found it "very difficult to invent."

While *Inventing for Fun and Profit* can be read for pleasure by the general reader, there is much in it to reward the specialist. Inventors can of course learn a lot from this master, but students of inventors and invention will also find much more than the title suggests. Rabinow gives a first-hand account of the mind of the engineer at work, and he shows how the visual and nonverbal dominate that mind. He shows how much of a social act invention is, for the interaction between inventor and society is paramount in providing problems and restricting solutions. In short, Rabinow places technical innovation in the much broader contexts in which it must take place, and he does it all in a totally engaging manner.

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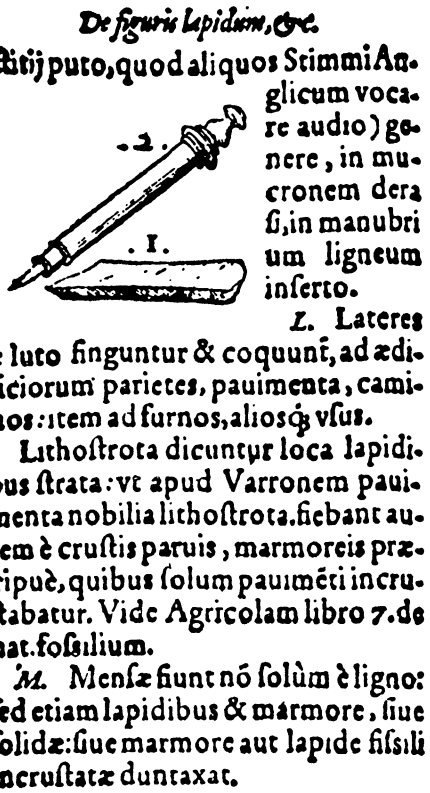
## Technology of the Ubiquitous

**The Pencil**. A History of Design and Circumstance. HENRY PETROSKI. Knopf, New York, 1990. xx, 434 pp., illus. $25.

Read this book and you will never look at pencils the same way. But it is probably safe to say that this is true for anything or anyone about which one has read 350 pages. So what? If you have ever sat staring at your pencil, wondering all that one can ask about such things—why is it yellow? why is it hexagonal? why does it start out 7 inches long? what is it made of? where did it come from?—then this book will satisfy your curiosity. But for the rest of us, this is not quite the motive to send us to *The Pencil*.

Henry Petroski, civil engineering professor, is prepared for us, however. To him, "pencil making is a near-perfect metaphor for engineering" (p. 338). That such a claim should be central to this work should come as no surprise to anyone acquainted with Petroski's earlier work, such as *To Engineer Is Human* and *Beyond Engineering*. The author is, in fact, one of the most eloquent spokesmen for the central role of engineering, not only in shaping our material environment but in defining our modern culture. It is thus particularly appropriate that the one figure who pops up again and again in this story is Henry David Thoreau. Thoreau himself is a kind of metaphor for Petroski's tale, for the transcendentalist philosopher was also a pencil manufacturer, and it is in explaining the linkages between these two roles that we find the most stimulating and original contributions in this book.

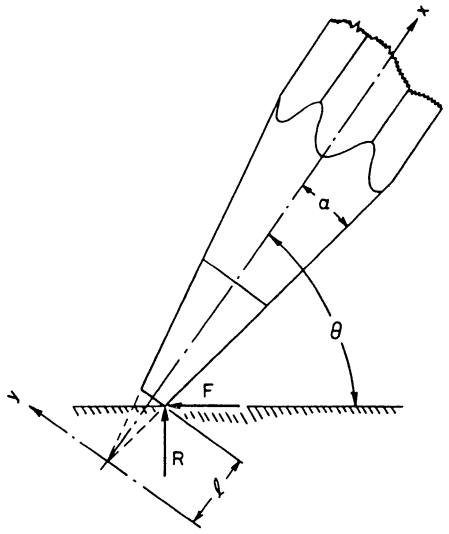



"The first known illustration of a lead pencil," from Konrad Gesner's *De Rerum Fossilium*. (1565), "pictured beside a piece of the mineral from which its marking point was made." [From *The Pencil*]

