missile, involving over 18,000 technical experts and 200,000 suppliers. From here he moves to the construction of Boston's Central Artery and Tunnel Project, America's largest urban transportation project. And finally he discusses the project called Arpanet (because it was financed by the Pentagon's Advanced Research Projects Agency), which connected networks of computers across the country and became the forerunner of the Internet.

His concern is the challenge of managing highly complex projects rather than the importance of the technological breakthroughs themselves. He assumes that scientific knowledge exists or can be discovered, but maintains that it was the application of far-reaching managerial innovations that constituted America's most impressive technological achievement. In the search for an antimissile defense system, for example, he dwells on the struggle for effective cooperation between the Pentagon and research universities, and the difficult task of integrating frontier thinking from experts in engineering, physics and economics. In the Atlas project he underlines two managerial advances: eliminating the old system of prime contractor in favor of a neutral "project czar," and applying new statistical techniques to quantify and monitor every component

of a complex process. And in the story of the Arpanet he points to the evolution of a new organizational ethos that anticipated the nonhierarchical, flexible management teams of Intel and Microsoft.

Hughes is enamored of leaders who can orchestrate complex systems. He emphasizes techniques of "systems engineering" and "operations research" that allow managers to link the many moving parts of a megaproject and to understand so deeply the many interfaces of a project that they can anticipate adjustments throughout the system required by any change in any part. A particularly intriguing chapter deals with the effort, during the Kennedy and Johnson Administrations, to adapt management processes developed in the military arena to solve great domestic problems. "The techniques that are going to put a man on the moon," Vice President Hubert Humphrey said, "are going to be exactly the techniques that we are going to need to clean up our cities." Hughes shows how Pentagon-supported research organizations like the Rand Corporation or defense contractors like TRW were enlisted in civil projects, and analyzes why such attempts ultimately failed.

The four case studies move quickly, and Hughes skillfully explains how lessons learned in one were applied to the next. He is at his best in providing texture by describing the backgrounds and personalities of some of the key figures -- like Jay W. Forrester, who led M.I.T.'s team to create a modern computer for missile defense; Gen. Bernard Schriever, the Air Force combat pilot and engineer who was a power behind the Atlas project; and Frederick Salvucci, an engineer and savvy mediator among special political interest groups in Boston. In all four projects he deftly describes both the political setting and the internal politics of the projects. His enthusiasm for the era is contagious.

The book has some shortcomings. There are almost no memorable anecdotes, and the few quotes cited stem from secondary sources. At times Hughes is a bit too breathless in his claims for unprecedented progress. No doubt the development of computers, missiles, the Internet and major transportation systems required new forms of management. But so did the building of the Panama Canal and the construction of the New York subway system -- both in the early part of this century -- and the interstate highway project begun in the Eisenhower era. Hughes hangs a lot of his enthusiasm on dramatic breakthroughs that "systems engineering" brought, but he could have been more convincing if he explained more lucidly what such techniques really entailed, how they worked and especially why they differed so much from the past.

Nevertheless, "Rescuing Prometheus" implicitly contains a powerful message. Throughout our history, great technological advances -- including the radio, the telegraph and the airplane -- have had a strong push from the military. For the last half-century, in particular, it is difficult to think of any major scientific breakthrough in America that cannot be linked to Federal subsidies to universities or to guaranteed Pentagon purchases of technology from private companies. But in recent years Government support for key areas like advanced electronics has been declining. The portion of American students going into hard sciences or engineering is also shrinking, and because of outsized compensation opportunities a growing percentage of graduates are going into private

industry and not research universities. Absent a national threat, or a powerful new vision backed by substantial financing from Washington, America's technological base will rest increasingly on the activities of companies whose prime interest is the price of their stock. Anyone reading this book -- with its uplifting description of what this country has achieved over the last few decades -- cannot help worrying about this trend.