The Quotidian Labour of High Tech: Innovation and Ordinary Work in Shenzhen

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[Accepted version]

Published in: *Science, Technology and Society*, 24, no 2: 218-236.

https://journals.sagepub.com/doi/abs/10.1177/0971721819841997

Introduction

China's economic trajectory is often described in terms of a progression from cheap manufacturing towards increasingly "high value" forms of work and production. According to these accounts, the former "workshop of the world" is now becoming something else - a space of innovation, or a space of creativity, or a space of design. This kind of rhetoric is especially prevalent in discussions of the "Silicon Valley of China": Shenzhen. This city, more than any other, has become the focus of hopes, dreams, and fears of Chinese technological development.

Shenzhen is best known as China's first Special Economic Zone (SEZ). The city emerged after 1980 as part of Deng Xiaoping's reform and attempts to open up China to the world. Shenzhen now boasts China's third largest urban economy (after Beijing and Shanghai) with a 2018 GDP of US$350 billion heavily dominated by high-tech industries including electronics and biotechnology (He 2019). In the 1990s, the SEZ became the site of large-scale foreign investment in electronics factories (for example, Hon Hai or Foxconn from Taiwan). Later, the city gave rise to some of China's largest and most dynamic high-tech companies including Huawei (the world's largest telecommunication equipment manufacturer), Tencent (China's most valuable technology company), and BYD (one of the world's fastest growing automotive companies). By some estimates, ninety percent of the world's electronics are made in Shenzhen (Harris 2017).

Most accounts of Shenzhen's development point to the growing importance of this home grown high-tech in the city's economy. In this narrative, Shenzhen was once just a factory site for overseas brands (Foxconn's manufacturing of iPhones, for example) but has progressed to have its own companies and products. The rise of indigenous brands with global reach from Shenzhen points to China's move "up the value chain." These industries are supposedly driven by a cast of characters that includes entrepreneurs, visionaries,

engineers, start-ups, hackers, makers, and industrial robots. In particular, much has been paid to the role of hackers and makers who have flocked to Shenzhen from both within China and from overseas. Silvia Lindtner's work, for example, has focused on the role of "do-it-yourself" makers as "individually empowered" – crafters of subject positions that see their hardware hacking as part of a larger attempt to remake China's economy, politics, and citizenry (Lindtner, 2015). Denisa Kera, too, while arguing that Shenzhen defies "stereotypes of where production and innovation happens" describes the city in terms of hackers, makers, incubators, visionaries, and entrepreneurs (Kera, 2014). This is a vision that, since 2015, has also been strongly endorsed by the central Chinese government. Beginning with Premier Li Keqiang's visit to Chaihuo Makerspace in Shenzhen, making and hacking has become a part of the government's "Made in China 2025" strategy for creating jobs and wealth through "mass innovation and entrepreneurship" (Xue 2018).

Such narratives reinforce a unilineal notion of technological development: Shenzhen (and, by extension, China) are following the United States (and, specifically, Silicon Valley) in moving from low-value (manufacturing) to high-value (design) forms of work. The valorisation of "hackers" and "start-ups" is premised on an idealized Silicon Valley model of development which follow a familiar trajectory: garage start-up, rounds of angel and venture capital investment, rapid growth, and IPO. In this vision, hackers and makers are celebrated as entrepreneurial, democratic, collaborative, global citizen-artisans (Gershenfeld, 2008). These formulations also suggest that Shenzhen – alongside other global cities – will follow a more-or-less pre-determined path towards a Silicon future. This is a version of technological determinism in which the particular technologies (silicon electronics) are inexorably tied to particular institutional and social forms of production (startups, garages, hacking, making, etc.). "Innovation" must look like a caricature of Silicon Valley in order to be seen as innovation.

This model is problematic for several reasons. First, it takes for granted that innovation and creativity amount to "progress" over manufacturing, and that silicon technologies (especially smart phones, tables, and other personal electronic devices) will be the way to achieve that progress. Nahm and Steinfeld (2013) have argued that the duplications, simplifications, and modifications that take place Chinese firms should not "be judged hierarchically in either commercial or normative terms" (p. 290). In a different context – laptop manufacturing – Ling-Fei Lin has shown how the purportedly clear separation between low-value manufacturing and high-value design is in fact an extremely murky one. This undercuts the notion that there is a clearly hierarchy between manufacturing

and design, or that economies should aim to move "up" from one to the other (Lin, 2016).

