

The Future of Making

THE WAY THINGS ARE MADE
IS BEING REMADE



Technology Horizons Program
124 University Avenue, 2nd Floor
Palo Alto, CA 94301 > 650.854.6322 > www.iff.org

about the ...

TECHNOLOGY HORIZONS PROGRAM

The Technology Horizons Program combines a deep understanding of technology and societal forces to identify and evaluate discontinuities and innovations in the next three to ten years. We help organizations develop insights and strategic tools to better position themselves for the future. Our approach to technology forecasting is unique—we put humans in the middle of our forecasts. Understanding humans as consumers, workers, householders, and community members allows IFTF to help companies look beyond technical feasibility to identify the value in new technologies, forecast adoption and diffusion patterns, and discover new market opportunities and threats. For more information about the Technology Horizons Program, contact Sean Ness at sness@iftf.org, (650) 233-9517.

INSTITUTE FOR THE FUTURE

The Institute for the Future is an independent, nonprofit strategic research group with more than 40 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide our members with insights into business strategy, design process, innovation, and social dilemmas. Our research generates the foresight needed to create insights that lead to action. Our research spans a broad territory of deeply transformative trends, from health and health care to technology, the workplace, and human identity. The Institute for the Future is located in Palo Alto, California.

AUTHOR: David Pescovitz

EDITOR: Jess Hemerly

PEER REVIEWERS: Marina Gorbis, Alex Pang, Anthony Townsend

PRODUCTION EDITOR: Lisa Mumbach

DESIGNERS: Karin Lubeck, Yeshai Lang

Contents

Introduction	1
Drivers	2
Trends	3
Implications	16

Introduction

On May 3 and 4, 2008, more than 75,000 people from all over the country descended on a fairground in Silicon Valley to see a glimpse of the future through a lens on the present.

This was the annual Bay Area Maker Faire, a celebration of do-it-yourself culture where more than 500 “makers” showed off their robot pets, home-brewed 3D displays, biofuel-powered vehicles, and extreme crafts. Sponsored by *MAKE* and *CRAFT* magazines, the event is a science fair meets craft fair meets farmer’s market. Yet, Maker Faire is not just about seeing great DIY projects. It’s about breaking established modes of thinking and questioning traditional approaches to living, working, and organizing. In Institute for the Future (ITF) terms, Maker Faire is ripe with weak signals that point toward the way technology may be used, or made, over the next decade.

Two future forces, one mostly social, one mostly technological, are intersecting to transform how goods, services, and experiences—the “stuff” of our world—will be designed, manufactured, and distributed over the next decade. An emerging do-it-yourself (DIY) culture of makers, only a fraction of whom were at Maker Faire, are boldly voiding warranties to tweak, hack, and customize their world. Inspired by the spread of open-source ideals, they expect to be able to personalize the products they buy. And what they can’t purchase, they build from scratch. Their tools are screwdrivers and soldering irons, but also 3D printers and laser cutters. Advanced fabrication tools are falling in price, driving a shift in manufacturing from massive, centralized factories to flexible, lightweight, and ad hoc production. In the next decade, some products will likely be manufactured from raw materials right at home.

These social and technological shifts—toward a maker culture and lightweight manufacturing—sit atop a platform of grassroots economics, where individuals are more involved in the production and distribution of goods without the need for deep-pocketed middlemen. The ability to design, manufacture, and distribute goods, at scale, becomes possible for all sizes of business with minimal barriers to entry. The new grassroots market structures developing online also point to a shift from stores and gross sales to communities and connections. It turns out that do-it-yourself may be a misnomer for this decidedly social movement; do-it-ourselves is a more apt phrase. Individual makers are amplified by social technologies that connect ideas, designs, techniques, and, of course, people.

As the maker culture grows, it will likely spur organizational changes in corporations as well. Do-it-yourselfers demonstrate skill sets and principles of collaboration that may not be consistent with most corporate cultures and processes. Yet, DIY communities are pockets of raw ingenuity, places for organizations to seek out innovation, from new approaches to R&D to novel methods of manufacturing. Indeed, the forecast in this report points toward an unprecedented opportunity for companies to engage with their customers. Traditional manufacturers and maverick makers will participate in the same conversations, sometimes cooperating, sometimes competing, but frequently blurring the boundaries that separate them.

Introduction

Inspired by the hackers, crafters, artisans, and tinkerers who are living this forecast already, IFTF's Technology Horizons Program set out to reverse engineer the future of making. First, we identified the **DRIVERS**, the social and technological forces that push the forecast forward.

PLATFORMS FOR SOCIABILITY

Social networking services are most commonly used for dating, job hunting, and keeping up with former classmates. But they can also be thriving hubs for collaboration and problem solving. Platforms for sociability are necessary in order to bring together large groups of experts to come up with the best solutions. Yet some vetting of people, and problems, is essential. The wisdom of crowds is only as powerful as the crowd is wise.

ECO-MOTIVATION

The planned obsolescence of today's technology doesn't jibe with the increasingly green aspirations of many consumers. A new mantra is emerging: Reduce, Reuse, Remake. Dissatisfied with the disposability of many products, some consumers are learning to fix things themselves, use old parts for new applications, or, at the very least, provide unused technology to others who might remake it.

