

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APRIL 1994

\$3.75



ALSO IN THIS ISSUE:

- ◆ GENES TO THE RESCUE ◆ TEAM INNOVATION ◆ SMART KIDS, DUMB SCHOOLS ◆
- ◆ SPRECHEN MIT DEUTCH: AN INTERVIEW AT THE PENTAGON ◆

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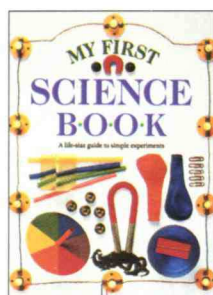
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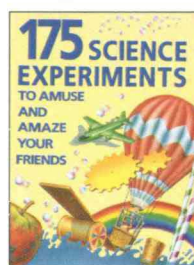


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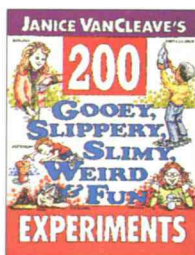
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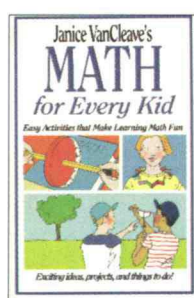


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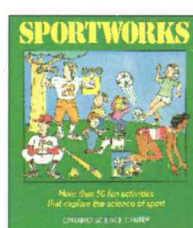


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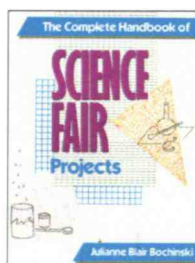


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by Julianne Blair Bochinski

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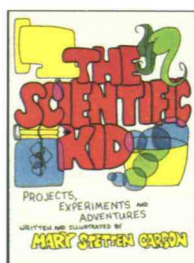


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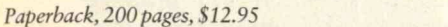
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Edited by Roger E. Axtell

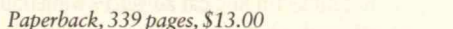
This fascinating guide helps thousands of high-powered executives and tourists avoid the missteps and misunderstandings that plague the world traveler. It includes facts and tips on protocol, custom, etiquette, hand gestures, body language, idioms, and gift-giving.



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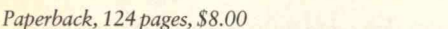
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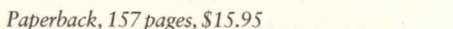
This book of games, exercises, and mental fitness tests is for you if you need to think smarter. Mensa Think-Smart is filled with tips, tricks, and useful rules on smart thinking.



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Edited by Michael Stueben INTELLIGENCE

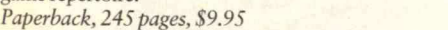
Over 100 brain teasers, board games, riddles, puzzles, and games involving memory, logic, words, and numbers. *Intelligence Games* is as informative as it is fun, and will test your judgement and creativity to compete in the power game.



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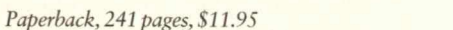
If rules are made to be broken, then dust off those old games lying dormant in your closet, because your game playing just got a lot more exciting! This book is a complete guide to hundreds of new twists and variations guaranteed to expand and enliven your game repertoire.



Codes, Puzzles, and Conspiracy

by Dennis Shasha A New Mathematical Thriller from Dr. Fern

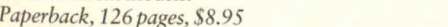
The second in the bestselling series of mathematical thrillers featuring the brilliant and eccentric Dr. Jacob Ecco. In this fast-paced book, readers are invited to solve a series of fascinating puzzles, and compete for the grand prize—a pair of roundtrip tickets to London.



The Ultimate Paper Airplane

by Richard Kline **THE ULTIMATE**

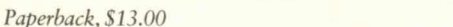
More than just a toy, the Kline-Fogleman airfoil earned its inventors two patents and was tested by NASA. Here is the story of its creation, along with the secrets behind its unmatched performance. Plus, instructions and patterns for making seven different models.



