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EXCERPT

How the iPhone was Made in China

When the iPhone launched in 2007, Apple's supply chain in China was still nascent. Yet as the product took off, Cheng Fei profited from the creation of its ever-advanced electronics industry.

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Review note by Inez Patrick McGee talk about *Apple in China* at Asia Society tomorrow, Oct 22, at *China Books Review* cover moderated by Wood senior writer Zoyi Tang.

On January 9, 2007, Steve Jobs stood before a packed auditorium, once again in a black turtleneck and blue jeans. "Every once in a while," he said, "a revolutionary product comes along that changes everything." Then he introduced it — the iPhone — to an audience mesmerized by full-screen web navigation and the basics of multi-touch, like pinch to zoom and swipe to unlock, or the way the screen would become a large keyboard at any moment you wanted any further. The prototype had experienced all kinds of software glitches in the days before, instilling feelings of anxiety and terror into a small group watching within the auditorium. "Here we were in the fifth row or something — engineers, managers, all of us — doing shots of Scotch after every segment of the demo," a radio engineer named Angy Grigioni once recounted. Other racks piled up in the demo, the person who was responsible for that particular demo had a fever. When the finale came — and it worked along with everything before it, we all just drained the flask. It was the best demo any of us had ever seen." The audience responded by giving that some executives at Blackberry maker Research In Motion thought it was fake.somehow.

Two weeks after unveiling "the one device," Steve Jobs walked into a routine divisional meeting. He was in a bad mood and didn't look good. Then he pulled out his prototype iPhone, which looked worse. The keys in his pocket had cut a huge gouge across its plastic screen. He threw the unit onto the boardroom table toward Steve Zadesky and demanded "Make it glass." It would be first time the idea had come up. In September 2006, just four months earlier, Jobs had given angry about smaller screen sizes and compared to a mid-level executive: "Look at this, look at this — what's with the screen?" The executive responded, "Well, Steve, we have a glass prototype but it fails the one drop test and we tested dozens of times and lost one hundred times." Jobs cut the executive off: "I just want to know if you're going to make the fucking thing work." Now, in January, Jobs wasn't taking excuses. Apple had just announced the phone would be available in June; the date couldn't be pushed back. Six months would've been a rush job; but they had even less time than that. The display is a module that had to be ready months ahead of the assembly.

What followed is perhaps the best-known anecdote on the manufacturing of the original iPhone. Jobs reached out to Wendell Weeks, CEO of Corning, a glassmaker in upstate New York, saying he needed the hardest glass they could make. Weeks told Jobs about Gorilla Glass, something Corning had developed for fighter jet cockpits back in the 1960s. They'd never found a market for it and abandoned the project. Jobs convinced him to begin production immediately.

The decision risked throwing Zadesky, who managed all the mechanical parts for the iPhone project, into a tailspin. He and Tony Fadell, another iPod veteran, had to quickly put together a touchscreen supply chain, as glass and plastic function in totally different ways. Senior Vice President Tony Fadell likens this "crazy" phase to landing in "front of 200 pro on an aircraft carrier, all within minutes of each other. And all the jets were running out of fuel." Apple needed to find manufacturers that were highly competent, but with enough capacity to free up their top talent.

Among the suppliers it found was Lens Technology, a glass specialist Apple worked with to cut and place Gorilla Glass. It was founded by Zhou Qunfei, who dropped out of high school at age sixteen and left her impoverished village to work in factories of Shenzhen. She found a job making watch lenses, earning about a dollar a day polishing glass. She hated the work but was eager to learn, and her boss offered her the chance to understand the science behind the manufacturing. Zhou — "Zaha" to Apple engineers — eventually saved up $1,000, started her own company in 1993, and 11 years later was making small glass screens for Motorola with a team of 1,000 people. Apple engineers grew to have great respect for her operational skill and ability to leverage help through political channels. The company's main factory was in Changsha, the capital city of Hunan province where Mao was born. One engineer working in the factory recalls a time when power went out across the district. Lens couldn't operate. But Zhou was so well connected that, in a short period of time, multiple fire trucks showed up. Each carried generators, and soon Lens was back to tempering and precision shaping glass — the only factory up and running for multiple blocks.