Second, this model obscures the multiplicity and diversity of high-tech work. Critical literature on hacking and making has drawn attention to the range of practices and models that actually constitute innovation work (Davies, 2017; Hunsinger and Schrock, eds., 2018). Celebratory narratives of making (and Silicon Valley) often serve to hide these more diverse practices. These observations take inspiration from Chachra's (2015) argument against the rhetoric and privileging of "creators," the masculinist orientation of the maker movement, and the consequent invisibility of "not-making, repair, analysis and especially caregiving." Similar observations have been made by scholars who have conducted detailed ethnographic studies of hacker and makerspaces (for example, Reed, 2016; Rosner and Fox 2016). Following these scholars, I argue that the electronics economy depends critically not just on "makers" but on all kinds of other labor, including the labor of caregiving that Chachra refers to.

One could also frame this in terms of class, rather than gender: the "maker" movement is a movement of the upper-middle classes: it is practiced by the globally mobile citizens, in China and elsewhere, for consumption by wealthy consumers. It is not so much that there are no female makers in Shenzhen – there certainly are; but rather, the city's innovation economy depends critically not just on "makers," but on all kinds of other labour. What seems most interesting about Shenzhen's electronics is that it not only relies on, but seems to spring in large from lower-middle class and lower-class work – devices made by small factories and shops, sold by small enterprises, and specifically designed for the less wealthy, especially those in developing countries.

By making certain workers and certain forms of work invisible, the Silicon Valley model assumes that innovation and development will emerge in China in ways that are similar to the west and that China is merely following patterns and paths established elsewhere. The aim of this paper is to turn attention to the actual practices of work in "high-tech" industries in Shenzhen. This means turning attention to multiple kinds of spaces in the production of high-tech electronics. By examining such spaces, I hope to shed light on the relationship between Shenzhen's "innovation economy" and the kinds of work that people actually do in making "high-tech" products.

I focus here on three kinds of spaces in Shenzhen: the Huaqiangbei electronics markets, small-scale factories, and industrial design workshops. I aim to show that the kinds of labor that are performed in these spaces are critical to the innovation economy that Shenzhen is now famous for. This work is unlike both the large-scale electronics

manufacturing taking place at Foxconn and other multi-national companies and the hacking and making that takes place in makerspaces and Silicon Valley-style start-ups. Rather, we find ordinary people and ordinary work – work that is nevertheless critical to the size, speed, and density of the markets, allowing devices and prototypes to be built and shipped rapidly, for parts to be available, and for customers to be available. Most of the kinds of work described here – the middle-tech and often invisible work – is performed by domestic migrants, women, and the lower (but not lowest) socio-economic tiers of Chinese society.

It is sometimes acknowledged that Shenzhen's "maker" scene (and Shenzhen's innovation economy more widely) depends and subsists on networks of small-scale sellers, industrial designers, and factories. But it is less clear what actually goes on in those spaces and how that work relates to the work of "making" and innovating. This essay aims to describe this work and attempt to situate it with respect to the more highly visible, large-scale factory production, start-ups, and "making" also taking place in Shenzhen. By focusing attention on different kinds of work and different kinds of spaces that support the local economy, we can begin to see just how the development of labor (and its relationship to technology) in East Asia is following complex and multiple paths. We need a way to describe these developments in ways that don't fall back on Silicon Valley models of "making" and "innovation."

Methodology

This paper is based on multi-sited ethnography in Shenzhen between 2014 and 2017 comprised of four visits to the city ranging in duration from a few days to a few months. This paper emerges from a broader project to document the rise of the biotech industry in Shenzhen and understand the place of biomedicine within the city (Stevens, 2018). Understanding the role of electronics in Shenzhen's development and economy became a critical part of this project. As such, I supplemented my visits to biotech firms with visits to other sites relevant to Shenzhen's "high-tech" industries more broadly. This included several trips to the Huaqiangbei electronics markets, maker spaces, one industrial design firm, and one small-scale factory. The majority of these visits occurred in the summer of 2017 during an extended visit to Shenzhen during which was a hosted as a visitor at the Centre for Special Economic Zone Research at Shenzhen University.

During visits to my fieldwork sites, I interviewed a variety of individuals, both Chinese and foreign, working in various parts of the "electronics industry" within Shenzhen. This

included “makers,” those working in electronics markets in various capacities, industrial designers, and small-scale factory owners. About a dozen interviews were conducted in total, ranging in length from brief unstructured interviews of several minutes to longer, more formal interviews of several hours. I recruited interviewees via email and WeChat, via contacts at Shenzhen University, and by approaching individuals directly in the electronics markets. In addition, I made several valuable contacts via Shenzhen University’s “English corner” – a bi-weekly campus gathering for students to practice their English.

As with any ethnography, one’s perspective is partial. The markets, as commercial spaces, are relatively open and easy to access and I could visit them freely. Factories, industrial design firms, and maker spaces are private or semi-private spaces and necessarily harder to negotiate access. Although my access to such spaces was limited, I used interviews, conversations, and secondary literature to widen and extend my view.