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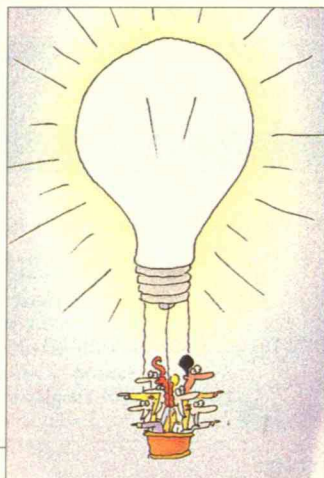
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Routine treatments are at least a decade away, but numerous clinical trials are now being conducted to develop safe, effective, and affordable gene-therapy techniques for combating diseases such as cystic fibrosis, sickle-cell anemia, and even cancer.

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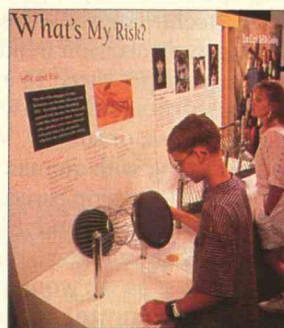


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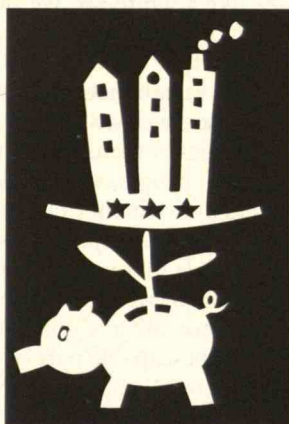
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Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October, and November/December) by the Association of Alumni and Alumnae of the Massachusetts Institute of Technology. Entire contents © 1994. The editors seek diverse views, and authors' opinions do not represent the official policies of their institutions or those of MIT. We welcome letters to the editor. Please address them to Letters Editor.

Editorial, circulation, and advertising offices: *Technology Review*, Building W59, MIT, Cambridge, MA 02139, (617) 253-8250; FAX (617) 258-7264. Printed by Lane Press, S. Burlington, VT. Second-class postage paid at Boston, MA and additional mailing offices. Postmaster: send address changes to *Technology Review*, MIT, Building W59, Cambridge, MA 02139.

Subscriptions: \$30 per year. Canada add \$6, other foreign countries add \$12. Contact *Technology Review*, P.O. Box 489, Mount Morris, IL 61054, (800) 877-5230 or (815) 734-1116; FAX (815) 734-1127.

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Printed in U.S.A.



First Line

Respecting the Instrument

I recently visited the Holocaust Memorial Museum in Washington, D.C., and during the same week saw the Steven Spielberg film *Schindler's List*. The combination was quite a dose of what must surely be the most nefarious chapter in human history, and few observers can fail to be moved by the monumental suffering and destruction thus depicted, or neglect to silently resolve "never again."

This gruesome twosome had another chilling effect on me: a reinforced understanding that the Nazi death machine did not arise simply or suddenly from ignorance, perversity, or lapses in moral judgment, though all three clearly contributed. Rather, the Holocaust resulted from logical, precise, prolonged, and comprehensive policy—a tour de force of technocracy in which barbarous but dedicated administrators and staffs built a far-flung network that consistently delivered the goods.

One can surely find no better example of organizational "success" at meeting measurable goals. And it's the ultimate demonstration that technology, which includes not just applied science but a systematic way of thinking and managing, can serve good and evil equally well.

Though nothing can match the Holocaust in degree, institutionalized cruelty and the misdirected application of powerful techniques have a long history that is not limited to outright genocidal acts. More familiar to science and technology practitioners, who usually strive to do good, are some subtler sins. The risks and side effects of bold innovations, or of experiments on human "guinea pigs," have frequently met with official inattention or indifference.

Consider, for example, the 40-year-long and federally administered Tuskegee Project in which uneducated sharecroppers in Alabama were intentionally left untreated for syphilis, or the cancerous fate of numerous "downwinders" in Nevada and Utah resulting

from nuclear testing, or the large-scale sacrifice of human laborers to build the megaprojects of the Soviet Union.

