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How U.S. Lost Out On iPhone Work

Apple's Experience Shows Why Jobs Are Flowing to China

By CHARLES DUHIGG and KEITH BRADSHER

WHEN Barack Obama joined Silicon Valley's top luminaries for dinner in California last February, each guest was asked to come with a question for the president.

But as Steven P. Jobs of Apple spoke, President Obama interrupted with an inquiry of his own: what would it take to make iPhones in the United States?

THE iECONOMY
An Empire Built Abroad

Not long ago, Apple boasted that its products were made in America. Today, few are. Almost all of the 70 million iPhones, 30 million iPads and 59 million other products Apple sold last year were manufactured overseas.

Why can't that work come home? Mr. Obama asked.

Mr. Jobs's reply was unambiguous. "Those jobs aren't coming back," he said, according to another dinner guest.

The president's question touched upon a central conviction at Apple. It isn't just that workers are cheaper abroad. Rather, Apple's executives believe the vast scale of overseas factories as well as the flexibility, diligence and industrial skills of foreign workers have so outpaced their American counterparts that "Made in the U.S.A." is no longer a viable option for most Apple products.

Apple has become one of the best-known, most admired and most imitated companies on earth, in part through an unrelenting mastery of global operations. Last year, it earned over $400,000 in profit per employee, more than Goldman Sachs, Exxon Mobil or Google.

DONALD CHAN/REUTERS

People flooded Foxconn Technology with résumés at a 2010 job fair in Henan Province, China.

However, what has vexed Mr. Obama as well as economists and policy makers is that Apple — and many of its high-technology peers — are not nearly as avid in creating American jobs as other famous companies were in their heydays.

Apple employs 43,000 people in the United States and 20,000 overseas, a small fraction of the over 400,000 American workers at General Motors in the 1950s, or the hundreds of thousands at General Electric in the 1980s. Many more people work for Apple's contractors: an additional 700,000 people engineer, build and assemble iPads, iPhones and Apple's other products. But almost none of them work in the United States. Instead, they work for foreign companies in Asia, Europe and elsewhere, at factories that almost all electronics designers rely upon to build their wares.

"Apple's an example of why it's so hard to

THOMAS LEE/BLOOMBERG NEWS

A production line in Foxconn City in Shenzhen, China. The iPhone is assembled in this vast facility, which has 230,000 employees, many at the plant up to 12 hours a day, six days a week.

create middle-class jobs in the U.S. now," said Jared Bernstein, who until last year was an economic adviser to the White House.

"If it's the pinnacle of capitalism, we should be worried."

Apple executives say that going overseas, at this point, is their only option. One former executive described how the company relied upon a Chinese factory to revamp iPhone manufacturing just weeks before the device was due on shelves. Apple had redesigned the iPhone's screen at the last minute, forcing an assembly line overhaul. New screens began arriving at the plant near midnight.

A foreman immediately roused 8,000 workers inside the company's dormitories, according to the executive. Each employee was given a biscuit and a cup of tea, guided to a workstation and within half an hour started a 12-hour shift fitting glass screens into beveled frames. Within 96 hours, the plant was producing over 10,000 iPhones a day.

"The speed and flexibility is breathtaking," the executive said. "There's no American plant that can match that."

Similar stories could be told about almost any electronics company — and outsourcing has also become common in hundreds of industries, including accounting, legal services, banking, auto manufacturing and pharmaceuticals.

But while Apple is far from alone, it offers a window into why the success of some prominent companies has not translated into large numbers of domestic jobs. What's more, the company's decisions pose broader questions about what corporate America owes Americans as the global and national economies are increasingly intertwined.

"Companies once felt an obligation to support American workers, even when it wasn't the best financial choice," said Betsey Stevenson, the chief economist at the Labor Department until last September. "That's disappeared. Profits and efficiency have trumped generosity."

Companies and other economists say that notion is naïve. Though Americans are among the most educated workers in the world, the nation has stopped training enough people in the mid-level skills that factories need, executives say.

To thrive, companies argue they need to move work where it can generate enough profits to keep paying for innovation. Doing otherwise risks losing even more American jobs over time, as evidenced by the legions of once-proud domestic manufacturers — including G.M. and others — that have shrunk as nimble competitors have emerged.

