Hacking Is Pervasive

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These days, "hacking" and "hackers" are often viewed negatively. Many people associate these labels with somebody breaking into a computer system with malicious or criminal intent. However, hacking's older definitions are quite different: interacting with a computer or any other technology-infused system in a playful or exploratory way,[1] or modifying an existing system (hardware, mechanical, or software) to improve performance or create an application that differs from the device's original purpose. These definitions are much broader, significantly more positive, and even (in many circles) laudatory.

Some associate hacking with (usually) harmless technical stunts or practical jokes (witness the dominant evolution of the term at MIT[2]).

However, the true hacker is an individual who can achieve miracles by appropriating, modifying, or "kludging" existing resources (devices, hardware, software, or anything within reach) to suit other purposes, often in an ingenious fashion. Gifted hackers can be thought of as transmutation or collage artists. They take everything from streamlined commercial products to bits of junk as their raw materials, leveraging the development and cost efficiencies of mass production as they modify established technology to serve their needs. Their work often juxtaposes unrelated modules in shotgun marriages, transforming off-the-shelf "lead" into technological "gold."

In this special issue, we turn our attention to this positive connotation of the hacker from the perspective of pervasive computing.

The drive to invent

Hacking becomes especially important in nascent fields that draw upon other established

practices or areas of inquiry. In these cases, plenty of devices and software applications exist that relate to needs in the newer field, but nothing really fits well. This creates a need to customize—or hack. In many ways, pervasive computing fits this category, drawing inspiration, practitioners, and practices from HCI, distributed computing, wearable computing, sensor networks, and other fields—creating a fertile environment for hacking.

communication technologies: the electronic television.

A source of inspiration

Hacking is also a cultural phenomenon that inspired many of us to become engineers. The generations coming of age in the '70s and '80s learned from pioneering electronic-project authors including Don Lancaster, Forrest Mims, Walt Jung, and Steve Ciarcia. They also learned from electronic cookbooks

series they're developing centered on invention-under-pressure.

Hackers growing up in the 1950s through the mid-60s often learned their craft through building and modifying ham radios. Young hackers in the late-60s through mid-80s tended to get their engineering chops through designing, building, and modifying electronic music synthesizers and audio gear (indeed, two of us—Zimmerman and Paradiso—went this route). Musical instruments still attract some of today's most creative hackers. You can see their inventions at venues ranging from circuit-bending mashups to formal conferences such as New Interfaces for Musical Performance (www.nime.org). These events prominently feature concerts and demos that exhibit innovative new instruments, often made from repurposed appliances or toys. In "A Solder's Tale: Putting the 'Lead' Back in 'Lead Users,'" one of the key players in this area, Nicolas Collins, gives us his personal perspective on this phenomenon. Researchers in musical interfaces often have a close association with pervasive computing, especially sharing a common interest in user I/O interface issues.

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Hacking also becomes important when external pressures limit resources and shorten schedules. There might be insufficient time or budget to design a finished solution or develop a new system from the ground up. This route is seen in diverse scenarios ranging from engineers and astronauts improvising life support onboard Apollo 13[3] to high-energy physicists making last-minute fixes to their accelerators and detectors.[4] We often deal with these pressures in pervasive computing, as we rush to meet conference deadlines and complete demonstrations with limited facilities.

Hacking also serves inventors who build mockups and prototypes to flesh out ideas before they're developed enough to warrant formal production. In "Hacking in Industrial Research and Development," Tom Zimmerman offers useful advice and principles for prototype hacking as he explores two case studies that involve a tracking system for shopping carts and a paperless airline check-in system for elite fliers. This perspective is also seen in this issue's interview with Kent Farnsworth, son of Philo T. Farnsworth who, with his wife and brother-in-law, hacked together in their kitchen one of today's most pervasive and influential mass-

such as the famous Sams series, as well as hobby magazines such as *Popular Electronics*, *Radio and Electronics*, and *Byte* (now *Circuit Cellar*).