RISE OF THE PROFESSIONAL AMATEUR

Passionate hobbyists blur the line between amateur and professional. These aren't passive consumers but active creators whose results often surpass that of accredited experts and big businesses. Take Wikipedia, for example. Paid, credentialed experts have traditionally written encyclopedias. In contrast, professional amateurs who have direct knowledge of the topics they write about are Wikipedia's primary writers.

ACCESS TO TOOLS

Tools of design and production are following something akin to Moore's Law but for manufacturing. As the cost of tools decreases and their capabilities increase, the barrier to entry for makers comes crashing down. Consider computer-aided design (CAD) software, which used to be relegated to a market of architects and industrial designers. Now, however, Google SketchUp offers a simplified toolset that, as the free product's tagline states, provides "3D for everyone."

OPEN-SOURCE EVERYTHING

From P2P file sharing to open-source software, many people now have very different expectations about what should be free and open to customization. Their aim is to make technology work the way they want it to. Linux, an open-source operating system, powers a growing number of consumer devices, from the PlayStation 2 to Motorola mobile phones. Apache, the Web server software, is at the heart of nearly every commercial Web site yet it's an icon of open-source software. Clearly, manufacturers are beginning to embrace the open-source concept internally. The next step is to bring the same mindset to bear on their relationships with their customers.

QUEST FOR AUTHENTICITY

To compensate for the inordinate amount of time spent in virtual worlds, from IM conversations to *Second Life*, many people have developed a newfound appreciation for physical, hands-on experiences. For example, the United States has seen a trending down in the average age of farmers. A new documentary film, *The Greenhorns*, explores this growing culture of young farmers driven by eco-motivation and the quest for authenticity. They're getting their hands dirty. For them, reality is still where the action is.

When these present-day drivers—technological, social, economic, and cultural—intersect and feed off one another, transformational trends emerge. In our research, we uncovered **SIX TRENDS** that will re-shape how we design, produce, and distribute things:

PERSONAL DESIGN AND FABRICATION: FROM THE MACHINE SHOP TO THE DESKTOP

Fab labs, where nearly anything can be manufactured quickly and inexpensively, might take the *Star Trek* replicator out of the realm of science fiction.

LIGHTWEIGHT MANUFACTURING: FROM CENTRALIZED PRODUCTION TO AD HOC FACTORIES

Rapid manufacturing technologies, personal fabrication, and the networking of supply chains into flexible “supply webs” will lead to fast, customized, and often greener microniche production.

CITIZEN R&D: FROM R&D LABS TO R&D COMMUNITIES

Research and development is moving outside the traditional laboratory and into communities and networks where ideation, iteration, and cash rewards fuel progress.

NETWORKED ARTISANS: FROM GARAGE INVENTORS TO MAKER MEET-UPS

Innovation is sparked by human interaction and the crosspollination of ideas. New networking technology and social media keep the conversations and collaborations thriving both online and off.

GRASSROOTS ECONOMICS: FROM PRODUCTS TO STORIES

Scale is built from the bottom up through open-source practices, peer-to-peer exchanges, new models for valuation, and a commons-based approach to commercialism.

“IF YOU CAN’T OPEN IT, YOU DON’T OWN IT”: FROM CLOSED IP TO OPEN INNOVATION

Openness isn’t about giving away the farm but rather connecting with your consumers. In the near future, open IP and innovation, especially in hardware, may be the best way to do business and build relationships with customers.

This forecast is supported with signals, present day examples that are like signposts pointing toward the evolution of larger trends: computer-controlled milling machines now available at Sears, for example, or the thriving maker community at Instructables.com openly sharing their project plans. Finally, the report closes with implications for your organizations. Consider these to be guiding principles informed by the forecast, from “fail early and often” to “reward solution seekers.”

This forecast is also illustrated on the accompanying map. Think of it as an at-a-glance view of the future of making. The map was distributed publicly at the Bay Area Maker Faire 2008 under a Creative Commons license that enables anyone to “remix” the material and create new works from it for non-commercial purposes. We chose to use the Creative Commons license because it embodies the open-source mindset that’s so integral to the future of making.



PERSONAL DESIGN AND FABRICATION:

From the machine shop to the desktop

Trend 1

DRIVERS: Access to Tools + Open-Source Everything

While the price of tools drops, the tools' power and precision are increasing. From Google's SketchUp simplified CAD software to sewing machines that connect to your laptop, it's become much easier for an individual to make whatever he or she imagines. Those capabilities will continue to increase, reminding us of the days when every garage had a workbench and sewing rooms were common in large homes. Only this time, the amount of stuff that can be homebrewed will increase exponentially.

Imagine that you're about to host a margarita party and your blender breaks just before the guests arrive. Instead of rushing to a store, you go online, click the model you want, hit "print," and a machine on your desk kicks into operation and prints out the components of the blender. Snap them together and it's tequila time!

Several technological developments are converging that may pull the replicator out of *Star Trek* and put it in our homes, or at least into a Kinko's-like fab lab down the block. The idea is similar to desktop publishing, but for products instead of paper.

