

China's fast Paced progress in Optomechanics

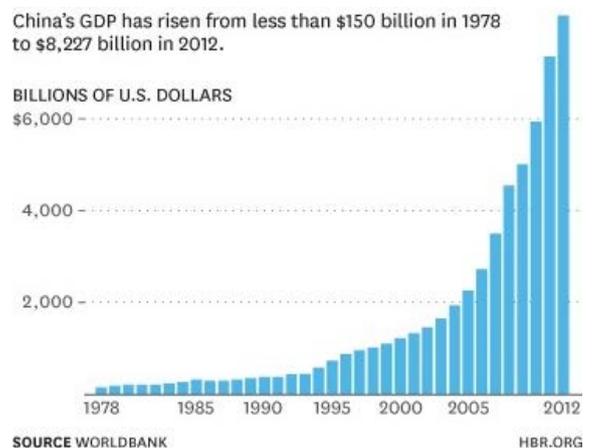
Following their 1949 revolution to establish People's Republic of China, Mao's misguided vision of "Great Leap Forward" struggled for three decades for survival but it eventually failed. It wasn't until 1977 when ideas of Deng Xiaoping espoused by Zhou Enli for modernization began moving China forward by empowering economic decision makers at the expense of communist party officials. By 1979 country had fully recovered from stagnation of "The Cultural Revolution". Chinese had already began coping of Leica camera, which was the most prolific brand of the time, and even copied Leica M5. This camera was one of the most sophisticated instruments of its time with built-in light meter, and interchangeable lenses. Today, those hand made cameras are sought after by many collectors, and are much higher in price than the real Leica M5 found on eBay. Other European products they copied were machine tools. I happen to own two of those



Segull optical company copied the prestigious Leica M5 (named Red Flag, left) in early 1960's. The real M5 (right) still is a marvel of engineering, and complexity. Such bold moves prepared China to shift from High quality to high quantity.



A factory floor in China producing parts. Many of the machines to make watches, camera bodies, and microscopes are not at all sophisticated as in Europe. Few assembly floors are modernized like the electronics board assembly, opposite page.



Huge container cargos heading towards US, Asia, and the rest of the world contains high volume quantities of optomechanical, and micromechanical instruments. China had enjoyed over 10% growth in their export sales since 1979.

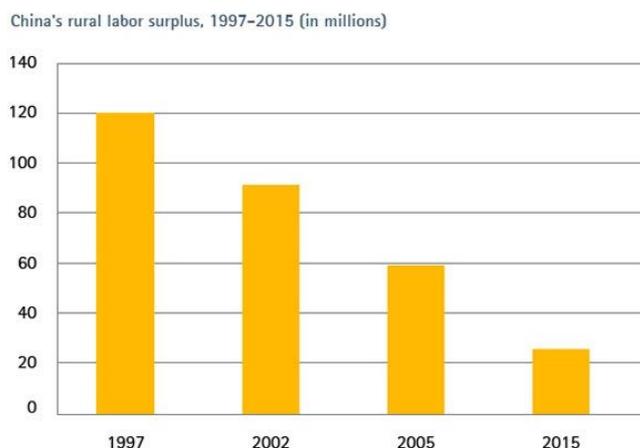
machines from that era, and they are beautifully crafted. Microscopes, binoculars, and telescopes were other favorite instruments that were being copied in China. Basically, China didn't spend money developing. They copied already made instruments with inferior quality. China was always interested in focusing on quantity than quality. Historically, Japan started the same way but they took a different path, focusing on producing products with higher quality at a higher cost.

Visiting a watchmaking factory in China, you'd hear production numbers in the range of 300,000 per month on just a single order. Toys inside kids meals at Mac Donald's, and Burger King are all made in China with quantities of 450,000 or more. The factory, and assembly floor in Chinese watchmaking factories are so different from their European counterparts. China assembly rooms are more like a sewing factory, with low cost hand operated stands to press crystal onto the watches, non-ergonomic assembly benches, and chairs. The intricate watch hands are pushed in with a \$5 hand held rod rather than a Bergeon press costing \$1,800 each. There are many skilled workers who lack higher discipline.