By the early '90s, hardware hacking became more difficult, owing to robotic-assembled consumer electronics with tiny components too small to be easily hand-hacked. Another hindrance was shrink-wrapped software running on closed, proprietary operating systems. However, the advent of the Web along with the rise of open source communities have brought a resurgence in hacking. A new generation of hackers is appearing, as evidenced in *Make Magazine* (filled with do-it-yourself projects) and Web sites such as Sparkfun (www.sparkfun.com). Formed by a group of students, Sparkfun offers tutorials and information and sells hacker-relevant electronic components and sensors, board-level modules, and prototyping tools. Other outlets for useful gear, techniques, and ideas are also appearing (see the sidebar).

Beyond the dedicated hacker, hacking today reaches far into popular culture through television shows ranging from robot battles to myth debunking. In "Engineered Reality: Prototyping Inventions for Television," Andrew G. (Zoz) Brooks and Joe Grand take you behind the scenes of the new TV

Game controllers also present a prime opportunity for hackers, most notably the Nintendo Wii, which is equipped with a 3D accelerometer, optical tracker, speaker, vibrator, and wireless data link. We're happy to present "Hacking the Nintendo Wii Remote," written by one of its best-known repurposers, Johnny Lee.

In "Hacking, Mashing, Gluing: Understanding Opportunistic Design," Björn Hartmann, Scott Doorley, and Scott R. Klemmer present a higher-level perspective by describing hacking in terms of "opportunistic practices." Such practices include copying and pasting code, reappropriating hardware, and shopping. Yes, shopping! Hackers are known to glean inspiration by thumbing through hardware catalogs or browsing racks of diverse equipment. Indeed, many university

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and corporate hackers lament the decline of in-house open stockrooms and local surplus stores for this reason. Recognizing the value of opportunistic shopping, professional design houses maintain curated displays and collections of "stuff" to inspire new ideas and solutions. In addition to outlining and classifying these practices, Hartmann, Doorley, and Klemmer sharpen their conjectures through interviews with hackers in disparate disciplines.

A new business model

Hacking isn't just for fun—it also represents (or perhaps requires) new approaches to doing business. We see commercial open source hardware appearing today, and building a successful business around such devices requires new thinking. In "Chumby: An Experiment in Hackable Pervasive Computing," Andrew "bunnie" Huang describes the development and business concepts behind Chumby, his new open source platform aimed at pervasive computing market opportunities.
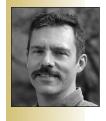
Finally, this issue's Spotlight department by Eric von Hippel and Joseph A. Paradiso considers the hacker as a "lead user" who reinvents and modifies products to better achieve his or her own needs. Indeed, this phenomenon seems central to human nature,

and studies of innovation indicate that the vast majority of corporate invention comes from such lead users rather than from formalized internal product development.

From practice to philosophy, the collection of articles in this issue works to paint a broad picture of traditional, benevolent, and playful "hacking" from a pervasive computing perspective. What we call hacking is pervasive throughout human history, from the first attempts to turn stones to knives and sticks to bows, to farmers who fix tractors with bailing wire and beer cans, and information workers who write Perl scripts on the weekend that can feed their fish and monitor their home. We have little doubt that hackers will carry the torch of innovation further, leading the way through elegant kludges and inspiring mashups as mankind moves through the age of ubiquitous computing and into the unforeseeable future. 🅿

REFERENCES

1. *The New Hacker's Dictionary*, E.S. Raymond, ed., MIT Press, 1996.

2. T.F. Peterson, *Nightwork: A History of Hacks and Pranks at MIT*, MIT Press, 2003.

3. A. Chaikin, *A Man on the Moon: The Voyages of the Apollo Astronauts*, Penguin Books, 1998.

4. A. Drain, "Masters of Improv," *Symmetry*, vol. 4, no. 3, 2007, pp. 8–13.

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