Product designers have been printing out objects for more than a decade. Load a digital design into a machine and it drips out thin beads of plastic and glue, building up layers until the object is complete. While these 3D printers improve in quality and drop in price, researchers are making headway on printable electronics—circuits designed to be spat out of modified inkjet printers or cranked out in rolls like a newspaper.

The next step is to print mechanical structures that can interface with the electronics, like motors or buttons. John Canny and his University of California, Berkeley colleagues propose filling inkjet cartridges with electroactive polymers, plastics that contract with an electric charge or generate voltage when flexed. What is the first thing one might build with a desktop factory? How about a copy of itself?

The goal of University of Bath engineer Adrian Bowyer's RepRap (replicating rapid prototype) project is to build a "universal constructor" that not only manufactures objects, but actually make copies of itself. Bowyer released all the blueprints and software code online to accelerate progress by tapping into the collective intelligence of the open-source community. Further along in development is the Fab@Home project, a collective effort to create a "low cost, hackable rapid prototyper kit."

Now, having access to the tools of design and fabrication doesn't instantly make someone a good designer or fine craftsman. In fact, there may be a consumer shift from paying for products to paying for plans. Well-known brands could sell new designs that would be manufactured at home or nearby fab labs. Creative types would use advanced versions of software like Google SketchUp to render their own product ideas. An open market for user-generated designs and personalized versions of commercial products will likely emerge online, culminating in the personal design and fabrication revolution, where products will be available for sharing like so much online media.

Better desktop tools for design and fabrication are making it so that access to a complex shop full of tools and machines or a formal vocational education is no longer a prerequisite to making cool things.

SIGNALS:



DESKTOP FACTORY WWW.DESKTOPFACTORY.COM

Desktop Factory's rapid prototyping printer builds functional models one layer at a time from standard 3D digital files. At \$5000, it's less than one-third of the cost of almost all other 3D printers currently on the market. The goal of the company is to "make low-cost high-performance three-dimensional printing pervasive in businesses, schools, and homes."



OPEN-SOURCE BIOLOGY WWW.OPENWETWARE.ORG

The next revolution in manufacturing may be biological. In the emerging field of synthetic biology, genes, proteins, and cells are snapped together like Tinkertoys to build living systems that don't exist in nature. Already, bacteria have been engineered to biologically manufacture precursors for some expensive pharmaceuticals. Biofuels are next. Eventually, these organisms, developed under the tenets of open-source science, might be the basis of a distributed manufacturing infrastructure producing raw materials in beakers and vats.



CRAFTSMAN COMPUCARVE WWW.SEARS.COM

A home CNC (computer numerical control) milling machine, the Sears Craftsman Compucarve retails for less than \$2000. According to the marketing materials, "It allows a novice to make a complete project without a shop full of tools." The machine comes with an expandable library of digital designs that "allow you to achieve professional results regardless of space, time, budget or skill."



CLAYTRONICS WWW.CS.CMU.EDU/~CLAYTRONICS

A basic research project from Carnegie Mellon and Intel, Claytronics—if the technology can be developed—is nothing short of programmable matter. The "clay" in claytronics consists of mounds of tiny microprocessors, called "catoms," that can communicate and automatically self-assemble by way of electrostatic forces.



Trend 2

DRIVERS: Access to Tools + Eco-Motivation

Tomorrow's factory may look very different from the massive, rigid machines familiar to us since the advent of the Industrial Revolution. Flexible manufacturing technologies on the horizon will shift fabrication from massive and centralized to lightweight and ad hoc. Historically, building an assembly line to crank out a widget has required a huge capital investment, and the company has a lot riding on the success of that product. Inventory planning becomes a magical art: If supply of the product is greater than consumer demand, the company takes a direct hit. Supply shortages can also be devastating. At the same time, consumers are demanding more accountability from manufacturers. They want to know what materials went into their products and their sources, who manufactured the products, and the journey the products took from factory to corner store.

However, in the near future, rapid manufacturing technologies, personal fabrication, and the networking of supply chains into flexible "supply webs" will transform the way goods are made. These technological developments, combined with global job shops, enable fast, customized, and often greener production. Moreover, general-purpose manufacturing technologies and desktop factories could trigger the rise of microniche production. Diverse communities could forego many mass-produced goods for custom-produced items that meet their specific needs.

You might think of TechShop as a community manufacturing facility. Launched in Silicon Valley, TechShop is an open-access workshop stocked with the most advanced tools for design and fabrication. It's similar to a gym in that members pay monthly dues for round-the-clock access to 3D printers, sewing machines, laser cutters, milling machines, electronics design facilities, and an array of traditional workshop tools.

"We are makers assembling a community of makers," TechShop COO Mark Hatch, a former Kinko's executive, said at IFTF's 2008 Technology Horizons Spring Exchange.

While many TechShop members are weekend tinkerers learning robotics or sheet metal fabrication, quite a few are entrepreneurs prototyping a product. The manufacturing tools at TechShop enable them to make proof-of-concept devices without investing in any tools or shop space. But where does a small business go when it's time to scale up—not significantly, but a little bit at a time?