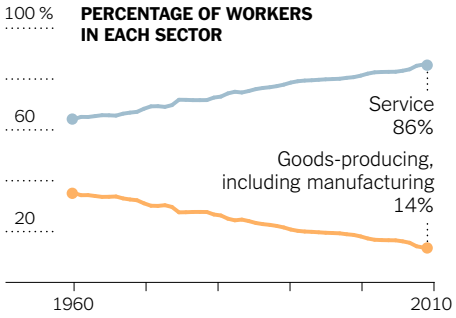
Apple was provided with extensive summaries of The New York Times's reporting for this article, but the company, which has a reputation for secrecy, declined to comment.

This article is based on interviews with more than three dozen current and former Apple employees and contractors — many of whom requested anonymity to protect their jobs — as well as economists, manufacturing experts, international trade specialists, technology analysts, academic researchers, employees at Apple's suppliers, competitors and corporate partners, and government officials.

Privately, Apple executives say the world is

A Shift From Manufacturing

A look at the largest employers shows how America's economy has changed. Over the last 50 years, the country has shifted from creating goods to providing services. Today, about a tenth of Americans work in manufacturing, while service providers and retailers like Walmart and temp firms like Kelly Services employ about six in seven of the nation's workers.



THE LARGEST EMPLOYERS

Goods-producing
Service-providing

1960

- General Motors 595,200 employees
- Bell System (later AT&T) 580,400
- Ford Motor 260,000
- General Electric 260,600
- U.S. Steel 225,100
- Sears, Roebuck 208,000
- Supermarket chain 153,000
- Brand owned by Standard Oil of N.J. (later Exxon) 140,000
- Bethlehem Steel 138,300
- International Telephone & Telegraph 132,000
- Westinghouse Electric 114,000
- U.S. military contractor 105,700
- Chrysler 105,400
- Sperry Rand 105,300
- International Harvester 104,300

2010

- Walmart 2,100,000
- A job placement agency 538,000
- I.B.M. 426,751
- Package delivery company 400,600
- McDonald's Corporation 400,000
- Operator of Taco Bell, KFC, Pizza Hut 378,000
- Target 355,000
- Grocery retailer 338,000
- Hewlett-Packard 324,600
- Home improvement retailer 321,000
- Sears Holding 312,000
- PepsiCo 294,000
- Bank of America 288,000
- General Electric 287,000
- CVS Pharmacy 280,000

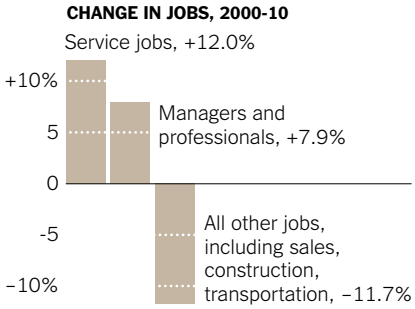
Apple

Apple is worth about $400 billion — more than General Electric and I.B.M. But with only 63,000 employees worldwide, it doesn't come close to appearing on a list of the nation's biggest employers.

The shift from manufacturing means the loss of a "job multiplier," creating new jobs in other industries, like construction, transportation and retailing. When an auto company hires 1,000 new workers, for instance, it creates more than four times as many additional jobs for marketers, managers, parts manufacturers and car salesmen. Service sector and retail jobs, on the other hand, are not big job multipliers.

FOR EVERY 1,000 JOBS CREATED IN:	ADDITIONAL JOBS CREATED
Retailing	240
Hospitals	670
Computer systems design services	1,190
Motor vehicle manufacturing	4,710
Steel product manufacturing	11,890

In general, while jobs for professionals and service employees have grown, **jobs for everyone else, like office clerks and factory workers, have shrunk**. For example, General Electric is the only company on the list of biggest employers in both decades. But today, its single largest unit by revenue is GE Capital, which sells financial services.



Sources: S&P Capital IQ (list of largest employers); Bureau of Labor Statistics THE NEW YORK TIMES

now such a changed place that it is a mistake to measure a company's contribution simply by tallying its employees — though they note that Apple employs more workers in the United States than ever before.

They say Apple's success has benefited the economy by empowering entrepreneurs and creating jobs at companies like cellular providers and businesses shipping Apple products. And, ultimately, they say curing unemployment is not their job.

"We sell iPhones in over a hundred countries," a current Apple executive said. "We don't have an obligation to solve America's problems. Our only obligation is making the best product possible."