Everything has a history, and Petroski has done a nice job putting together a story that goes back to the mid-16th century, when the Swiss naturalist Konrad Gesner described a writing tool made "from a sort of lead." The discovery of graphite deposits in England's Lake District is credited with leading to the creation of the first carefully made wood-cased pencils. The quality of these tools was directly linked to the graphite that was carefully sliced and shaped to fit into their cases. In the recapitulation of a tale common in the history of materials, dependence on a relatively scarce substance (the high-quality Cumberland graphite) led to the careful experiments of Nicholas-Jacques Conté in the late 18th century that gave us the modern baked graphite-clay pencil "lead." Indeed, Petroski makes clear that the technical refinement of pencils was usually dependent on the ability to manipulate and improve materials. The actual design of the device, after all, changed only slightly through the centuries, being shaped as much by popular perceptions and commercial campaigns as by technical considerations.

The cultural expectations that molded these perceptions and the economic and social considerations that influenced business enterprise are every bit as much part of Petroski's story as the technical history. The rise of the once-dominant German pencil industry, for example, may be seen as a case study in the circumstances that allowed German industry in general to play such a disproportionate role on the world stage in the late 19th century. Similarly, the precociousness of American efforts to mechanize pencil making fits neatly into more general images of what made 19th century American industry so distinctive. Indeed, the story told here of entrepreneurs, inventors, family networks (just keeping straight the list of various pencil-making Fabers, from Anton to Wilhelm, is no small task), and bureaucratic intrusions is as fine a case study as one will find of the key historical elements that have shaped modern material life.

As such, *The Pencil* is an admirable addition to an honorable and useful literature. In another context, perhaps, this extended treatment of an artifact and its historical development would be called "antiquarianism," and its audience would be an appreciative, but small, group of collectors, like-minded scholars, and students of the minutiae of material culture. Petroski's book, however, has been packaged and promoted as something else—a popular exposition of the character and dynamics of modern technology. "The story of a single object told in depth," Petroski claims, "can reveal more about the whole of technology and its practitioners than a sweeping survey of all the triumphant works of civil, mechanical, electrical, and every other kind of engineering." To make sure that his readers do not miss the point, Petroski interrupts his narrative with some frequency to say that such-and-such a problem in pencil-making is just like that encountered by bridge builders. The implication here, curiously enough, is that




"An engineering scientist's idealization of a pencil point and the forces exerted upon it during use." [Drawing by Fred Avent; from *The Pencil*]

the significance of the story would be clear if the subject were bridges, but since it's pencils we need these reminders that we are not simply learning trivia.

Therein lies the paradox of *The Pencil*. On the one hand, Petroski has sought to rescue a tool whose very ubiquity and ordinariness make it almost invisible in the technological landscape. On the other, he will not let us accept the story of the pencil on its own terms. Perhaps even he cannot believe that such a small and simple thing can justify an entire book. His doubts are infectious, and though his readers will look at their pencils differently, they may not be quite certain it was worth the effort.

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# Policy Shortfalls

**The Environmental Protection Agency**. Asking the Wrong Questions. MARC K. LANDY, MARC J. ROBERTS, and STEPHEN R. THOMAS. Oxford University Press, New York, 1990. xvi, 309 pp. $29.95.

Twenty years after its creation, the Environmental Protection Agency (EPA), the protagonist of this book, stands on the verge of being elevated to a cabinet department. It is an opportune moment to take stock of the agency's achievements and failures. The environmental problems of the next two decades promise to test our scientific and political ingenuity even more than those we have experienced to date. What lessons from the past should the nation's environmental policy-makers bear in mind as they struggle to fashion solutions for the future?

The historical record compiled by the authors, all highly respected policy analysts, does not look encouraging. It is a story of missed opportunities to illuminate complexity, to designate reasonable priorities, to rise above self-interest, and to educate citizens about the costs, risks, and benefits of alternative approaches to environmental protection. These themes are elaborated in a sequence of five case studies covering some of EPA's most controversial regulatory undertakings: revising the air quality standard for ozone, writing the Resource Conservation and Recovery Act (RCRA) regulations, passing Superfund, forging a "cancer policy," and enforcing the Clean Air Act against the steel industry. Upon this "small canvas" framed by one agency's experiences, the authors set out to paint a most ambitious picture, not merely of failures in U.S. environmental policy, but of much that ails government in America today.