I heard an interesting story about how one Chinese factory assembled a medium sized order of watches: The finishing steps to assemble the watch was done on the cargo ship. Their logic was the workers would work more efficiently if they did the assembly onboard the ship. This is because if someone's uncle died, or his mother got sick, they'll still show up to work because they are in the ship, and they can't go anywhere!

High volume production is China's specialty. Unfortunately, in micromechanics, just copying won't work at all if you don't know the tolerances. China got away with this by relying on customers for specification. I remember back in 1995, a Chinese factory had Mitutoyo micrometer copies on their table top display at Laser Munich. They looked terrible, both in surface finish, and design proportions. Next year, they were made to look almost the same. I bought one sample for testing, and soon found the anvil tip had an eccentric motion, and I don't know if they ever fixed it. But what about Europe?

The way it works in Germany is they have an apprentice program called the Dual System. After a new employee is hired at say, Carl Zeiss, and starts his/her work, they are sent to this training school 2 out of 5 days per week. German government, and Carl Zeiss both will pay for the training, and for a precision engineer, it would last 3 1/2 years. During this apprentice program, they learn how to do things very professionally with their hands. Those who will work with CNC



The handwork on Chinese made watches is amazing. A watch uses very fine pieces to fit together in a very small package. How they do it is driven by China's business economy. Everything in China is business oriented even during tourism trips.



Non-ergonomic chairs used in China factories (left) is not fair to the employees. Basically, the low cost is at the expense of diccomfort for employees. For high tech assmblies, and because of customer visits, work ergonomics has improved.

machines, would file the metal they'll be machining for six months. This rigorous filing, and filing teaches them about the material they will be working with. This is how world class quality manufacturing is achieved in Germany.

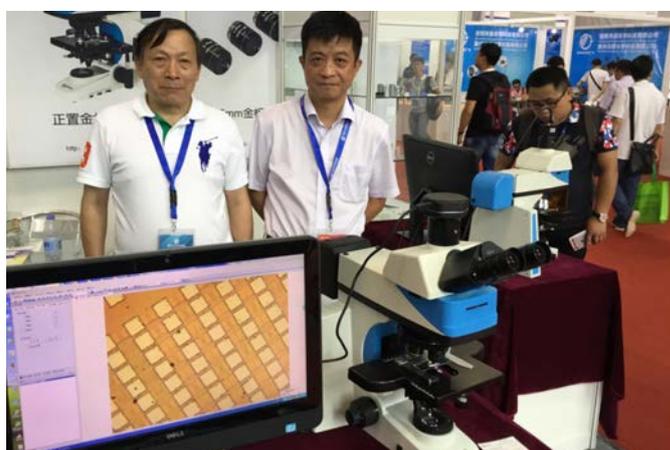
In China, handwork would cost a lot less, and that's where many low cost products are sent to be made. No matter how fast a modern machine can machine parts, it's cost would increase the overhead rate of the shop. The cost of a small European live tooling CNC machine made by Emco or Index is around \$100-350,000. Higher end machines like Hardinge, and Nakamura would go as high as \$650-800,000. The monthly payment to pay for these machines determines the overhead cost of the shop. In US, the average running cost of a machine shop is \$65 at its best, and around \$85 for shops with high end machines, whereas in countries like China, it's \$25-40. This is because parts are produced by older generation machines costing around \$15-20,000, and the rest of the work is completed by cheap labor but this wasn't by choice. Technological development has advanced gradually in factories, and outdated equipment continue to be used.



Microscopes: Leica DM6000B is made by Leica Instrumnets LTD, Shaghai, Olympus CX31 is made in Philipines, Nikon E100 is made by Novel Optics in NanJing, and Zeiss Primo series (right) are made by Motic Group in Xiamen plant.



The hardinge machine on display at Shenzhen show reveals micron repeatability, and concentricity. Why automated machines like this haven't yet replaced low cost workers in China, and Vietnam? The answer lies in the total overhead cost.



A copy of OLympus BX2 microscope (left), high performance microscopes (right) are made by manufacturers not very well known to the west. The marketing company who sells in Europe or in US puts their name brand on the products.