And as we know from recent extensive media coverage, human subjects were methodically dosed with radiation—without their awareness or consent—in experiments sponsored by the U.S. government from the 1940s to the 1970s and conducted by scientists from some of the country's leading research institutions. Most scientists justified such work as ultimately providing benefits to

*Decent engineering
requires an appreciation of
"carbon-based units."*

society, though not all bought the argument. One biologist at the Atomic Energy Commission in 1950, invoking the memory of heinous medical experiments at Nazi concentration camps, wrote that the studies might have "a little of the Buchenwald touch."

What would allow normally compassionate individuals to put their humanity on hold? There are no definitive answers, but in a seeming shift from the profound to the mundane, I can offer a few simple but valuable insights from, of all places, the movies: maybe the people behind the "Buchenwald touch" thought that their subjects were *not* people, or were at least of sufficiently low status that they slipped below the line.

Why, for example, is Henry F. Potter, the town potentate in *It's a Wonderful Life*, so indifferent to the welfare of his fellow citizens? People are not human beings to him, asserts good-guy rival George Bailey, "they're cattle." Thus to herd 'em up and move 'em out is not such a moral dilemma.

But cattle are still flesh and blood; we can dehumanize even further. In *Star Trek: The Motion Picture*, a robotic being from another world classifies people, and all other earthly creatures, as machines—no different except for their

particular chemistry and construction. Humans are unsentimentally viewed as mere "carbon-based units" whose testing, production, and repair, as well as disposal when their functional days are over, involve no more thought on the part of the user than upgrading a computer or junking a worn-out vehicle.

In real life, the treatment of people as livestock or machine equivalents is unfortunately not such a fantasy. The commoditizing mentality is especially applied to those who are disadvantaged, below some threshold or average, or simply deemed unworthy or undesirable by those in charge (who are presumably the real people). This is not only morally reprehensible, it's lousy engineering.

Good "technologists"—broadly defined to include decision makers of virtually every stripe—need to appreciate the characteristics of their raw material, product, process, or subject. Whether a person is dealing with animate or inanimate "units," long-term success requires that he or she recognize and respect, even if just for selfish purposes, their actual properties. Just as we wouldn't treat a Ferrari like a minivan, an orange orchard like a field of wheat, or a chimpanzee like a white rat, we should not regard a human being—*any* human being—like Elsie the Cow or R2D2.

To build valuable technologies, institutions, and societies we have to recognize the properties of the underlying human element. All people, whether leaders or followers and whether clever or slow, possess emotions, hopes, ideas, and talents. All have unique contributions to make, and all merit respect. These built-in traits are not always convenient, but they're an inescapable part of the equation. Ignore them, and, to paraphrase our president, the dog just won't hunt—at least, not for long.

Albert Schweitzer advised "a reverence for all life," both as a moral principle and as a precondition for a civilized and productive world. Now there was not only a great humanitarian but a great technologist.

—STEVEN J. MARCUS

The Apple Report On PowerPC

NUMBER 2 – RISC PERFORMANCE AND CROSS-PLATFORM COMPATIBILITY

Many of the most popular applications have been or are being optimized to take advantage of the high-performance PowerPC processor.

PowerPC chips are faster and less expensive than Pentium chips – so are the personal computers they will run.

A complete Macintosh system with PowerPC will cost well under \$2,500, but will offer better performance than higher-priced Pentium-based systems.

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For more information about Macintosh with PowerPC, call 1-800-732-3131, ext. 150, in the U.S. We'll send you a copy of our informative, free booklet, *PowerPC Technology: The Power Behind the Next Generation of Macintosh Systems*. In Canada, call 1-800-665-2775, ext. 910.

In the first half of 1994, Apple will introduce a new family of computers that already has the entire computer industry standing on end.