'I Want a Glass Screen'

In 2007, a little over a month before the iPhone was scheduled to appear in stores, Mr. Jobs beckoned a handful of lieutenants into an office. For weeks, he had been carrying a prototype of the device in his pocket.

Mr. Jobs angrily held up his iPhone, angling it so everyone could see the dozens of tiny scratches marring its plastic screen, according to someone who attended the meeting. He then pulled his keys from his jeans.

People will carry this phone in their pocket, he said. People also carry their keys in their pocket. "I won't sell a product that gets scratched," he said tensely. The only solution was using unscratchable glass instead. "I want a glass screen, and I want it perfect in six weeks."

After one executive left that meeting, he booked a flight to Shenzhen, China. If Mr. Jobs wanted perfect, there was nowhere else to go.

For over two years, the company had been working on a project — code-named Purple 2 — that presented the same questions at every turn: how do you completely reimagine the cellphone? And how do you design it at the highest quality — with an unscratchable screen, for instance — while also ensuring that millions can be manufactured quickly and inexpensively enough to earn a significant profit?

The answers, almost every time, were found outside the United States. Though components differ between versions, all iPhones contain hundreds of parts, an estimated 90 percent of which are manufactured abroad. Advanced semiconductors have come from Germany and Taiwan, memory from Korea and Japan, display panels and circuitry from Korea and Taiwan, chipsets from Europe and rare metals from Africa and Asia. And all of it is put together in China.

In its early days, Apple usually didn't look beyond its own backyard for manufacturing solutions. A few years after Apple began building the Macintosh in 1983, for instance, Mr. Jobs bragged that it was "a machine that is made in America." In 1990, while Mr. Jobs was running NeXT, which was eventually bought by Apple, the executive told a reporter that "I'm as proud of the factory as I am of the computer." As late as 2002, top Apple executives occasionally drove

two hours northeast of their headquarters to visit the company's iMac plant in Elk Grove, Calif.

But by 2004, Apple had largely turned to foreign manufacturing. Guiding that decision was Apple's operations expert, Timothy D. Cook, who replaced Mr. Jobs as chief executive last August, six weeks before Mr. Jobs's death. Most other American electronics companies had already gone abroad, and Apple, which at the time was struggling, felt it had to grasp every advantage.

In part, Asia was attractive because the semiskilled workers there were cheaper. But that wasn't driving Apple. For technology companies, the cost of labor is minimal compared with the expense of buying parts and managing supply chains that bring together components and services from hundreds of companies.

For Mr. Cook, the focus on Asia "came down to two things," said one former high-ranking Apple executive. Factories in Asia "can scale up and down faster" and "Asian supply chains have surpassed what's in the U.S." The result is that "we can't compete at this point," the executive said.

The impact of such advantages became obvious as soon as Mr. Jobs demanded glass screens in 2007.

For years, cellphone makers had avoided using glass because it required precision in cutting and grinding that was extremely difficult to achieve. Apple had already selected an American company, Corning Inc., to manufacture large panes of strengthened glass. But figuring out how to cut those panes into millions of iPhone screens required finding an empty cutting plant, hundreds of pieces of glass to use in experiments and an army of midlevel engineers. It would cost a fortune simply to prepare.

Then a bid for the work arrived from a Chinese factory.

When an Apple team visited, the Chinese plant's owners were already constructing a new wing. "This is in case you give us the contract," the manager said, according to a former Apple executive. The Chinese government had agreed to underwrite costs for numerous industries, and those subsidies had trickled down to the glass-cutting factory. It had a warehouse filled with glass samples available to Apple, free of charge. The owners made engineers available at almost no cost. They had built on-site dormitories so employees would be available 24 hours a day.

The Chinese plant got the job.

"The entire supply chain is in China now," said another former high-ranking Apple executive. "You need a thousand rubber gaskets? That's the factory next door. You need a million screws? That factory is a block away. You need that screw made a little bit different? It will take three hours."

In Foxconn City

An eight-hour drive from that glass factory is a complex, known informally as Foxconn City, where the iPhone is assembled. To Apple executives, Foxconn City was further evidence that China could deliver workers — and diligence — that outpaced their American counterparts.

That's because nothing like Foxconn City exists in the United States.

The facility has 230,000 employees, many working six days a week, often spending up to 12 hours a day at the plant. Over a quarter of Foxconn's work force lives in company barracks and many workers earn less than $17 a day. When one Apple executive arrived during a shift change, his car was stuck in a river of employees streaming past. "The scale is unimaginable," he said.