Access was also limited by language. The *lingua franca* in Shenzhen, a city of migrants, is Mandarin, although many more educated workers also speak English. In the electronics markets, one can hear a variety of Chinese dialects including Cantonese, Hakka, Teochew, and Fujianese. I have visited these spaces both with and without a local-language-speaking guides. I conducted interviews either in English or with the assistance of a local translator (also recruited through my contacts at Shenzhen University).

The paper will open with a very brief description of the development of the electronics industry in the city. The subsequent three parts will then describe, in turn, the kinds of work taking place in small-scale factories, industrial design workshops, and electronics markets, respectively. The final section will analyze the implications of these various types of work for thinking about work, innovation, and high-tech manufacturing in East Asia.

The emergence of Shenzhen’s electronics industries

Shenzhen’s economy started largely with garment manufacturing. Overseas firms took advantage of cheap land and cheap labour in the SEZ. However, by the late 1980s the economy began to transition to other industries such as electronics manufacturing, much of it driven by overseas investment. Companies such as Foxconn set up factories in Shenzhen, bringing manufacturing expertise with them. By the late 1990s, Shenzhen had a large workforce with experience in the electronics manufacturing industry and a dense clustering

of electronics manufacturing firms. Under the OEM contract manufacturing system, large-scale manufacturers were able to fill orders for multinational consumer electronics firms. However, the growing global demand for DVD players, MP3 players, and cellular phones meant that smaller markets also existed, both within China and other developing economies. Because many of these consumer devices were being manufactured in Shenzhen, smaller firms could quickly gain knowledge and know-how through imitation, reverse engineering, or outright copying.

By the early 2000s, such conditions had given rise to an entirely new electronics industry in Shenzhen based not large-scale manufacturing for multinationals, but rather on rapidly prototyping and manufacturing of cheap consumer electronics for developing world markets, often in small production runs. Such manufacturing was often based on small tweaks of existing technologies, running roughshod over intellectual property laws (Nahm and Steinfeld 2014). This practice has become known as "shanzhai" – literally "mountain stronghold" in Mandarin – denoting an escape from the government rules and in particular here, escape from the rules of international intellectual property (Yang and Li, 2008).

Factory

Such descriptions give a very general idea of *what* is produced in Shenzhen but very little idea of *how* the work of producing electronics actually happens. The rest of this essay is devoted to describing the kinds of spaces and kinds of work in and through which electronics get made. I begin here with the description of a small-scale factory on the outskirts of Shenzhen that I visited in the summer of 2017. Although Shenzhen is home to large-scale factories such as those that belong to Foxconn and other contract manufacturers, small-scale factories such as the one described here are ubiquitous in the city and form the core of its work. As I shall argue, such factories and the flexible work they offer, are critical to the way in which electronics manufacturing functions in Shenzhen.

* * *

The BaseCam factory is located near a new subway station in the northern part of the metropolis. Hong, the factory owner, shows me the products he is currently producing.[1] They are cameras designed to be installed in shops or homes that wirelessly feed images to your

[1] I use pseudonyms to refer to both the names of companies and informants.

smartphone. The cameras can be viewed and controlled in real time; re-aligned, zoomed, set to record, set to take still shots, or set to motion-detect modes. Because the cameras work via the Internet, a user could be surveilling their premises in Australia while on vacation in China. Hong pulls up some feeds on his phone to demonstrate — it feels like spying over Skype.

The office shelf itself contains maybe as many as a dozen different models, some smaller, some larger, some prototypes, some newer models. BaseCam is constantly refining as revising its designs, sometimes borrowing or copying from other camera designs and sometimes developing his own ideas. This is where Shenzhen itself becomes important for this kind of work: "everything is already here," Hong stresses. Ninety percent of their production materials are locally produced; even the chipset is from Huawei, a local company. This allows new ideas to prototyped in as little as twenty days, Hong tells me. In this kind of work, "what matters is not the size but the speed"; even the ideas themselves are not very important since they can be tested and used or discarded so quickly.

The factory floor itself is across the hall from Hong's office, and not much larger than it: about fifteen meters by twenty-five meters, with windows running along the far wall. By the time we arrive at the factory the Saturday shift is over; but Hong described to me the workings of the factory floor. The workers would be arranged along three rows of waist-high benches that run almost the full length of the room. At each position on the bench, a drill-like tool hangs down from the ceiling. The rows of benches form a kind of production line within the room, with each worker responsible for attaching a different piece in the camera assembly (figure 1). Raw materials are stockpiled in boxes lined up against the wall nearest the door. The workers would retrieve items they need from these boxes, process them by assembling one or more pieces together, and then pass the resulting product down the bench to the next worker. The last row of benches, under the windows, is the quality control area where the devices are inspected and tested before being packed into the boxes that are stacked up against the far wall.