To stay competitive, all the big four microscope manufacturers rely on plants in China or Philippines to build many of their models. Technically, Chinese microscopes have always had the sticky grease problem that caused the sample, and focusing stages' knobs to be too stiff to turn in winter, or too loose in summer. This problem still exists in their current low cost microscopes. A typical price break down of a Chinese made microscope sold in US is as follows: It would cost \$100 to build it, \$70 overhead, and \$130 for profit. It is imported to US for \$300 by a major distributor, and by the time it reaches a catalog house like Edmund optics, it is marked as high as \$1,600. In this cycle, everyone involved gets their share.

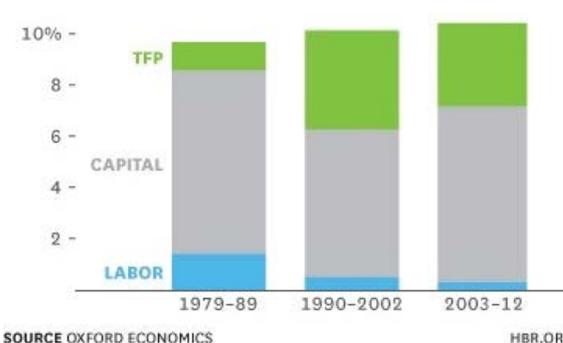
China has gained the know-how to offer a wide range of low cost biological microscopes. These microscopes have built-in cameras (see below) that would hook directly to a computer for image capture at 1/20 th of the cost of Olympus. Of course, the Olympus version would be twice as tall, and four times as heavy. The educational market demands cheaper microscopes in a compact size. Yes, it still uses peanut butter-like grease inside the microscope stages but it has otherwise very good functionality. Cheaper sells, and the world keeps consuming the "Made in China" label. When it's time to publish the images taken with the cheaper microscopes though, it is soon realized that image quality through a Zeiss, Leica, Nikon, and Olympus can not be achieved through inferior optics. Although all these companies might manufacture some of their high end models in Asian plants, the optics side is still made in Europe, or Japan.

Conclusion

Just like Japan, China took the bold path of copying quality products in the past, but after the 1979 economic boom, they gained the know-how by keeping up with higher requirements set by their customers. In most part, Chinese manufacturers still rely on older generation machines, and lower worker's compensation rights to reduce their overhead costs. Today's cost effective formula to produce world class quality is to produce the less critical parts such as mechanical stage, and main body casting, and illumination portion in Asian plants while allocating the more critical components such as high end objectives, and critical optical coatings, and assemblies to plants in Europe, and Japan. In today's competitive playground, it still takes discipline, and passion to produce high end products. Discipline, and passion can not be achieved with poorly trained workers, and cheap tools. It takes time, persistence, and proper apprenticeship to crate highly skilled habits in a factory floor to excel in product quality. It would then take good pay, and worker benefits to keep it running.



A Chinese student microscope at Kashan University (left) with built-in CMOS camera, and USB computer interface. We added one of Olympus objectives (right) to achieve much higher optical clarity, and contrast, but with much added cost.



Capital has been the major driver in China's growth over the last three decades, not labor or productivity increase (as measured by total Factor Productivity (TFP), the ratio of output to inputs)

Higher tolerance fabrication of optomechanics requires more expensive machines with an overhead cost of \$85 per hour. The Hdringe collet mount above is built right into the spindle to deliver better than 1 Micron parts concentricity.

Made In China Counterfeit Industries

Every nation is good at producing their traditional local handicrafts. Swiss are good at watchmaking, Germans in producing high quality optical Instruments, Iran is good at making rugs, and China, and India rank high in producing silk, and stone carvings. Why are countries pushing so hard to preserve these local crafts?

Nations are very good at producing what they are passionate about. There is a strong bond between culture, and its handicrafts. China is good at manufacturing only high quantity products. When it comes to other nations' crafts, they could copy watches, but only to mimic its shape, and carvings at a glance. By close examination, the details are missing in a copy versus the real authentic watch. The mechanics are also not there. If you ever wind a German made A Lang & Sohne watch, you could feel the big difference. The efforts in perfecting a product that have been carried from heart to hert in a nation can not be reproduced by those who try to copy it.