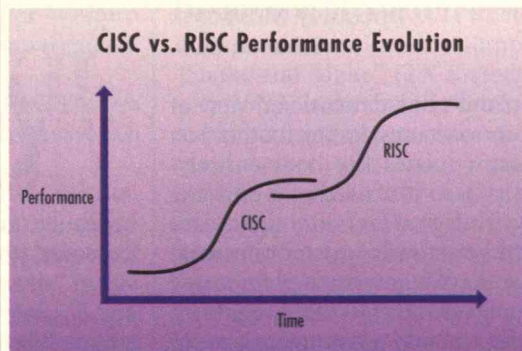
They will offer better performance than computers based on the X86 microprocessors. They will be extremely competitive on a price basis. And they will be compatible with Windows and DOS applications, by using SoftWindows software.

They will be based on the revolutionary new PowerPC™ microprocessor, created jointly by Apple, IBM and Motorola.

For the first time, desktop personal computers will take advantage of RISC chip architecture previously found only in high-performance workstations. This advance will make possible quantum improvements in the way we manage and work with information.

RISC vs. CISC.

Tremendous advances have been made in CISC architecture over the years. However, the physical limitations of the new, high-performance CISC design mean that CISC chips must be significantly bigger and more complex, and must run at hotter temperatures to perform the same tasks as comparable RISC chips. Consequently, the newer generation of CISC chips, like the Pentium, are much more expensive to manufacture. Which means that personal computers powered by PowerPC chips can offer a significant advantage in price as well as in performance.



As you can see on the chart, RISC microprocessors offer dramatically greater potential for growth, leading us well into the next century and increasing the practicality of features like voice recognition, videoconferencing, object-oriented software and multimedia capabilities – functions that will be integral to doing business in the 21st century.

More compatible personal computers.

Apple's new generation of Macintosh® personal computers built around the PowerPC chip offer the ability to run MS-DOS and Windows applications, as well as Macintosh software. Moving from one environment to the next will be seamless and, even more importantly, it will be effortless.



PC users who move to Macintosh with PowerPC will gain access to the large number of new applications which take advantage of the incredible performance of the new PowerPC chip.

Higher-performance optimized applications.

When PowerPC microprocessor-equipped Macintosh computers begin shipping, software developers including Microsoft, WordPerfect, Adobe, Aldus and Claris will begin shipping new versions of their most popular software, specifically rewritten to take full advantage of the new processor's capabilities.

These optimized, sometimes called "native," applications will offer significantly faster performance than their MS-DOS, Windows or current Macintosh counterparts.

Unprecedented value.

Because RISC-based personal computers cost less to manufacture than equivalent systems based on CISC chips, we will be able to make this technology available for well under \$2,500 for a complete mainstream desktop system.* Competitive with a lower-performance, Pentium-based PC.** Watch for Apple Report #3, coming soon.



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Letters

INVESTING IN SPACE

In "What Price, Columbus?" (*TR November/December 1993*), Alex Roland entirely overlooks the effects of five centuries of investment in technological and economic progress when he maintains that space programs cost a much higher proportion of GDP today than Columbus's explorations did in his time.

Compared with fifteenth-century Spain, twentieth-century America has a much larger percentage of income available to spend on such items as travel, entertainment, health care, education, and, yes, research and exploration. To see how absurd the Columbus analogy is, simply extend it to any other part of our economy. For example, Roland surely would not advocate cutting health-care expenditures, as a percentage of national income, back to fifteenth-century levels.

Roland also incorrectly asserts that we are "hocking not the crown jewels but our future" to fund the space program. Any first-year business student knows that debt is, in itself, neither good nor bad; it is the use to which debt is put that determines the wisdom of incurring it. America is not mortgaging its future with its paltry expenditures on research and exploration—it is doing so with its spiraling spending on consumption programs.

I can't help wondering whether the departments of Agriculture, Energy, and Transportation would stand up to the kind of cost-benefit analysis Roland recommends for the space program.