China, of course. But to do it right, you need a middleman like Liam Casey, dubbed "Mr. China" by *The Atlantic Monthly*. Casey is the founder of PCH International, a supply chain management company that navigates the intricacies of Shenzhen, China's "factory to the world" for a host of technology companies, from huge firms to small open-source operations. A nimble supply web and proximity to flexible job shops mean that PCH can take a product from a concept all the way to consumer delivery in just eight weeks, with minimal risk to the business owner.

"Everyone talks about Chinese manufacturing and how cheap that is," Case says. "What few realize is that by converting manufacturing and shipping to JIT [Just-In-Time] a company never has to store the items it is selling. By reducing the initial cash outlays, a smaller company can afford to make its own hardware and scale up rapidly."

As he sees it, the big story is that a disruptive supply chain, combined with disruptive manufacturing technology, leads to "disruptive commerce."

Unlike assembly lines and dedicated factories,
job shops enable fast, flexible, and
customized production.

SIGNALS:



PONOKO WWW.PONOKO.COM

Based in San Francisco, Ponoko is the ultimate short-run job shop. Anyone can submit 3D digital designs—e.g., furniture designs—that the company then manufactures on demand. Their Web platform also enables individuals to sell their plans and finished products with no upfront costs, no minimum orders, and no required inventory. “Consumers no longer have to accept what they find on the shelf,” says Ponoko co-founder Derek Elley. “Instead they can have something that’s designed and made especially for them, something ‘individualized’ from scratch.”



ALAMEDA COUNTY COMPUTER RESOURCE CENTER WWW.ACCRC.ORG

As manufacturing changes, so does de-manufacturing. The Alameda County Computer Resource Center (ACCRC) embodies the maker mantra of “Reduce, Reuse, Remake.” The nonprofit accepts anything that you can plug into a power outlet. If the equipment works or is repairable, they’ll refurbish it and find a charity, nonprofit, school, or disabled individual who wants it. If it’s dead, they disassemble it and send the base elements to green recyclers for processing. On Earth Day and other special occasions, makers from around the world are invited to scavenge the ACCRC warehouse for raw materials that are combined and remade into new things. At ACCRC, “obsolescence is just a lack of imagination.”



ADAFRUIT INDUSTRIES WWW.ADAFRUIT.COM

Ikea’s “some assembly required” furniture has taken off, so why not electronics? Adafruit Industries sells kits for open-source electronics hardware. Reminiscent of the original personal computers that were sold as kits, the Adafruit Industries kits range from an external iPod battery pack and recharger to TV-B-Gone, a prankster’s dream device that turns off any television within 150 feet. The company is a prime example of how a maker turns prototypes into products while maintaining an open-source approach to intellectual property.



CITIZEN R&D:
from R&D labs
to R&D
communities

Trend 3

DRIVERS: Platforms for Sociability + Rise of the Professional Amateur

In the last few years, social networking sites have become the quintessential services of the Web 2.0 world. Friend-of-a-friend networks like MySpace, Facebook, and LinkedIn are hotbeds for human-human interaction, connecting employers with potential employees, single people looking for each other, bands with their fans, and even politicians with their supporters. Meanwhile, passionate hobbyists and even retired experts in a variety of fields are blurring the line between professional and amateur. These professional amateurs are tackling problems, creating media, and producing goods that are often superior to those of accredited experts and big businesses.

When professional amateurs are augmented with platforms of sociability, the social networks that emerge online and off become thriving hubs for collaborative research and problem solving. Research and development moves outside the traditional laboratory to communities and networks where ideation, iteration, and cash rewards fuel progress. In these communities, one can seek the “wisdom of crowds”: the collective intelligence that is greater than the sum of its parts.

InnoCentive and Six Sigma are examples of marketplaces for high-quality collective intelligence. Online services exist where organizations can offer a bounty on problems in chemistry, engineering, design, math, computer science, physical science, and business. Cash rewards range from a few thousand to one million dollars in what InnoCentive calls a “global knowledge economy” of open innovation. To keep the crowd wise, both InnoCentive and the participating company vet problem solvers before providing them access to the competitions.

Jill Panetta, InnoCentive’s chief scientific officer, says this R&D community has cracked 30% of the problems posted on the site, “30% more than would have been solved using a traditional, in-house approach.”

Yet while InnoCentive and Six Sigma are about linking individual experts with problems, other R&D communities are specifically designed to leverage the collective intelligence of non-experts, or rather, those with more direct experience than formal expertise. At Patients-LikeMe, almost 10,000 people with diseases ranging from Parkinson’s to Multiple Sclerosis to AIDS congregate on the PatientsLikeMe forums, sharing personal narratives, medical experiences, and treatment advice.

The difference between this site and other online health forums is that experiential data drives PatientsLikeMe, which has been called by the *New York Times* “MySpace for the afflicted.” Community members share specifics about how long symptoms lasted, side effects of new medications, etc. The data is then presented in aggregate as charts and graphs for patient self-analysis. This approach points toward a shift in how research and development is done, away from a model where only accredited “experts” are welcome to provide and analyze data and hierarchies are established by the letters after your name or the number of scientific publications you have on your curriculum vitae.

Research and development is no longer relegated to a lab where only “experts” are welcome. Makers reach out to communities and networks to ideate, iterate, and solicit feedback.