All in all, when BaseCam is operating, this room would contain about thirty people. There is little automation to be seen here. Some of assembly the processes for Hong's products requires small powered hand tools, but much of it is manual labour, requiring dexterity and practice. Hong described how this small workforce can be easily retrained and re-arranged within the room to assemble a new product or a new design. Changing from building one type of camera to another might involve only introducing a few new parts or rearranging a couple of workers and their bench-stations. More elaborate shifts from one type

of product to another could also be performed relativity quickly by re-organizing the whole room.

Hong employs about eighty people overall, including the office staff. Like other factories in and around Shenzhen, the workers work from 9am to 6pm with an hour and a half break for lunch, five days per week, plus every second Saturday. Mostly migrant workers, they live within the factory compound in dorms of between six and eight. The workers are both men and women.

What matters here, as Hong remarked, is not the scale — the factory is remarkably small — but speed and flexibility: the ability to produce quickly and move from one design to another quickly either to meet the demands of new customers or to keep up with the latest technologies. The supply chains are mostly local, drawing on some of the thousands of other small-scale factories and businesses in and around Shenzhen. And Hong's business associates and networks are local too. His business partner and vice-president is a close friend, his wife plays many roles within the business, and many of his suppliers and customers are connected by friend and family networks. These close and local networks are critical to his ability to do business rapidly.

It is this kind of factory – this kind of business – that is critical to what Shenzhen's electronics industries are able to accomplish. It is precisely this localness, the small-scale, and the human-centeredness of the work that allow businesses like BaseCam to rapidly adjust to new technologies or new markets and to prototype (and then retool for) new designs. This has an indirect effect on larger-scale manufacturers like Foxconn and Huawei as well: such small-scale factories are not only suppliers and customers but also contribute to maintaining a supply of semi-skilled workers who move between the larger and smaller factories. This suggests that there is significant informal circulation of knowledge between larger and smaller firms.

Industrial design

Factories form only one part of the ecosystem of electronics manufacturing in Shenzhen. Evidence from my informants suggested that it may actually be industrial designers that are the most important links in the economy of the city. Designers not only do the work of transforming ideas and products concepts into manufacturable products, but in doing this, they link together entrepreneurs and consumer electronics companies with factories and with suppliers in the electronics marketplaces. Big and small consumer electronics firms, both

Chinese and overseas, rely on designers and design firms (such as the one described here) to connect them to networks through which they can source materials and actually produce their products.

* * *

On one of my visits to Shenzhen I was invited to visit an industrial design firm. The firm, Suntop Designs, is part of Shenzhen Design Industrial Park in an area called Nanshan. I had been introduced to Mark at a Shenzhen makerspace, a place he hangs out for fun; his day job is as an industrial designer at Suntop. Along with one of his colleagues, Mark shows me around his workplace. Suntop is one of the larger design firms in the industrial park — it covers six floors of a relatively large building – and employs over one thousand designers, not just in Shenzhen but in several Chinese cities as well as in Sydney.

Part of the ground floor of the company houses a kind of design museum for Suntop's products. The range is enormous: phones, and other consumer electronics of course, but also medical equipment, household appliances, and military hardware. Suntop works with both local and international firms to guide them through the design, prototyping, and manufacturing process. "Complete industry chain design and innovation," Mark tells me, includes not only the physical design of products but also research and development, developing a supply chain, user testing, branding, marketing, guiding products through the production process, and help with intellectual property (they have a separate patent services office).

On most of the floors of the building, the designers and engineers are seated at low wooden desks, mostly tapping away at laptop computers. The work that goes on in the office is critical to the firm's business, but Mark and his colleague stress to me the importance of designers leaving their desks, especially to visit factories. Good design is a back-and-forth process: customers may have an idea, but the job of Suntop's employees is to make sure it can become a reality. This means ensuring that it is feasible — that it can be built and scaled up for mass production. This most often means physically going and checking on what factories can and cannot do.

The second floor of the building was reserved for a sort of library of materials. Rows and rows of shelves contain plastic, cloth, and metal samples, in a variety of shapes and colours. It is here that designers come to work out what materials they can use to build their products — a sample of almost every material, texture and colour available in Shenzhen's factories can be found here. Each sample is carefully coded such that it points back to a particular factories or specific suppliers that can produce or stock that material.

A typical product development process would usually begin with a client approaching the firm with an idea for a product. Suntop's designers would utilize their local knowledge of the electronics markets to find out whether similar products already existed and in what forms. This might result in abandoning the idea altogether (if a very similar product already exists, for example) or refining the idea (including borrowing ideas from similar products). Any refinements would focus on rapidly developing a prototype that could be scaled-up quickly. These steps depend on knowledge of what materials are available (including the library described above) and what capabilities exist for moulding or shaping particular materials. Here again, local networks are critical in providing knowledge about what factories can actually do: designers would liaise with factory bosses like Hong to determine what their factory can make, with what materials, and how quickly.