Foxconn employs nearly 300 guards to direct foot traffic so workers are not crushed in doorway bottlenecks. The facility's central kitchen cooks an average of three tons of pork and 13 tons of rice a day. While factories are spotless, the air inside nearby teahouses is hazy with the smoke and stench of cigarettes.

Foxconn Technology has dozens of facilities in Asia and Eastern Europe, and in Mexico and Brazil, and it assembles an estimated 40 percent of the world's consumer electronics for customers like Amazon, Dell, Hewlett-Packard, Motorola, Nintendo, Nokia, Samsung and Sony.

"They could hire 3,000 people overnight," said Jennifer Rigoni, who was Apple's worldwide supply demand manager until 2010, but declined to discuss specifics of her work. "What U.S. plant can find 3,000 people overnight and convince them to live in dorms?"

In mid-2007, after a month of experimentation, Apple's engineers finally perfected a meth-

ABOVE, THOMAS LEE FOR THE NEW YORK TIMES; AT LEFT, JIM WILSON/THE NEW YORK TIMES

In China, Lina Lin is a project manager at PCH International, which contracts with Apple. "There are lots of jobs," she said. "Especially in Shenzhen." In California, Eric Saragoza joined Apple as an engineer in 1995, but as more work occurred overseas, he was laid off.

od for cutting strengthened glass so it could be used in the iPhone's screen. The first truckloads of cut glass arrived at Foxconn City in the dead of night, according to the former Apple executive. That's when managers woke thousands of workers, who crawled into their uniforms — white and black shirts for men, red for women — and quickly lined up to assemble, by hand, the phones. Within three months, Apple had sold one million iPhones. Since then, Foxconn has assembled over 200 million more.

Foxconn, in statements, declined to speak about specific clients.

"Any worker recruited by our firm is covered by a clear contract outlining terms and conditions and by Chinese government law that protects their rights," the company wrote. Foxconn "takes our responsibility to our employees very seriously and we work hard to give our more than one million employees a safe and positive environment."

The company disputed some details of the former Apple executive's account, and wrote that a midnight shift, such as the one described,

was impossible "because we have strict regulations regarding the working hours of our employees based on their designated shifts, and every employee has computerized timecards that would bar them from working at any facility at a time outside of their approved shift." The company said that all shifts began at either 7 a.m. or 7 p.m., and that employees receive at least 12 hours' notice of any schedule changes.

Foxconn employees, in interviews, have challenged those assertions.

Another critical advantage for Apple was that China provided engineers at a scale the United States could not match. Apple's executives had estimated that about 8,700 industrial engineers were needed to oversee and guide the 200,000 assembly-line workers eventually involved in manufacturing iPhones. The company's analysts had forecast it would take as long as nine months to find that many qualified engineers in the United States.

In China, it took 15 days.

Companies like Apple "say the challenge in setting up U.S. plants is finding a technical work force," said Martin Schmidt, associate provost at the Massachusetts Institute of Technology. In particular, companies say they need engineers with more than high school, but not necessarily a bachelor's degree. Americans at that skill level are hard to find, executives contend. "They're good jobs, but the country doesn't have enough to feed the demand," Mr. Schmidt said.

Some aspects of the iPhone are uniquely American. The device's software, for instance, and its innovative marketing campaigns were largely created in the United States. Apple recently built a $500 million data center in North Carolina. Crucial semiconductors inside the iPhone 4 and 4S are manufactured in an Austin, Tex., factory by Samsung, of South Korea.

But even those facilities are not enormous sources of jobs. Apple's North Carolina center, for instance, has only 100 full-time employees. The Samsung plant has an estimated 2,400 workers.

"If you scale up from selling one million phones to 30 million phones, you don't really need more programmers," said Jean-Louis Gassée, who oversaw product development and marketing for Apple until he left in 1990. "All these new companies — Facebook, Google, Twitter — benefit from this. They grow, but they don't really need to hire much."

It is hard to estimate how much more it would cost to build iPhones in the United States. However, various academics and manufacturing analysts estimate that because labor is such a small part of technology manufacturing, paying American wages would add up to $65 to each iPhone's expense. Since Apple's profits are often hundreds of dollars per phone, building domestically, in theory, would still give the company a healthy reward.