SIGNALS:



PARTICIPATORY URBANISM WWW.URBAN-ATMOSPHERES.NET/PARTICIPATORYURBANISM

A project of Intel research scientist Eric Paulos, Participatory Urbanism represents a shift in the mobile device from communication tool to “networked mobile personal measurement instrument.” By outfitting traditional mobile phones with sensors for air quality, noise pollution, or other environmental factors, citizens are empowered to collect and share high-resolution data about their immediate environment in a new form of civic participation.



MY DAUGHTER'S DNA WWW.MYDAUGHTERSDNA.ORG

Dr. Hugh Rienhoff's young daughter has a genetic syndrome that physicians have been unable to diagnose. So he's taken matters into his own hands, analyzing his own daughter's genome and designing a treatment for her. Rienhoff launched My Daughter's DNA to share what he's found and encourage others to do the same. The primary purpose of the site, he says, is to “help the interested community of geneticists, patients, physicians, scientists, and family members” to understand rare and mysterious variations in our own genome.



GOOGLE LUNAR X PRIZE WWW.GOOGLELUNARXPRIZE.ORG

The mission? Be the first privately funded team to send a robot to the moon, travel 500 meters, and transmit data back to the Earth. The winner will be rewarded with \$20 million. The effort encourages communities of “entrepreneurs, engineers, and visionaries” to do what it once took an orchestra of government agencies, academia, and private sector companies to accomplish.



LEGO MINDSTORMS MINDSTORMS.LEGO.COM

LEGO's programmable robot construction kit is a quintessential example of “lead user innovation” driven by a passionate ad hoc R&D community. Weeks after LEGO launched Mindstorms, hackers reverse engineered the technology and developed new software and uses for the product. LEGO quickly encouraged these hackers and eventually consulted their community while developing their next-generation product, Mindstorms NXT.



**NETWORKED
ARTISANS:**
From garage
inventors to maker
meet-ups

Trend 4

DRIVERS: Platforms for Sociability + Quest for Authenticity

The two-guys-in-a-garage story of invention persists as an archetype of Silicon Valley mythology. It's a contemporary manifestation of the mad scientist holed up in solitude in his lab, awaiting a great flash of inspiration. But in reality, human interaction fuels innovation. This crosspollination of ideas will become easier as makers leverage platforms of sociability to connect with one another. The amount of time we spend online is driving a newfound appreciation for offline interaction, too. Real world meet-ups, shared workshops, and DIY festivals add a layer of authenticity to virtual communities that celebrate ingenuity among peers.

Dorkbot is a semi-monthly gathering where engineers, artists, and designers informally present their work, critique each other's efforts, share technical tips, and drink lots of beer. Dorkbot was founded several years ago in New York City by Douglas Repetto, a computer music instructor at Columbia University, who was searching for "artists, hackers, engineers, activists, and crackpots hacking away in the backroom on some obsession."

"I wanted to create an environment where lots of different sorts of people could come together and share those obsessions," he says. "There's something very compelling about being in the very room where something strange is happening. You're not reading about it, it's not streaming video, it's not a photo slide show. It's right there in front of you. Something might break. And that's good, and invigorating, and exciting."

Today, more than a dozen cities around the world have Dorkbots. At one San Francisco meeting, high-voltage engineer Greg Leyh, who spends his days working at the Stanford Linear Accelerator Center, outlined his after-hours effort to build the Advanced Lightning Facility, a pair of 12-story high transformers that spit out 300-foot lightning bolts. At another Dorkbot session, Maribeth Back

demonstrated an interactive children's storybook embedded with radio frequency identification tags.

"Dorkbot is like informal peer review," says Dorkbot-SF founder Karen Marcelo. "The work you present doesn't have to be finished. It might even just be an idea that you want feedback on."

Once you've actually built your idea, you might also post it on Instructables.com, a thriving online destination that embodies the shift from R&D labs to R&D communities. It's a hub of how-to where passionate hackers and hobbyists post detailed plans for gizmos ranging from a wheelchair for an injured dachshund to a pressurized air-powered bicycle.

A team of MIT grads founded the site to harness the "creative cycles" of tens of thousands of passionate hackers and hobbyists. "If you can amplify the voices of people in the form of community, they're really going to share the things they're good at," co-founder Eric Wilhelm said at IFTF's 2008 Technology Horizons Spring Exchange.

Instructables grew out of Thinkcycle.org, a collaborative system they launched as students for tackling tough tech problems in developing nations, from filtering water to treating cholera. Instructables is Thinkcycle for a wider audience, people who might get a kick out of constructing a 3D chocolate printer from Legos, an aquarium coffee table, or a laptop bag made from a discarded wetsuit.

"DIY also means community—you aren't, in fact, doing it by yourself," says Dale Dougherty, founder of MAKE and Maker Faire. "By creating something, you join communities of practice: hobbyists, enthusiasts, clubs, whatever. You start sharing ideas, recipes, tools, techniques, and connecting to people on the basis of what you make."

**Makers aren't tinkering alone in garages, backyards,
and basements. They're building communities,
forming networks, and meeting up to collaborate
and celebrate their creations.**

SIGNALS:



THE SHIPYARD WWW.THESHIPYARD.ORG

The Shipyard is a collective compound for makers in Berkeley, California, whose residents build their workshops in shipping containers. They derive much of their power from an innovative solar energy system of their own design. While the community members pursue a variety of projects, the organization's collective focus is on the development of new alternative energy technologies for buildings and vehicles.