One of the book's most impressive features is the extraordinarily detailed rendition of the five cases. The authors have spoken personally, often obviously at length, with most of the principal actors who dealt with environmental policy in the Carter and Reagan years. Though EPA administrators figure most prominently in their account, a multitude of congressmen, staffers, industry representatives, and environmental advocates also play important parts in these briskly written stories. One has the sense of real battles fought out among real people. It is a flesh-and-blood world, where human stakes and motivations matter.

All this is perfectly consistent with pluralist politics as we know it, but the book presents a spirited argument against pluralism as a way of governing, at least in the context of environmental policy. The pluralist preference for "muddling through" is denounced as a front for rampant self-seeking, a mode of problem-solving that downgrades values, advances parochial agendas, and ignores the substantive merits of different possible outcomes. The authors are committed instead to an altogether more active and idealistic model of government, one that promotes civic education, responds strategically to public needs, and is attentive to the technical feasibility and effectiveness of proposed policies.

That EPA fails to measure up to these high expectations is hardly surprising, though some may find the extent of the shortfall remarkable. Beset by internal squabbles and obsessed with short-term concerns, the authors argue, EPA repeatedly overlooked possibilities for developing deliberative and integrative policies. Oversimplification substituted for analysis in virtually all of the cases—for example, when EPA chose to treat ambiguous and ill-defined concepts like "safety," "carcinogenicity," or "most sensitive populations" as if they were amenable to purely scientific resolution. The result was a focus on the wrong questions, so that policy inevitably was directed toward unachievable or indefensible ends.

How could the agency have done better? As the subtitle implies, the authors are particularly concerned about actions and attitudes that hindered the formulation of productive questions. The case studies identify numerous moments when individual decision-makers could have acted differently in order to promote deliberation over ideology and civic virtue over narrow programmatic interests. These examples give the book a strongly prescriptive flavor, for the authors do not hesitate to dole out praise and blame. We learn, for instance, that David Hawkins and William Drayton, two forceful Carter appointees, might have agreed earlier on a cost-effective "bubble policy" if they had not imported into the bubble debate their contrary views of how much cleanup should be required of the beleaguered steel industry. Anne Gorsuch, Reagan's first EPA administrator, could and should have done more to protect EPA's internal bureaucracy and to placate the agency's external constituencies. By contrast, her successors William Ruckelshaus and Lee Thomas win commendation for their efforts to strengthen EPA's risk-analysis capabilities and to educate the public about uncertainty.

Though it is easy to admire, and for the most part to agree with, the authors' normative instincts, a difficulty arises when one asks how EPA or any federal agency might begin to live up to the standards set in this book. The problem that confronts us, after all, is not merely "what are the right questions about environmental protection?" but "how can we get policy-makers, in a sustained way, to ask and answer better questions?" Yet it is the first part of the problem that dominates the book; the second, more structural issue is raised only in the final five pages, where it gets predictably short shrift.

There are two reasons for this imbalance. First, the case study approach almost by definition emphasizes the individual and particularistic features of a situation, making it difficult to draw systemic conclusions. Indeed, one of the paradoxes of the book is that it purports to speak of EPA as a single actor while brilliantly demonstrating that "EPA" is at best a notional entity, a cluster of conflicting mandates, programs, and personalities that cannot easily be united under a common purpose. The uniformly negative cast of the five cases also hinders generalization. One or two equally compelling success stories would have helped establish that it is possible, without revolutionary transformations, to induce individual decision-makers or whole programs to behave in ways that the authors value.

It is all too easy, finally, to pillory a regulatory agency for failing to take the long view and succumbing to immediate political pressure. In rightly stressing the virtues of critical thinking and policy integration, academic policy analysts should not lose sight of the government's need to act. The Iranian hostage crisis was a recent and powerful reminder that stasis born of too much delib-