But such calculations are, in many respects, meaningless because building the iPhone in the United States would demand much more than hiring Americans — it would require transforming the national and global economies. Apple executives believe there simply aren't enough American workers with the skills the company needs or factories with sufficient speed and flexibility. Other companies that work with Apple, like Corning, also say they must go abroad.

Manufacturing glass for the iPhone revived a Corning factory in Kentucky, and today, much of the glass in iPhones is still made there. After the iPhone became a success, Corning received a flood of orders from other companies hoping to imitate Apple's designs. Its strengthened glass sales have grown to more than $700 million a year, and it has hired or continued employing about 1,000 Americans to support the emerging market.

But as that market has expanded, the bulk of Corning's strengthened glass manufacturing has occurred at plants in Japan and Taiwan.

"Our customers are in Taiwan, Korea, Japan and China," said James B. Flaws, Corning's vice chairman and chief financial officer. "We could make the glass here, and then ship it by boat, but that takes 35 days. Or, we could ship it by air, but that's 10 times as expensive. So we build our glass factories next door to assembly factories, and those are overseas."

Corning was founded in America 161 years ago and its headquarters are still in upstate New York. Theoretically, the company could manufacture all its glass domestically. But it would "require a total overhaul in how the industry is structured," Mr. Flaws said. "The consumer electronics business has become an Asian business. As an American, I worry about that, but there's nothing I can do to stop it. Asia has become what the U.S. was for the last 40 years."

Middle-Class Jobs Fade

The first time Eric Saragoza stepped into Apple's manufacturing plant in Elk Grove, Calif., he felt as if he were entering an engineering wonderland.

It was 1995, and the facility near Sacramento employed more than 1,500 workers. It was a kaleidoscope of robotic arms, conveyor belts ferrying circuit boards and, eventually, candy-colored iMacs in various stages of assembly. Mr. Saragoza, an engineer, quickly moved up the plant's ranks and joined an elite diagnostic team. His salary climbed to $50,000. He and his wife had three children. They bought a home with a pool.

"It felt like, finally, school was paying off," he said. "I knew the world needed people who can build things."

At the same time, however, the electronics industry was changing, and Apple — with products that were declining in popularity — was struggling to remake itself. One focus was improving manufacturing. A few years after Mr. Saragoza started his job, his bosses explained how the California plant stacked up against overseas factories: the cost, excluding the materials, of building a $1,500 computer in Elk Grove was $22 a machine. In Singapore, it was $6. In Taiwan, $4.85. Wages weren't the major reason for the disparities. Rather it was costs like inventory and how long it took workers to finish a task.

"We were told we would have to do 12-hour days, and come in on Saturdays," Mr. Saragoza said. "I had a family. I wanted to see my kids play soccer."

Modernization has always caused some kinds of jobs to change or disappear. As the American economy transitioned from agriculture to manufacturing and then to other industries, farmers became steelworkers, and then salesmen and middle managers. These shifts have carried many economic benefits, and in general, with each progression, even unskilled workers received better wages and greater chances at upward mobility.

But in the last two decades, something more fundamental has changed, economists say. Mid-wage jobs started disappearing. Particularly among Americans without college degrees, today's new jobs are disproportionately in service occupations — at restaurants or call centers, or as hospital attendants or temporary workers — that offer fewer opportunities for reaching the middle class.

Even Mr. Saragoza, with his college degree, was vulnerable to these trends. First, some of Elk Grove's routine tasks were sent overseas. Mr. Saragoza didn't mind. Then the robotics that made Apple a futuristic playground allowed executives to replace workers with machines. Some diagnostic engineering went to Singapore. Middle managers who oversaw the plant's inventory were laid off because, suddenly, a few people with Internet connections were all that were needed.

Mr. Saragoza was too expensive for an unskilled position. He was also insufficiently credentialed for upper management. He was called into a small office in 2002 after a night shift, laid off and then escorted from the plant. He taught high school for a while, and then tried a return to technology. But Apple, which had helped anoint the region as "Silicon Valley North," had by then converted much of the Elk Grove plant into an AppleCare call center, where new employees often earn $12 an hour.

There were employment prospects in Silicon Valley, but none of them panned out. "What they really want are 30-year-olds without children," said Mr. Saragoza, who today is 48, and whose family now includes five of his own.