THREADLESS.COM WWW.THREADLESS.COM

Members of Threadless, a community-centered online apparel store, submit designs for new T-shirts, and the "winners" are printed and sold on the site. The individual creators are paid for the designs and also receive a gift certificate. The site is as much about the thriving community around the product as the product itself.



BURNING MAN WWW.BURNINGMAN.COM

An annual art event and temporary community, Burning Man takes place in the Black Rock Desert of Nevada. Tens of thousands of people participate in this eight-day "experiment in community, radical self-expression, and radical self-reliance." A city is built, celebrated, and then destroyed, with the goal being to "leave no trace" behind. No spectators allowed.



GRASSROOTS ECONOMICS:

From products to stories

Trend 5

DRIVERS: Quest for Authenticity + Rise of the Professional Amateur

We see a growing demand for products and experiences that are personalized and authentic. At the same time, the rise of the professional amateurs leads to a supply of products that meet this demand. Historically, linking niche sellers with niche buyers has been challenging. But the Web has changed that, spawning a grassroots economy where individuals and small businesses can design, produce, and market goods without the need for big retailers or deep-pocketed middlemen. These new structures for production, exchange, and value creation form a framework for a grassroots economy. Scale is built from the bottom up through open-source practices, peer-to-peer exchanges, new models for valuation, and a commons-based approach to commercialism. This level of manufacturer-customer engagement can lead to an authentic, honest relationship where you just don't buy into a marketing myth about a product; you buy into the product itself.

"Products are their own media," says Douglas Rushkoff, author of *Get Back In The Box: Innovation From The Inside Out*. "Things communicate better about themselves than marketers do. The product has to speak for itself."

Web site and online community Etsy embodies this kind of authenticity. Think of it as a traditional craft fair, but virtualized so that anyone can set up a personal storefront and sell goods they make, from hand-woven baby blankets to elegant jewelry fashioned from recycled computer parts. With more than 50,000 artisans offering 500,000 items to 250,000 registered buyers, Etsy provides sellers with scale—but not at the expense of their independence. In November 2007, buyers spent \$4.3 million on Etsy purchases. As with eBay, a growing number of Etsy sellers make their entire living via the site. The company hosts events, co-working sessions, and workshops where sellers can hone their craft or learn about business strategy. From that perspective, Etsy is as much a platform for sociability as it is a virtual shopping mall.

In fact, this sense of personal connection between buyers and sellers gives Etsy its authenticity. If you like a particular hand-knitted sweater design but wish it had a smaller collar or came in another color, you can just email the creator. For example, an IFTF researcher's wife wanted a quilt made from their son's baby T-shirts. She found a quilter on Etsy whose work she liked and the two collaborated to design the quilt at a cost that was a fraction of what a handmade, designer quilt sells for in a department store. This grassroots marketplace hints at a shift where authentic products actually serve as platforms for stories that the manufacturer and the consumer create together. In the global village, Etsy sellers are the town artisans.

That's also the philosophy at TCHO, a new chocolate company in San Francisco that blends DIY ingenuity, self-taught science, and online community. From hacking together a homebrew chocolate lab for \$5,000 instead of buying a \$100,000 "pro" system to tricking out thirty-year-old chocolate factory equipment with modern technology, TCHO embodies a maker mindset that its founders call "scrappy not crappy." Founder Timothy Childs's business plan depends on using the Web to transform the supply chain into a supply loop. TCHO will use digital video and other media to tell the chocolate's life story, opening the lines of communication between, say, the Chilean farmer who grew a particular bean and the customer on another continent. The entire manufacturing process will be transparent, he explains, from bean to bar. TCHO will be the communication hub between the supplier and the sweet tooth.

"TCHO isn't just selling chocolate, but rather the whole chocolate experience," says CEO Louis Rossetto, best known as the founder of Wired magazine. "People want their products to tell stories and chocolate is the medium for this particular story."

Makers are turning away from big retail and venturing out on their own, often online, to share and sell goods and services in marketplaces where shoppers want to know the people and stories behind the products.

SIGNALS:



AMPLIFIER WWW.AMPLIFIER.COM

Under the tagline of “independent distribution,” Amplifier is a fulfillment house for grassroots Internet publishers, from conversational blogs to DIY book authors, who want to launch merchandising programs. They print products on demand, from T-shirts to full-color coffee table books, and handle all orders, inventory, fulfillment, and accounting. Their pitch is all about a “virtuous circle”: “By reducing noise and increasing the time you have with your audience, we actually can increase your opportunities to create and sell totally new creative works.”



MAKER SHED WWW.MAKERSHED.COM

Maker Shed is the online store spun out of *MAKE:* and *CRAFT* magazines. As the magazines grew in popularity, the publishers realized that many readers wanted to spend more time building projects than sourcing parts. Now, the magazines work with individual makers to “kit” their projects and act as a distribution channel for small companies in the kit business, from an LED-augmented Hula Hoop to a programmable processor for homebrew electronics. The Maker Shed also sells specialized tools, a carefully curated selection of books, and offers *MAKE:It* Workshops where students can gather in the real world and collaboratively learn how to build, for example, a humanoid robot.