DOUGLAS J. McMAHON
Belmont, Calif.

Alex Roland's one-dimensional view of our efforts to secure a lasting foothold on the cosmos misses the boat entirely. Humanity is in dire need of a unifying and inspiring goal far more significant than the pyramids or monumental works of old. We have an unprecedented opportunity to move forward, out from the cradle, to build a lasting presence in space. We must pool the best minds from

the world's developed and developing countries alike, for such an effort combining our many complementary talents and resources.

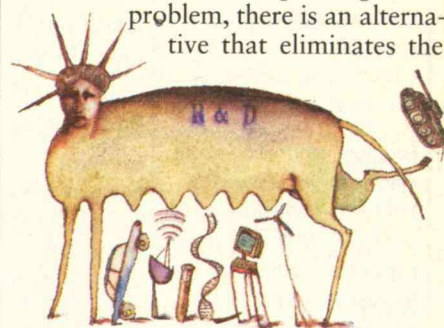
The overriding objective should simply be to develop space settlements in a logically progressive manner, building the new space infrastructure brick by brick, year by year, while not damaging the very economies on which we rely. If 0.7 percent over the lifetime of a space program is deemed too costly at this juncture, pare it back to 0.5 percent or 0.4 percent of our annual budget. To the ultimate benefit of earthly inhabitants, we may find that this exploration also provides us with clean space-based energy sources with a sizable economic and environmental payback.

GEORGE NEWMAN
Boston, Mass.

GET GOVERNMENT OUT OF R&D

In "Nurturing Winners with Federal R&D" (*TR November/December 1993*), Don E. Kash and Robert W. Rycroft charge that R&D spending by U.S. industry is inadequate and misallocated—for example, too little is directed at improving industrial processes. They therefore propose massive federal funding of "commercially oriented R&D" through a "politically insulated corporation," using money diverted from defense, space, and energy budgets.

However, if R&D spending is the problem, there is an alternative that eliminates the



bureaucratic blunders, administrative expenses, policy waffling, and congressional "oversight" inherent in the Kash and Rycroft proposal: give R&D funds attained through business taxes back to the private-sector firms that earned

them, accompanied by a warning that taxes will be reinstated if firms do not spend the money on improving manufacturing processes.

Inevitably government meddling in business is counterproductive for businesses and consumers; the only "winners" are gratuitously empowered bureaucrats. As the authors put it, in characterizing R&D funds now spent by federal defense, space, and energy agencies: "Vast sums are often justified as producing commercial benefits but rarely do." Would implementing the authors' proposal yield better results? Isn't "federally established, politically insulated corporation" a contradiction in terms?

DAVID A. NELSON
Kirkland, Wash.

EXPANDED CONTEXTS FOR ENGINEERING

In "Palchinsky's Travels: A Russian Engineer's Adventures Among Gigantic Projects and Small Minds" (*TR November/December 1993*), Loren R. Graham writes: "While American engineers and their followers in other countries praised Taylorism and Fordism for their ability to boost efficiency, Palchinsky asked what effects these methods might have on workers."

The author could have quoted from V.I. Lenin himself, who in April 1918 wrote, "In Russia, studies of the Taylor System and how to teach it must be organized, [while] systematically testing and adapting the system." Apparently, Soviet managers, after listening to their master's voice, were even more single-minded than U.S. and other Western Taylorers in forcing workers to give it their all.

ULF EDSTAM
Lerum, Sweden

As Loren Graham writes, P.A. Palchinsky railed against the narrow education of Soviet engineering students because it allowed them to ignore the broad human context of their work. Hence gigantic projects were undertaken that often had little economic justification

and high environmental and human costs.

Engineering education in the United States has certainly not become as narrow as that in the former Soviet Union. On the other hand, there was a clear trend in the United States, following World War II, to emphasize mathematics and science and implicitly deemphasize the context—issues such as those relating to engineering-projects management, manufacturing processes, and environmental effects—in which engineering takes place. Clearly some of these contextual issues, such as manufacturing and design, are being addressed once again. Graham's article points out the need for paying even greater attention to them.