Once a design is agreed upon, a prototype would be rapidly produced, usually in under a month. Samples of the prototype would be sent to the client who might also share them with their potential clients in order to garner feedback. This would result in a further process of refining the design in consultation between the client, Suntop's designers, and the factories and suppliers involved. In bringing the product into production, Suntop would help to find suppliers of source materials and to locate a suitable factory or factories for production. The designers would also assist with patenting and marketing the product if necessary.

John, an informant who runs a makerspace in Shenzhen, described a similar story of how new products get developed. The "real innovators" in the city, John argued, are not makers and hackers. Rather, in the electronics markets one could find middle-aged Chinese men in polo shirts with a leather briefcase; they would probably be flying business class from some other part of China and staying in an upscale hotel. These men, John reported, are the real ones who come up with new ideas for new products, based on informal market research they conduct back in their home towns. They come to Shenzhen, as they have been doing for many years, to see their friend the factory boss and present their ideas. Together, the out-of-town businessman and the factory boss decide which idea are feasible. Then, they hire some industrial designers (such as those at Suntop) to design a prototype. This takes place incredibly rapidly, over just a few weeks. Meanwhile, the businessman eat nice dinners, sing karaoke, and play golf. The businessman then takes a few suitcases full of prototypes back to his home towns to try to generate orders for production. Here, the real innovators are not young entrepreneurs in a makerspace but older businessmen out on the town (Stevens, 2017).

It is in these types of interactions between designers, factory bosses, and

entrepreneurs that the special features of Shenzhen become important. Mark stressed to me what made Shenzhen so critical for their business. First, Shenzhen (and the cities surround it, especially Dongguan) have long been homes for suppliers of electronics; this create the dual advantages of "information and location." These factories have the latest technologies and the latest materials, getting it first and developing it fast. This give firms here an immediate advantage over those in other cities. The sheer size and speed of the market here also means that designers quickly become experienced and knowledgeable, giving them a further advantage over their competitors.

As well as the factories, the electronics markets at Huaqiangbei were important partners for Suntop designers too — as described in the following section, parts could come quickly from contacts and suppliers located there. But the markets were also sources of new ideas and new designs too; design firms including Suntop contributed to the design and development of "copycat" electronics such as shanzhai phones, collaborating with local businesses based in Huaqiangbei. Close cooperation between the various parts of this ecosystem (designers, factories, electronics markets) – what Mark described as "win-win coexistence" – was essential for success.

Second, Mark stressed the role of the business environment in Shenzhen. As the "first open city in China" it had attracted immigrants, mostly young people, from all over China. According to Mark at least, this meant more openness (including to foreign firms), less orientation towards the government, and more "business" orientation. People here not are looking for graft, but rather to make money and get things done. This made for a business environment that was superior to other cities in China.

* * *

"Design" is now lauded in the west as a new and celebrated kind of "knowledge work" that is central to the innovation economy (see, for instance, Miller 2015). In Shenzhen, "design" is not a separate "knowledge work" activity, but deeply integrated into the broader ecosystem of electronics manufacturing. As I have suggested here, the most important aspects of design are not "ideation," but rather working closely with suppliers of materials and with factories to produce manufacturable products that can be scaled-up to mass production. Nahm and Steinfeld (2014) aptly call this form of innovation "making designs come true" (p. 296). Although some of these designers are well educated and well paid, their work remains dependent on local networks of small factory bosses, small suppliers, and small businesses. Shenzhen's competitive advantage lies in the fact that design and engineering are tightly integrated into the processes of manufacturing: it is precisely the dense social networks that

exist between designers, factories, and suppliers that allow products to be quickly produced and reproduced.

Electronics markets

The final section of this paper turns to examine the most visible face of the electronics industry in Shenzhen: the markets at Huaqiangbei. These markets have usually been described as purely commercial spaces, especially as places for the selling of illegal and counterfeit goods (eg. Hu 2008). However, markets showcase the scope, range, and diversity of activities of electronics-making and serve a range of purposes: they sell finished goods to customers in China and overseas (often through middle-persons of various kinds); they supply materials to manufacturers and small factories both in Shenzhen and elsewhere; and they act as wholesalers, resellers, distributors, and middle-persons for a range of electronics-related goods. Perhaps most importantly, they serve as a public space within which the range of actors in electronics design, manufacturing, and sale can interact and observe the range of products and activities on offer; the markets serve as a highly visible marker of the diversity of what is made and re-made in Shenzhen.