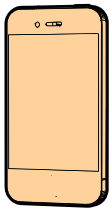
After a few months of looking for work, he started feeling desperate. Even teaching jobs had dried up. So he took a position with an electronics temp agency that had been hired by Apple to check returned iPhones and iPads before they were sent back to customers. Every day, Mr. Saragoza would drive to the building where he had once worked as an engineer, and for $10 an hour with no benefits, wipe thousands of glass screens and test audio ports by plugging in headphones.

Paydays for Apple

As Apple's overseas operations and sales have expanded, its top employees have thrived. Last fiscal year, Apple's revenue topped $108 billion, a sum larger than the combined state budgets of Michigan, New Jersey and Massachusetts. Since 2005, when the company's stock split, share prices have risen from about $45 to more than $427.

Some of that wealth has gone to sharehold-

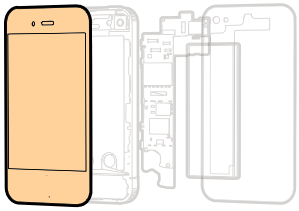
The iPhone: Designed in the U.S. . . .



43,000
jobs in the U.S.

Dreamed up in California

Apple once boasted that its products were manufactured in the United States. No longer. Specifics differ between versions, but an estimated 90 percent of iPhone components are manufactured overseas, by workers in Germany, Singapore, Korea, Taiwan, China and elsewhere.



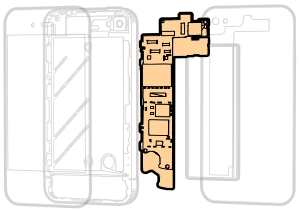
DISPLAYS

5,000 – 10,000
jobs in South Korea and other Asian countries

An industry lost

America was once a leader in television and other display manufacturing. Today, virtually no displays are made in the United States. They mostly come from Asia, especially South Korea and Japan, where wages are not much cheaper but technical manufacturing has outpaced American capabilities.

. . . Made Overseas . . .

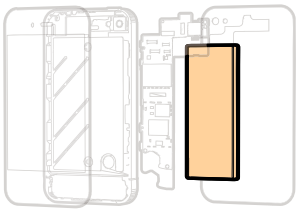


SEMICONDUCTORS (CHIPS)

7,000 – 20,000
jobs in Taiwan, Singapore, Malaysia, Japan, Europe and elsewhere

An industry outsourced

The semiconductor was essentially invented in the United States. Then foreign nations discovered that semiconductor manufacturing could jump-start technology industries. In the 1960s, assembly was outsourced to Asia. Higher-skilled jobs soon followed. Although the latest iPhone processor is made in Texas, most of its other chips are made abroad.



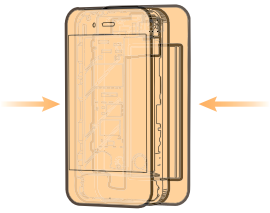
BATTERIES

300 – 1,000
jobs in China

No catching up

Sony helped develop the lithium-ion battery in the early 1980s for use in its consumer electronics devices, including the Walkman. Japan came to dominate the manufacturing of these batteries. Energizer built a battery factory in Florida in the 1990s, but raw material costs and labor rates made it unable to compete.

. . . Assembled in China



ASSEMBLY

200,000
jobs in China

It's not just cheap labor

The iPhone is assembled in China by Foxconn, the largest electronics assembler in the world. U.S. executives say they cannot function without companies like Foxconn. The Taiwanese company has 1.2 million workers, many willing to live in company dorms and spend 12 hours in a factory, six days a week. Chinese workers are cheaper than their American counterparts — but just as important, they are more flexible and plentiful, and thousands can be hired overnight.

Sources: Paul Semenza, senior vice president, Analyst Services, DisplaySearch, an NPD Group Company; Linley Gwennap, founder and principal analyst, the Linley Group; Ron Turi, owner, Element 3 Battery Venture; Wayne Lam, IHS iSuppli

THE NEW YORK TIMES

ers. Apple is among the most widely held stocks, and the rising share price has benefited millions of individual investors, 401(k)'s and pension plans. The bounty has also enriched Apple workers. Last fiscal year, in addition to their salaries, Apple's employees and directors received stock worth $2 billion and exercised or vested stock and options worth an added $1.4 billion.

The biggest rewards, however, have often gone to Apple's top employees. Mr. Cook, Apple's chief, last year received stock grants — which vest over a 10-year period — that, at today's share price, would be worth $427 million, and his salary was raised to $1.4 million. In 2010, Mr. Cook's compensation package was valued at $59 million, according to Apple's security filings.

