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The Global Plant Floor

From MIT's small-scale digital fabrication to Boeing's more collaborative model, a revolution in manufacturing is under way

By Don Tapscott and Anthony D. Williams

Somewhere in rural Ghana, a student team is designing a low-cost mobile refrigerator that they hope, one day soon, will be manufactured in local villages across Africa. And not by General Electric (GE), or some other multinational, but using a $25,000 fabrication laboratory supplied by MIT.

In a remote village in India, the locals use an identical "fab lab" to make replacement gears for out-of-date copying machines and diagnostic tools to reliably test milk and human blood. In the Lyngen Alps of Norway, shepherds watch over their flocks from afar, using fab-lab-constructed wireless-networking devices. Local fishermen use the same technology to track their boats at sea.

The all-purpose machine behind these local manufacturing innovations was built with off-the-shelf, industrial-grade fabrication and electronics tools developed by MIT's Center for Bits & Atoms. They call it a fab lab, but think of it as part high-tech workstation, part assembly line. It has everything you need to make just about anything, including nifty gadgetry such as laser cutters to etch out 2D and 3D structures, digital carving tools for making circuit boards and other precision parts, and a suite of electronic components and programming tools for constructing cheap microcontrollers.

FAB @ HOME

Putting a fab lab in every home, says MIT professor Neil Gershenfeld, would deliver a profound change in how we design and assemble physical goods. Just as the information revolution placed the means to manipulate information and media in the hands of everyone within reach of a computer, a similar wave of digital fabrication technology could eventually put the means to produce physical objects in the hands of every household and community. Might this eventually make us genuine producers of the everyday objects that have long been the province of large-scale industrial manufacturers? It's hard to say.

In theory, many things that people want could be manufactured in the home to the exact specifications required. But whether having a personal home factory is at all practical, or even desirable, is debatable, to say the least. It's unclear, for example, how people would procure the raw materials for individualized production or whether personal fabrication would ultimately be cheaper than today's mass-production systems. One certainty is that it will be many years before we even know whether personal fabrication of the kind envisioned by Gershenfeld is even feasible on a large scale.

And yet, our increased participation and collaboration in the design and assembly of physical things isn't a blue-sky dream. The collaborative methods of open source software developers will eventually be as amenable to cars and airplanes as they are to software and encyclopedias. In some pockets of industrial design, open-source-like methods are already here today. Peer production of physical things is coming of age, and smart companies are getting with the program.

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PEER-PRODUCED CHOPPERS

Nowhere are these transformations more evident than in China's burgeoning motorcycle industry, where the characteristics that make local companies such as Lifan, Zongshen, and Jialing competitive also make for a particularly fascinating tale of how mass collaboration has the potential to reshape even the most stodgy manufacturing firms.

Unlike traditional manufacturing industries, in which tightly regimented production hierarchies spit out end products under the command of a single leader, the Chinese motorcycle industry consists of hundreds of different suppliers that collaborate on motorcycle design and manufacturing. The assemblers typically set out rough blueprints, suppliers of closely related components (like the frame and fairings) work in tandem to design and deliver complete subassemblies to final assemblers in tight intervals.

This decentralization allows for rapid iterations, experimentation, and informal networking among adjacent suppliers, while assemblers integrate components and subsystems into finished products without having to impose much direction. If production problems arise, managers go to teahouses in their spare time to iron-out solutions, swap market intelligence, and coordinate ideas for future product designs.

THE NEW NORM

The bottom line is that Chinese companies design and build new motorcycles faster and less expensively than conventional industry supply chains. The approach has been so successful that motorcycle production has quadrupled from 5 million to more than 20 million vehicles a year since the mid-1990s, giving China about 50% of the global pie. Over 30% of production is now geared toward the rapidly expanding Asian export markets, where Chinese efficiencies have driven the average price from $700 to $200. Honda, Suzuki, and Yamaha, once dominant throughout Asia, have lost 40% of their market share in the last 10 years.

The emergence of highly collaborative design and manufacturing ecosystems isn't unique to China or the motorcycle industry. Such processes are becoming the norm in industries where intellectual property and production capacity is fragmented among hundreds of specialized companies. Increasingly, lead producers in fields such as semiconductors, computers, cars, clothing, and bicycles are responsible mainly for product concepts and marketing. They outsource manufacturing and many, if not all, aspects of component design. And they rely on a global plant floor consisting of hundreds of companies to assemble finished products.

Such mass collaboration is the future of manufacturing, even for the most complicated product we can think of—the new generation jumbo aircraft. Boeing is leading the way with its Boeing 787 Dreamliner by replacing its entire modus operandi with mind-boggling global collaborations.

LEGO-BLOCK AIRPLANE

Today's modern aircraft consist of tens of thousands of high-tech parts sourced from hundreds of specialized suppliers. In the past, companies such as Boeing wrote detailed specifications for each part and asked suppliers to build to plan. Boeing gathered the parts on the plant floor and spent weeks assembling a single airplane.

For example, Mike Bair, who heads up the 787 program for Boeing, explains that when the company sent the specifications for the electronics supplier for the 777 (the predecessor to the 787) the document was 2,500 pages long. "There wasn't a lot left to their imagination," he says. "We told them exactly what we wanted in excruciating detail." The equivalent specification document for the 787 is a mere 20 pages, which means suppliers have more latitude to apply their specialized knowledge.

Deepening supplier involvement in all stages of the process has significantly boosted efficiency. Today, Boeing and its suppliers co-design airplanes from scratch and deliver complete subassemblies to Boeing's factory, where a single plane can be snapped together like Lego blocks in as little as three days.

BITS AND ATOMS

Like other leading manufacturers, Boeing is taking historic strides toward a new model of the corporation—a truly global company that breaks down national silos, deploys resources and capabilities globally, and harnesses the power of human capital across borders and organizational boundaries. For the companies in charge of coordinating these sprawling webs of value creation, innovation is less about inventing and building physical things and more about nurturing and coordinating good ideas.

The transition isn't necessarily easy. Some engineers inside the organization worry that Boeing's extensive partnering and sharing of data may cause it to lose its engineering edge. And there's a risk that too much knowhow will leak out to partners or give rise to a powerful new competitor.

Though leaky knowledge is a risk in any partnership, it's a trade-off that companies can manage in order to reap the efficiency benefits of specialization and collaboration. In the meantime, Boeing is honing new skills. "The knowledge that we have gained in organizing this program is a unique competency. I don't think there's anybody else that could do this," says Bair. And while Airbus is embroiled in difficulties, with some suggesting its new generation aircraft may never come to market, Boeing is now the darling of the industry.

Because mass collaboration applies to the world of atoms, in addition to the world of bits, manufacturers in industries around the world need to rethink their business models. How will global plant floors and collaborative manufacturing techniques play out in markets such as health care, diesel earth-moving equipment, or construction? Use your imagination. As Boeing shows, the sky's the limit.

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