Huaqiangbei is an area located in the central business district of Futian in Shenzhen. The majority of businesses in Huaqiangbei are small vendors selling a wide variety of consumer electronics components: wires, screen, power supplies, batteries, resistors, etc. These markets look something like medium-sized, windowless shopping malls. Upon entering, the electronics shopper is greeted with a complex warren of almost-overlapping businesses. While the lower floors often house spaces selling finished name-brand consumer goods, the higher floors are home to a wider variety of electronics-related businesses. Individual stalls can be as small as about two square meters (some are even smaller, a few are larger). Despite the size, rents are high, especially for prime positions in the markets: one informant told me he paid RMB10000 per month (about $1500 USD, a high price for a very small space with few amenities). The rest of this section describes the kinds of work that are taking place here, roughly in order of how common they appeared to be.

i) Assembly

One of the major kinds of work is various forms of “assembly” of electronics components for sale. This word is to be construed broadly here, and there is a range of

complexities of activities involved. For example, one of my informants' business was to sell screens, mostly for tablets. When I first asked about this, it seemed that this was merely a kind of wholesale business – on-selling the screens from factories to tablet manufacturers in China and overseas.

However, some minor assembly work was involved – I watched as my informant and his employees completed one order in which they took the screens and attached the button and the associated wiring to the back side of it: the button and wiring assembly was attached to adhesive paper and their work was to remove it and place it correctly on each screen and then wrap the screens for shipment. Similarly, the next-door stall was wrapping mobile phone batteries in plastic for shipment. This is hardly complex work, but it is a critical part of the economy of consumer electronics manufacturing (figure 2).

Compared to these very simple tasks, other stalls had what an informant described as "small factories." Here, I observed workers using soldering irons to actually wire components together, or using desktop sized pieces of equipment such as metal presses and cutters to shape and cut logos cases for phones or tablets, for example.

This kind of work is continuous and even overlapping with what goes on in "real" small-scale factories in other parts of Shenzhen, such as the one described above. There is an overlap in personnel too: many of the workers in these markets are former employees in Shenzhen's factories. One of my informants had worked in a bicycle factory in Shenzhen before opening his own small electronics business in the Longsheng Communications Market. It is hard to know exactly how widespread such circulation is, but it is likely that other business owners in the market had worked in electronics assembly and manufacturing elsewhere, allowing them to draw on their contacts back in the factories as both suppliers and customers.

ii) Recycling and Repair

The second most common type of work was repair and recycling of electronic parts, especially mobile phones and tablets. In some cases, this would involve a one-off customer wishing to get their phone repaired: phones or tablets would be sent to particular booths within the market specializing in particular types of repair (eg. screens or batteries).
But this appeared to be small fraction of the repair business within the electronics markets. More importantly, the markets have become clearing houses for old, discarded and broken phones (and other devices). Discarded phones are collected or bought by these small

businesses and refurbished for re-sale as second hand phones. Many of these small businesses have extensive networks either in China other parts of the world including Thailand, Vietnam, the Middle East and Africa where the market for such second-hand phones is large (because people can't afford new phones).

In Shenzhen, collection points for old phones and tablets can be found across the city, often in transparent "mailboxes" on the street. Such phones likely end up at the Huaqiangbei markets. Even when phones cannot be salvaged as second hand, these businesses operate in stripping them down and selling the parts, recycling the various valuable components of the phones, either as spare parts or raw materials. Some vendors had piles of hundreds of old phones on their workspaces waiting for such treatment.

iii) Testing

Hand-in-hand with repair goes testing. The testing of components and finished consumer electronics products is also a big part of the activities at the markets. This is sometimes part of the assembly and repair and recycling businesses, but sometimes separate. Often, particular vendors specialize in testing particular parts and have specialized equipment and skills for doing so.

For example, I watched as one worker in the markets connected screen after screen to the body of a smartphone and performed a routine of standardized set of tests on each one: attach the screen, move finger up, move finger down, move finger left, move finger right, swipe up, swipe down, disconnect the screen and proceed to next one. This took about thirty seconds per screen. Another booth had a specific device for charging up tens of phone batteries at once in order to test them. Another woman was at work in a stall where she had a much more sophisticated machine into which she could plug mobile phone chips – she could then execute a series of commands on a laptop attached to the device which would check that the chip was booting up correctly.

Since many of the goods could be described as "grey market" (coming from, for example, extra shifts at factories), such testing is no doubt critical for ensuring that products are working or meeting specifications. Individual vendors have customer relationships to protect, so testing is important to making sure they can guarantee not necessarily the highest quality

products, but at least products that are working.

iv) Packing and Shipping

Many of the customers for all of the goods sold in the markets are either in other parts of China or overseas, especially in the developing world. In many cases, these customers may never be seen in person. For customers in China, orders are often received via WeChat, for example. The electronics markets are also one of the few places you are likely to find foreigners in Shenzhen. There are a few Europeans, but it is easy to pick out amongst the crowds many individuals from Russia, the Middle East and Africa, in particular. These individuals are either looking to buy parts for assembling phones or other electronics in their home countries or looking to buy finished products (such as shanzhai phones) for resale overseas. They will likely be placing medium sized (500-1000 units) or even large (5000 to 50000 units) orders.