The first iPhone, release in June 2007. (Arcamundi)

Another important supplier was TPK, which placed a special coating on the Corning glass, enabling the user's fingers to transmit electrical signals. The Taiwanese start-up had been founded just a few years earlier by Michael Chiang, an entrepreneur who in the PC era had reportedly made $30 million selling monitors and then lost it all on one strategic mistake. In 1997 he began working with resistive touch panels used by point-of-sale registers. When Palm was shipping PDAs that worked with a stylus, Chiang worked on improving the technology to enable finger-based touchscreens, even showing the technology to Steve Jobs in 2004, when a glass supplier introduced TPK to Apple. An iPhone engineer calls Chiang "a classic Taiwanese cowboy [who] committed to moving heaven and earth" by turning fields into factories that could build touchscreens. The factory was in Xiamen, a coastal city directly across from Taiwan. "The first iPhones 100% would not have shipped without that vendor," this person says. He recalls Chiang responding to Apple by saying, "We can totally do that!" — even though [what we were asking was something] nobody in the world had ever done before."

Among the techniques Apple codeveloped with suppliers was a way to pattern, or etch, two sides of a piece of glass to do the touch sensor, at a time when film lithography processes were being done on only one side. Another pioneering technique is called rapid-to-rapid lamination, a process for bonding two materials using heat and pressure, which Apple applied to tape a stack of LCD displays to touch sensors and cover elements to secure raw material. The process was performed in a clean-room environment with custom robotics.

Apple was secretive about each of these cutting-edge methods. One result of this is that outsiders failed to grasp the advancements taking place in China for the iPhone. In the Western press it was common to misinterpret China's role as being all about low-wage assembly. These studies were based on opening an iPhone and breaking down where the display, chips, and other components come from. As most engineers were typically from Korea, Japan, and the United States, those doing the assessing would conclude that China's contributions were de minimis. "China [just] happens to be the last stop in a given product's long global supply chain," wrote the president of the Export Import Bank of the United States. "The Chinese make products like the iPhone possible without requiring much of the benefits." Similarly, at one point, two analysts declared that the work performed by Chinese workers contributed just 3.6% to the $179 wholesale cost of an iPhone. When *The Wall Street Journal* picked up on the study, it headlined the article: "Not Really Made in China."

The analyses were wrong. Apple was making spectacular investments in China; it's just that the contributions weren't found within the iPhone, but in the machinery and processes that made it. "Sure, the glass comes from Corning, but does it come in that shape?" says one manufacturing design engineer referring to the U.S. trade glass on the iPhone. "Corning glass is useless until Lens makes it so." As for wages, observers were often counting only the steps in final assembly, oblivious to all the labor that went into building the components. Even so, it's true that Chinese wages for iPhone were a small percentage of the wholesale cost; however, this wasn't reflection of their insignificance but, counterintuitively, a sign of the China-based factories' importance. The low cost per unit reflected their efficiency.

Only after all this complexity making the touchscreen glass with cutting-edge processes did the tedious monotony of actually assembling the iPhone begin over at Foxconn's Shenzhen factories. As *The New York Times* would famously uncover later, once Apple worked out how to make the glass screens, a foreman issued 8,000 workers inside the Foxconn dormitories, gave each employee "a biscuit and a cup of tea, guided [them] to a workstation and within half an hour [they] started a 12-hour shift fitting glass screens into beveled frames. Within 96 hours, the plant was producing over 10,000 iPhones a day."

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In 1999, the Taiwanese electronics manufacturer Foxconn was a company with $1.8 billion of revenue, far smaller than Solectron, SCL, or Flextronics, its U.S. rivals. By 2010, Foxconn revenues were $90 billion, more than those of its five biggest competitors combined. And Foxconn extraordinary growth in those eleven years is the consequence of one client more than any other: Apple.

The Apple–Foxconn relationship goes back to the early 1990s, but in a limited way. Foxconn had been championed by H. L. Cheung, a Singaporean Apple executive from 1981 to 1997, who would later join Foxconn. But Terry Gou's company was mostly just a supplier of affordable components, like those connecting printed circuit boards to the housing. Apple engineers from the mid-1990s remember it as "the connector company." But Foxconn quickly expanded its skill set, and approaching the year 2000, it was demonstrating its prowess as a jack-of-all-trades with a model different from the other Taiwanese companies expanding to the mainland.