EBAY WWW.EBAY.COM

eBay continues to sustain broad participation from makers and buyers through a very powerful instrument of the grassroots economy: reputation systems. When you buy a custom-made tube amplifier on eBay, how do you know the transaction won’t end with a sucker’s payoff, in which the seller gets your cash and never sends the item? At eBay, however, buyers rate sellers, and vice versa, so that every participant in a transaction can be judged by their reputation. The higher your reputation, the better prices you can achieve on your goods.



**IF YOU CAN'T
OPEN IT, YOU
DON'T OWN IT:**
From closed IP
to open innovation

Trend 6

DRIVERS: Open-Source Everything + Platforms for Sociability

Open source began as a model for software development in which developers release an application's code for distribution and modification by the users. The users then release their modifications back into the commons. Much of the Internet as we know it today was built on that framework and, in many ways, it drove the rapidly transformative effects of the online world. A secondary consequence of the open-source story is that a culture has emerged that expects that same level of "openness" not only in the bits they use, but also in the stuff they buy or make. Platforms of sociability enable these makers to share their modifications, improvements, and even grand failures with their communities. It's networked innovation bubbling from the bottom up.

In 2004, *MAKE: Magazine* contributing editor Mister Jalopy wrote the "Maker's Bill of Rights." The manifesto outlined the level of importance DIYers place on such things as replaceable batteries, parts lists included with products, and other requirements to make products hackable and repairable by their owners. The bottom line is, as Mister Jalopy wrote, "If you can't open it, you don't own it." What it means to own something is changing, as more people want the option to customize and personalize their products. Yet, technology companies are racing to prevent this, developing digital rights management strategies and other security features to maintain control over a product even after the customer has taken it home. Arguably, though, these approaches to secure market-share stifle innovation and lead to stagnation in the marketplace.

In its purest sense, the original concept of open source may not have broad applications beyond the software running your computer, or especially, running on the Web. Still, openness as a concept is moving way beyond software and into myriad facets of our lives, and it's not about giving away the farm, either. In the near future, open IP and innovation, especially in hardware, may be the best way to do business.

The makers of the Chumby hope this is the case. The Chumby is a wireless Internet device in the form of a beanbag with a touch-screen. It can track stock prices, tell you the weather, act as a digital picture frame, play music, list incoming email, or cycle through popular YouTube clips. An entirely open-source hardware platform, Chumby runs user-created and also commercial widget applications.

"In the design of the system, we consider not only open-source software hackers, but also hardware hackers and artists and 'crafters'—e.g., people who are equally skilled in their ability and passion to do non-computer things, such as metalworking, sewing, carpentry, etc.," says Chumby co-inventor Andrew "bunnie" Huang. Prior to Chumby, Huang gained online notoriety for hacking the Microsoft Xbox.

All of the Chumby design specs, from the beanbag case patterns to the circuitry, are available online for free. The Chumby officially launched in Spring 2008, but reviews are strong and hundreds of applications and hacks are already available. And with a device like Chumby, only users' ambitions and skills limit the possibilities of what the device can do. Skeptical of its missing keyboard? "If you're a hacker and don't mind voiding the warranty, you can probably find a way to make a mouse or keyboard work with a Chumby," states the company's Web site.

Over the next decade, the most successful products may remain in a permanent state of beta, open for tweaks, improvements, and unintended uses appearing in the unlikeliest of places. The Open Prosthetics Project is a community hoping to spur innovation in the industry by facilitating a community of lead users "whose contributions are often of a greater value and at a faster pace than the companies that produce the products they use." Consumers become co-developers, so long as companies share and share alike.

What it means to own a creation is changing as more makers expect their hardware and software to remain in beta, open for tweaks, improvements, and unintended uses.

SIGNALS:



SHARED DESIGN ALLIANCE WWW.SHAREDESIGN.ORG

Launched by the founders of the Open Prosthetics Project, the Shared Design Alliance is an advocacy group and platform for opening physical products for modification and pushing the design information into the public domain. They list the following benefits of sharing design: It lowers entry barriers by providing a platform for low-cost experimentation, allows collaboration across boundaries, accelerates technical evolution, increases societal wealth, and coordinates efforts to benefit underserved communities.



THINGLINK WWW.THINGLINK.COM

Think of Thinglink as a UPC code for small producers such as artists, designers, makers, and crafters to share information about the things they make. An individual can create a unique code for any item and populate a form with information about the object—where the idea originated, the materials and techniques used, its historical context, etc. You can then download a label for printing or to “tag” your item virtually. Thinglink can become the storehouse of stories around products, as described earlier in this paper, or the location for open-source information about products. Even the database and product code are free and open.



OSCAR WWW.THEOSCARPROJECT.ORG

Dedicated to “spreading the Open-source idea in the real physical world,” Oscar is a German-based effort to develop a car following the principles of open source. According to the Oscar manifesto, first written almost a decade ago, “Building a car ... without an engineering center, without a boss, without money, and without borders ... but with the help of the collective creativity of the Internet community—that is the meaning of empowerment, the meaning of ‘challenge.’” The community of more than 100 contributors around the world has a very short list of rules. The first three: Trust is the basis for our cooperation, everyone has a voice, and knowledge is free.