A person close to Apple argued that the compensation received by Apple's employees was fair, in part because the company had brought so much value to the nation and world. As the company has grown, it has expanded its domestic work force, including manufacturing jobs. Last year, Apple's American work force grew by 8,000 people.

While other companies have sent call centers abroad, Apple has kept its centers in the United States. One source estimated that sales of Apple's products have caused other companies to hire tens of thousands of Americans. FedEx and United Parcel Service, for instance, both say they have created American jobs because of the volume of Apple's shipments, though neither would provide specific figures without permission from Apple, which the company declined to provide.

"We shouldn't be criticized for using Chinese workers," a current Apple executive said. "The U.S. has stopped producing people with the skills we need."

What's more, Apple sources say the company has created plenty of good American jobs inside its retail stores and among entrepreneurs selling iPhone and iPad applications.

After two months of testing iPads, Mr. Saragoza quit. The pay was so low that he was better off, he figured, spending those hours applying for other jobs. On a recent October evening, while Mr. Saragoza sat at his MacBook and submitted another round of résumés online, halfway around the world a woman arrived at her office. The worker, Lina Lin, is a project manager in Shenzhen, China, at PCH International, which contracts with Apple and other electronics companies to coordinate production of accessories, like the cases that protect the iPad's glass screens. She is not an Apple employee. But Mrs. Lin is integral to Apple's ability to deliver its products.

Mrs. Lin earns a bit less than what Mr. Saragoza was paid by Apple. She speaks fluent English, learned from watching television and in a Chinese university. She and her husband put a quarter of their salaries in the bank every month. They live in a 1,080-square-foot apartment, which they share with their in-laws and son.

"There are lots of jobs," Mrs. Lin said. "Especially in Shenzhen."

Innovation's Losers

Toward the end of Mr. Obama's dinner last year with Mr. Jobs and other Silicon Valley executives, as everyone stood to leave, a crowd of photo seekers formed around the president. A slightly smaller scrum gathered around Mr. Jobs. Rumors had spread that his illness had worsened, and some hoped for a photograph with him, perhaps for the last time.

Eventually, the orbits of the men overlapped. "I'm not worried about the country's long-term future," Mr. Jobs told Mr. Obama, according to one observer. "This country is insanely great. What I'm worried about is that we don't talk enough about solutions."

At dinner, for instance, the executives had suggested that the government should reform visa programs to help companies hire foreign engineers. Some had urged the president to give companies a "tax holiday" so they could bring back overseas profits which, they argued, would be used to create work. Mr. Jobs even suggested it might be possible, someday, to locate some of Apple's skilled manufacturing in the United States if the government helped train more American engineers.

Economists debate the usefulness of those and other efforts, and note that a struggling economy is sometimes transformed by unexpected developments. The last time analysts wrung their hands about prolonged American unemployment, for instance, in the early 1980s, the Internet hardly existed. Few at the time would have guessed that a degree in graphic

design was rapidly becoming a smart bet, while studying telephone repair a dead end.

What remains unknown, however, is whether the United States will be able to leverage tomorrow's innovations into millions of jobs.

In the last decade, technological leaps in solar and wind energy, semiconductor fabrication and display technologies have created thousands of jobs. But while many of those industries started in America, much of the employment has occurred abroad. Companies have closed major facilities in the United States to reopen in China. By way of explanation, executives say they are competing with Apple for shareholders. If they cannot rival Apple's growth and profit margins, they won't survive.

"New middle-class jobs will eventually emerge," said Lawrence Katz, a Harvard economist. "But will someone in his 40s have the skills for them? Or will he be bypassed for a new graduate and never find his way back into the middle class?"

The pace of innovation, say executives from a variety of industries, has been quickened by businessmen like Mr. Jobs. G.M. went as long as half a decade between major automobile redesigns. Apple, by comparison, has released five iPhones in four years, doubling the devices' speed and memory while dropping the price that some consumers pay.

Before Mr. Obama and Mr. Jobs said goodbye, the Apple executive pulled an iPhone from his pocket to show off a new application — a driving game — with incredibly detailed graphics. The device reflected the soft glow of the room's lights. The other executives, whose combined worth exceeded $69 billion, jostled for position to glance over his shoulder. The game, everyone agreed, was wonderful.

There wasn't even a tiny scratch on the screen. ■

David Barboza, Peter Lattman and Catherine Rampell contributed reporting.