Because of this, a huge amount of the work of these markets is packing and shipment. Some whole businesses are based on packing. One woman had a whole table full of thousands of tiny screws neatly arranged in small boxes in front of her; a finished iPhone is held together by about twenty different kinds of screws of various lengths and sizes that go in different places inside the phone. The woman was packing small plastic bags containing one complete set of all the screws necessary to assemble one iPhone. These packets could then be sold to other businesses who either assembled or repaired iPhones.

At the entrances to almost all the markets one can also find dedicated stalls for shipping. Often, they prominently display the logos of DHL, FedEx, etc., but many of them have nothing to do with these multi-national companies. These businesses are responsible for delivering the products of the market to customers all over China and the rest of the world. These activities as critical to the markets' work – the speed, scale, and global reach that these markets can have depends critically on all these activities.

v) Branding

There is also a significant amount of work in the market that is focused on what might loosely be called "branding." These operations are usually also on the ground floor, near the shippers, suggesting that it is something that businesses do as they are getting their products out the door. This includes activities such creating logos and stickers for products that can be

placed on cases and boxes. For example, designs can be etched or stamped, or cut, into the metal cases of phone or tablets.

These services can very quickly produce any logo at all. Businesses can put an Apple or Samsung logo on their phones, or something resembling a recognisable brand (there are lots of "pear" phones available), or they can design their own. Some vendors will print stickers or sticky labels. If a business needs one thousand "Toshiba" stickers to put on the laptops they just assembled, these can be printed up rapidly and on the spot.

All this is certainly part of the shanzhai economy too. The ability to produce and ship completed goods (including labels and brand names) — including "copycats" and "lookalikes" — is part of "Shenzhen speed." In 2014, when I first visited these markets, there were also older women (and they did seem to be all women) who stood outside the electronics markets with what looked like big calculators in their hands. Their service was to provide fake receipts – if you wanted a receipt to say you had actually bought five hundred Toshiba laptops, they would sell the necessary documentation for a few dollars. These vendors too served an important purpose within this copycat "grey economy."

vi) Caregiving

Finally, I want to note several other kinds of work that take place in these markets that are certainly in plain view, but easily overlooked or rendered invisible. The stalls within the electronics markets are most often family-run small businesses. One of my informants got into the business via his sister-in-law, setting up shop almost alongside her. Extended family and local networks are also important – two young girls working together in one stall came from the same home town and had known each other there; now they worked together in the market.

The Golcunda market, in particular, was obviously a family space. Lots of children were running around or playing with toys or asleep in strollers in the aisles and spaces between the stalls. Childcare was very clearly part of the work taking place in these markets. The very long hours and labour-intensive work of assembly and packing means that children in many cases had to be in the markets with their parents. Indeed, the markets also provided a flexible kind of environment for this – work (for example, packing boxes or assembling parts) could be done in between or simultaneously with child care.

Also within these markets were other kinds of stalls that supported the electronics work: food sellers, mini-mart type stalls, stalls selling tools, and I even found stalls selling

bottles of liquor (presumably for celebrating a big deal). Perhaps even more unexpectedly, one stall told only teapots; tea is an important part of market activities – most stalls have quite an elaborate tea set somewhere on their counter or inside the stall. This is likely because this is because offering and drinking tea together with a potential customer or client is an important part of the ritual of doing business; tea is also critical to the ecology of shanzhai electronics.

* * *

It may seem strange to focus on childcare and mini-marts in a discussion of electronics manufacturing. However, my argument here is that it is precisely this kind of "ordinary labour" that enables Shenzhen's "innovation economy" to function as it does. It is the human scale and social dimensions of these forms of work that allow dense and overlapping networks of suppliers, factory bosses, and designers to function. This is not just about having many people and small businesses in one place, but also about the diversity of practices – repair, recycling, packing, assembly, caring, shipping, networking – that allow the markets to supply parts cheaply, at speed, and to order. Without the human and social practices of tea-drinking, child care, and other "ordinary" activities, these markets could not operate at the scale, density, and pace that they do; and it is these very features that make Shenzhen's electronics economy so unique. These forms of work promote and enable the dense integration of manufacturing, customers, suppliers, designers and knowledge exchange between them.

Conclusions

Scholars have accounted for the early success of Silicon Valley by pointing to the unique ways in which its industries were organized – cooperative networks allowed information sharing and outsourcing, as AnnaLee Saxenian (1994) has argued. The flexibility offered by cooperation allowed Silicon Valley to outcompete vertically integrated firms elsewhere in the United States. There are some important similarities here with Shenzhen's industries: flexibility, rapid flows of information, and outsourcing. Ge and Fujimoto (2014), for example, have pointed out the importance of horizontal coordination amongst motorcycle firms in China and Brandt and Thun (2010) have noted the importance of close-knit supply networks in various manufacturing industries.