One issue facing engineering education is time. There is not enough time to address both the technical and contextual issues in a four-year program. This is one reason for developing Five-Year First-Professionals Degree Programs, as is currently being done in MIT's School of Engineering. Engineering schools will also need to pay greater attention to the educational needs of their graduates throughout their careers. Contextual issues become increasingly important as one moves up the career ladder. This will call for Second-Professional-Degree Programs for engineers in their late twenties and early thirties, which we are currently discussing with our colleagues in the Sloan School.

JOEL MOSES
Dean, School of Engineering
MIT

DESIGN FOR MANUFACTURING

A basic unquestioned assumption in "Shake and Make" (*TR Reporter, January 1994*) is that small parts used in a manufacturing process have to be oriented before they can be assembled because they inevitably arrive in bulk. This assumption reflects the traditional factory concept in which each department, and sometimes each operation, is an independent cost center trying to minimize its own costs without considering the consequences to other departments.

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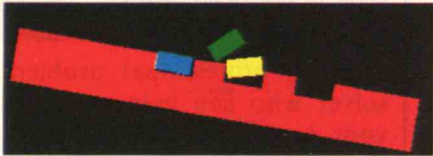
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Parts dumped into a bin not only become hard to assemble but also bulk handling can damage them and lead to product failures. Manufacturers should look for procedures in which such reorientation is not necessary, reducing product costs in the process.



Using the term "design for manufacturing" to describe parts designed for "shake-and-make" assembly seems oxymoronic. The point is to design for the entire manufacturing process—not for isolated steps within it!

LEO HERZENBERG
Chicago, Ill.

TIMELY ORGAN DONATION

In "Toward Remedying the Organ Shortage" (*TR January 1994*), Susan Reed insightfully concludes that the solution to the organ donor shortage is "likely to be a cocktail rather than a magic bullet."

There is no question that as the transplant waiting list grows and the donor pool shrinks because of increases in the incidence of HIV and hepatitis C and a decrease in motor vehicle fatalities, technologies such as animal-organ transplantation and organ bioengineering become more important. But while we must continue to invest in new technologies for the future, the 33,000 Americans awaiting transplants need an effective solution now.

Our experience shows that organ donation can nearly double if hospitals identify all potential donors, ask their families about donation, and request donation after the family members have

understood and acknowledged that their loved one is dead. It's also important that a hospital caregiver and coordinator together offer donation in clear, sensitive language. Today, unfortunately, hospitals follow this process in only a fraction of potential donor cases.

MICHAEL J. EVANISKO
President, Partnership for Organ Donation
Boston, Mass

CORRECTION

"Scientific Flying on the Cheap" (*TR November/December 1993*) erroneously identifies the ER-2 and the Condor as the same aircraft. The Department of Defense put the Condor, a high-altitude pilotless aircraft, in storage late in 1992 after its funding was cut. The Condor was not used for atmospheric research. The National Aeronautics and Space Administration currently uses two ER-2 aircraft for such studies as well as remote sensing.

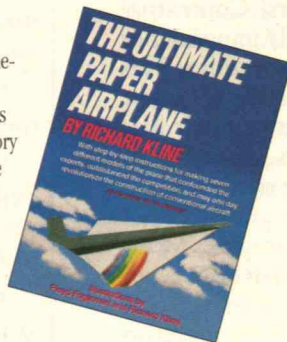
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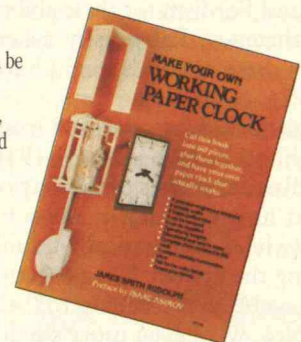


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