Historically, China has made copies of Leicas, and Swiss watches. I don't think there is any nation in the world that wouldn't want to be able to do that. What makes it questionable is why are they putting the original name brand on it? When the Swiss make watches, they spend as much time that it takes on it to achieve the level of quality they are culturally accustomed to. This is called passion, and this is how all original crafts stay preserved in their country of origin. It's a common mistake when people make when they see Chinese made copies of a product. China simply can not reproduce the same quality. Passion always prevails, but nations do lose their original product when they start losing faith on it.

I saw the same feelings when visiting a stone handcraft factory in Shenzhen. Our guide was a very pleasant, sensitive man, and showed us how each piece was being hand-made by the workers. He was upset why some visitors weren't respectful of those hand made Chinese crafts. He said the stones we carve are tied to our ancient culture, and people don't want to pay for the time that is spent on making them because they say it's made in China! It was ironic to see even Chinese are having a hard time preserving their historical hand crafted artifacts because of "made in China" branding.



We examine the details of a replica watch (left): The Chinese copies are only made to look authentic, but machine made Chinese Geneva Stripes are easily spotted as opposed to more refined Code de Geneva lines (right) in Swiss Watches.



At a well known shopping center in Shenzhen, near Hong Kong border, brand names are sold at a fraction of their original price. It is not hard to see the quality isn't there but you could buy a fake Rolex for \$50, and a fake Gucci for a lot less.

After China's industrial revolution in 1979, the country grew enormously in private business, and enjoyed over 10 percent growth in export sales each year for almost four decades. There are now 3,000 watch factories in Shenzhen alone, and they would all make watches per order. The usual turnaround is around 60 days to receive the first prototype of a new watch. These factories strive on made to order watches, and China has become the primary source for fashion watches.

China's production quality was divided in three categories: Cheap, fair, and good, with a huge difference in price. The cheapest products are sent to 3rd world countries. Who to blame for this is a group of importers with dishonest business ethics that ask for the cheapest possible cost, and Chinese manufacturers are good at saying yes to such demands. When I visited Chinese bookstores in Shenzhen, and Beijing, I saw their best quality products were being sold there. China's copying of name brands is yet another side of this manufacturing power house that is able to produce look-a-like products at a cheap price for many name brand fans who can't afford the real cost of their favorite brand names.



The real Gucci bag sells for \$1,500 a few blocks away. The real authentic brand feels, and handles so different. It is worth the money for someone who appreciates the quality. Made in China seems more fair than anyone might think.



Which one is a fake Rolex, and which is real? I was amused when I entered a Rolex shop, and the salesman was warning me about fake Rolexes, and he casually said: "By the way, this is a fake one". Genuine Rolex movement is shown on right.



Public destruction of 7,000 fake Rolex watches (left) in 2010. This theatrical performance in front of the press was arranged between concerned watchmakers, working in tandem with custom officials. Right, inside Longio watch factory.

The real art of Chinese Watchmaking

Now that I have discussed the counterfeit industry in China, I would also like to discuss the genuine watch factories in China that are trying to make their own mark. Two such factories are Longio, and Beijing Watch factory. What these watchmaking factories are trying to do is to provide something the current watchmaking culture is not set up to do as their European counterparts. By producing fake watches for so many years, the passion for real watchmaking has emerged in China, and is changing the mass produced Chinese culture to a more authentic hand made mechanical wonder. You could still find high volume production habits present in hand made watches, the most apparent one being the CNC decoration patterns instead of refined Code de Geneva lines that are applied by hand one at a time in Europe.



When passion adds to manufacturing, the work shop starts to look like the masters. In Beijing Watch factory, more serious watches are being made than just copies. The \$80,000 “Wu Ji” watch (right) are sought after by many watch collectors.



In a Tourbillion watch, the Pallet Wheel, the Pallet, and the Balance are all mounted on a rotating carriage. The pallet wheel (which rotates like the second hand) is engaged to a stationary gear (right) that causes the entire carriage to rotate.



If you like micromechanics, “Wu Ji” (Infinite Universe) axial tourbillion made by Beijing Watch factory (left) would intrigue you. This newcomer is not as impressive as the \$400,000 Gyro Tourbillion reverso made by Jaegar La Coultre (right).