But there are also critical differences between China and Silicon Valley. First, the state has played a very different role in China, both in fostering the growth of SEZs (Zeng 2011) and in continuing to promote the development of particular townships and "strategic" industries (Barbieri, Di Tommaso, and Bonnini, 2012). Second, the foreign firms and foreign investment have played (and continue to play) a key role in the development of Shenzhen's electronics industry (Ernst and Naughton 2012). Third, as the factory described here suggests, Shenzhen's ecosystem is based on small-scale industries. Saxenian's work refers to medium-to-large companies engaged in capital-intensive semiconductor manufacturing. Fourth, Silicon Valley depended on a highly educated workforce of scientists and engineers, many of who emerged from elite universities (such as Stanford). Much of the "innovative" labour of Shenzhen, on the other hand, is performed by relatively non-elite workers. Not only the factory workers, but even many factory bosses, managers, and suppliers are not elites either in terms of education or money.

In short, these differences suggest that the superficial similarities between Silicon Valley's ecosystem and Shenzhen's are overshadowed by important differences in the kinds of work that are being performed and the kinds of people that are undertaking it. Nellie Chu (2016) has argued that the "fast fashion" garment industry in Guangzhou is critically dependent on new kinds of practice that combine "craft" with mechanized mass manufacturing. Sitting at an "ambiguous boundar[y] between craft and industrial modes of production…[t]hese craft-like practices feature piecework, low-volume production, modest technical skills, and hand labor." Such a description could also apply, with few modifications, to much of the work in electronics factories and electronics markets in Shenzhen. The blurring of the boundaries between industry and craft, between worker and boss, between wage worker and entrepreneur is as much a feature of high-tech industries as it is of garment manufacturing. As Chu argues, these craft-like practices enable the rapid responsiveness, small order sizes, just-in-time, and low costs that characterize "fast fashion."

Likewise, the Shenzhen's productivity in electronics depends critically on what I have described here as "ordinary" work: the diverse practices of electronics-making described here and the tight networks and connections that exist between them. It is these connections that facilitate the speed of creativity and innovation that allows products to be copied, reverse engineered, designed, built and shipped rapidly: they enable parts to be available and for the parts, in various stages of assembly, to move rapidly between buyers and sellers. All the kinds of work described here – the middle-tech and often invisible work – creates the ability to do things fast, to change fast, to be flexible, to make fast, and to ship fast. The role of

caregiving, packing, shipping, branding in close geographical and social proximity to one another contributes to the kinds of rapid back-and-forth processes and the flexible and customer-oriented systems on which the innovation economy depends. Without the family-centred, small-scale, craft-like, workshop-based practices describe here, this system could not operate at the density and speed that makes it successful.

All this might be described in terms of "flexible specialization" and "economies of scope": flexibility in product design and rapid responses to changing market demand (Piore and Sabel 1984). However, my aim here has been to describe how such specialization arises from variety of different activities in a variety of different spaces within the city. This is not just a story about factories rapidly switching from one product to another, but about how new ideas, designs, and products emerge from *interactions* between factory workers, factory bosses, industrial designers, small-scale entrepreneurs, and others working in the electronics markets. This is a story about innovation arising from diverse forms of work and diverse people in diverse places.

Xue Yujie has recently argued that China's makerspace bubble now appears to have burst (Xue 2018). This presents an opportunity to re-think the emphasis on making and hacking that has dominated much of the thinking about electronics in Shenzhen. The ecosystem I have described here suggests that we need to rethink accounts of innovation that derive largely from Silicon Valley. Rather than assuming linear progress from "low value" to "high-value" forms of work or from "manufacturing" to "design," close attention to how electronics manufacturing actually operates in Shenzhen suggests its success depends on intricate combinations of imitation, small-scale adaptation, specialization, craft, design, and other forms of work. All these depend on the unique and specific history, geography, and social structure of Shenzhen.

It is now impossible discover a "purely Chinese" notion or practice of innovation since what is happening Shenzhen and elsewhere is playing out in response to Western models. However, this should not blind us into thinking that what is happening in China is a straightforward "copy" of what happened in Silicon Valley or elsewhere. We should not expect Shenzhen to take the same technological paths as the United States. Rather, high-tech electronics manufacturing in China is embedded deeply within a very different history and a very different social structure. The forms of work that I have outlined here have been an attempt to sketch out this very different Chinese path towards "innovation." Ultimately, I hope that this argument will help to destabilize the self-serving and triumphalist accounts of "innovation-centered" technological progress that have emerged from Silicon Valley. By

seeing how new products, new ideas, and new designs can emerge from a very different ecosystem, we might be able to begin to break free of Silicon Valley's grip on our technological imagination and, most ambitiously, see new possibilities for organizing the relationships between technology and society.

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