Foxconn began offering final assembly on the cheap for the same reason Costco sells hot dogs: It gets people in the door. Foxconn then upended the world of tooling by giving it away for free. That is, Gou would offer to pay the up-front costs of building the custom molds, dies, fixtures and other equipment necessary to start building a product at scale. "That can be half a million or a million dollars," says a former Apple engineer. "And that was absorbed by the manufacturer — by Foxconn. So Apple just paid for the production parts." Then Foxconn would work to integrate all procurement, manufacturing and logistics into a one-stop shop. It made no money back the same way a mobile carrier might — giving customers a free phone but earning fees in a two-year contract. This Apple engineer describes Gou's approach as a why bet to lure in Western companies, giving them hooked on the logic of cheap production, and creating a sticky relationship based on Foxconn's choice of components. "Once they get you in the door, that's it — they control you," he says. "Foxconn isn't called Fox-cool for nothing. Terry Gou was a gambler, and the end game of the company is Hon Hai. That was changed to Foxconn because he's a fox, and he's a con artist."

Terry Gou's perseverance had won Foxconn the exclusive contract to build the iPhone, but his strategy to make Apple dependent on his operations — so he could squeeze out every profit — failed spectacularly. Instead, Apple squeezed Foxconn, leveraging higher volumes to attain lower costs while obstructing Foxconn's efforts to choose which sub-suppliers to work with. In 2000, the first year Foxconn produced major operations for Apple, it had reported net margins of 10.6%. As it got more work with Apple, revenues soared while margins plummeted — to 4.6 percent in 2007 and then to 2.3% in 2011. So while Foxconn revenues were than double — from $15 billion in 2007 to $107 billion in 2011 — profits were inched up from $2.42 billion to $2.53 billion. "It was just brutal the way we'd work with suppliers," a former Apple VP says. "We wanted something, and we just got it. And they just wanted our business. It was incredible … The red carpet was rolled out everywhere we went."

For the original iPhone, Foxconn had even agreed to a no-quibble warranty, an onerous clause known internally as "Terry Gou Special," after Apple's procurement specialist with a reputation for negotiating absurdly good deals across the supply chain. The clause compelled Foxconn to take full responsibility for any iPhone failures within the first twelve months after purchase. "The no-quibble warranty meant that if we got a return, we're sending it back to you, and you fix it and deal with it," another person says. The clause was an incentive for Foxconn to maintain high quality standards — so fussy business like saving on costs by using unauthorized suppliers, the sort of trick contract manufacturers were infamous for.

Blevins had already been a spectacular negotiator, and at Apple grew, he developed further ways to tilt the field. He'd organize suppliers into adjacent hotel rooms, then travel from one to the next, pushing prices lower and subtly indicating that some of had just made a better offer. Blevins wouldn't let the suppliers order food or leave the rooms, and depending on the situation, he'd lay with the temperature. If it was the kind of hot and humid summer in Hong Kong when nobody would think to have brought a jacket, Blevins would crank up the air-conditioning in the hotel room, to the point where only the Apple team was appropriately dressed. "But they would go all night long with their coats on," one colleague says. It was always hard to say no to Apple, and Blevins knew it. In the 2010s, Apple would often ramp a product from hundreds of thousands of units to the tens of millions. Margins might be razily low, but a supplier could become rich off the volumes.

The no-quibble terms were a legacy of the iPod, a relatively simple product and one for which Foxconn was directly sourcing many of the parts. Apple had taken control of the more strategic and high-value added items, but Foxconn had sourced commodity components on its own. Lacking any data on the iPhone before it was released, Foxconn treated it like an iPod and agreed to the same terms. But committing to the same clause for such a different product proved to be a disaster. For the first iPhone, the percentage of units that came back within twelve months — when Apple calls TWR, standing for total warranty repair — was around one in seven. There were problems with the home button and the volume controls, and a spate of issues that didn't meet standards from the perspective of field durability.

Foxconn wasn't necessarily building it poorly; it was simply the first consumer electronics product of that complexity to be used multiple hours a day. Apple's quality standards were high, but they weren't built to meet smartphone addiction — a concept that hadn't really existed before. "You see an iPod occasionally, but you see the iPhone all the fucking time," says an executive involved in manufacturing the original unit. The no-quibble clause was maintained for at least two to three generations of iPhone, until it got to a point where Foxconn was losing money and they had to plead with Cupertino to amend the contract. "It became untenable from a business standpoint," says a person familiar with the change. That Foxconn would even sign such a contract demonstrated their willingness to do anything to work with Apple. Their hunger got to the point of being irrational — and Apple would fully exploit the situation.

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Reader: A Chinese national flag at the Apple Store in Chongqing's Jiefangbei General Business District, October 2021. (Cheng Xin/Getty)

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