Implications

Whether your organization deals in bits or in atoms, the imminent transformation of the way things are designed, tested, produced, and distributed will have a profound impact on the way you work. To that end, we've identified a range of implications spurred by this forecast. Think of these as rules of thumb to help your organization engage early with the future of making.

FAIL EARLY AND OFTEN

Research and development becomes easier as networked communities enable spontaneous trials, tests, and feedback. The new tools for rapid manufacturing permit organizations to continuously prototype and tweak products. Meanwhile, the new channels of communication with customers/ collaborators provide organizations a direct line for input. Products can be released in beta, a term from the software industry, where lead users are encouraged to put them through their paces and help you uncover and correct mistakes.

NETWORK YOUR ORGANIZATION

Many of the best ideas may come from unexpected contributors, including those who are so far outside your organization's walls that they speak a different language. Develop a community around your products and your brands. Engage with experts and thinkers from a variety of disciplines to provide an outside-in perspective on your organization, from how it operates to the products in the pipeline. Invite guest speakers to speak to your team on topics of intellectual or creative interest even if the direct business applications aren't immediately apparent. Once you are open to the idea of a networked organization, it's relatively easy to identify and engage with external networks of exceptional people through community R&D platforms such as Instructables, InnoCentive, and NineSigma.

CONNECT WITH YOUR COMMUNITY

Organizations must develop skills for engaging, participating, and fostering communities relevant to their products and services. The first step is identifying a community to engage with. It's much easier (and authentic, see below) to find an existing group of people who share an interest than to start your own when one (or many) already exists. Identify someone, hopefully internally, who already participates in online communities to be your "community manager." This individual keeps conversations on track and is the liaison between the organization and the community. Eventually, "community managers" will emerge from the community itself. Reward them. Respect them. They are the "true believers" in your brand.

COLLABORATE WITH YOUR CUSTOMERS

Real-world gatherings provide an opportunity for organizations to recognize alpha users and develop authentic relationships. Organize your own versions of Maker Faires that harness the creativity of your employees or your communities. Makers within your organization are likely doing valuable, inspirational, and innovative work that goes completely unrecognized. Internally, you could invite your employee makers to show their projects and personal innovations both around your products and outside of your core business. Externally, identify and celebrate the maker spirit through contests, sponsorships of events, and smart ad campaigns that reach lead users of all stripes. Instead of litigating against makers and policing what your customers do with the products they own, future-thinking organizations invite makers to the table and reward them for their efforts.

REWARD SOLUTION SEEKERS

Many organizations suffer from “not invented here” syndrome: the rejection of an idea because it originated outside. Employees are often rewarded for solving a problem, but not for identifying someone else’s solution and integrating it. It makes no sense to reinvent the wheel, except, of course, when it does. For example, an existing solution may be too expensive or inadequate in some way. Also, the process of reinvention itself can reveal new and valuable information or discoveries. Problem solvers think deeply, but solution seekers think broadly. A good organization rewards both.

BE AUTHENTIC

As cyberspace becomes a layer on top of the physical world and we spend more of our lives online, a newfound appreciation emerges for authentic experiences, interactions, and products. This quest for authenticity permeates all aspects of the retail ecology, from manufacturers to customers to consumers. For example, many purchases will likely be made on the basis of how much the product conforms to the real, or aspirational, self-image of the buyer. Products that enable a consumer to think, “I see me in you” feel more authentic and, indeed, are authentic. The most direct path to that sense of authenticity is for the customers to have a hand in the creation or customization of the product. That way, they have imbued it with a story and created a personal connection to the item. Not every sweater can be hand-knit by your grandmother, but almost every product can tell a story of some kind.

BECOME QUIETLY TRANSPARENT

As people’s curiosity and knowledge about how things are made increases, they’ll seek out more information about the products they buy. Where were the materials sourced? How green were the factories? Pervasive computing technologies will enable products to document their own states, locations, and movements, to tell their own stories. For organizations, this new realm of visible data will be useful in understanding their own products’ lifecycles. But for customers and users, this data is just more “news you can use” when making choices in the marketplace. Don’t brag or you’ll be called on it. The better approach is to be quietly transparent by sharing what you know, because if you don’t make it transparent, someone else will.

ERR ON THE SIDE OF OPENNESS

Open-source software usually refers to “source code under a license (or arrangement such as the public domain) that permits users to study, change, and improve the software, and to redistribute it in modified or unmodified form.” In recent years, the open-source mindset has been applied to physical objects, too. Open-source hardware might include circuit diagrams, software that is user accessible, cases that can be opened up with a standard screwdriver, or anything else that invites the owner to roll up her sleeves and look under the hood. This kind of openness encourages user innovation and peer production, the coordinated efforts of large numbers of creative people. The end result is usually a better mousetrap (or computer mouse). The *MAKE: Magazine* motto is, “If you can’t open it, you don’t own it.” Successful organizations will embrace open-source culture in an authentic, well-considered way that’s good for both the customers and for the bottom line.