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WILLY SHIH

Fuyao Glass America: Sourcing Decision

Wen Li, the Head of Global Sales for Fuyao Industry Group, was getting ready for one of her regular meetings with Cho Tak Wong, Chairman and Founder of the company. The topic today was the sourcing strategy for a new contract to supply an Ontario, Canada factory belonging to a major North American automaker. The factory was a short distance from the U.S. border and Detroit, Michigan, where the largest U.S. auto manufacturers were based. To win the contract, Fuyao made an aggressive bid to supply front windshields and "backlights."[a]

Over the past decade, Fuyao had grown to become the largest supplier of automotive glass in the world. It had recently established a factory in Moraine, Ohio, to serve as a springboard for serving U.S.-based automakers spread along the Interstate 75 "auto alley" that reached from Detroit and central Michigan in the north through Indiana, Kentucky, and Tennessee to Georgia and Alabama in the south.

Fuyao had three factories in the U.S. The facility in Moraine supplied General Motors Co., Fiat Chrysler Automobiles (FCA), Hyundai Motor Co., Honda Motor Co., and Kia Motors Co. A second facility in Mt. Zion, Illinois, produced flat glass sheets (called *float glass*) that were shipped by truck to Moraine and used as a raw material input. Fuyao was also in the process of completing a third facility in Plymouth, Michigan (near Detroit), which was planned as both a finishing location for adding features to glass sets and a distribution center linked to its customers' just-in-time (JIT) supply chains.

Production location choice was always a hot topic every time Fuyao bid for a contract. Managers had to weigh comparative labor costs, as well as factor costs such as energy and the price of raw materials. Fluctuating transportation costs, transit times, currency exchange rates, and potential duties were also weighed in the decision.

The contract in question was a challenge. Fuyao had several factories in China that could fulfill the contract. The Tianjin, China, facility was one of its most modern and had labor costs that were a fraction of those in Ohio. But the shipping cost for glass from the other side of the world was expensive compared to what it was worth.

Alternatively, Fuyao could assign the production to Moraine. The Moraine plant was newer than the plant in Tianjin, so it had not progressed as far down the cost learning curve, so at least initially it would lose money on each unit shipped. Work at Moraine also progressed differently than what Cho

[a] Backlights are also called rear windows.

Professor Willy Shih prepared this case with the assistance of Associate Director for Research Nancy Hua Dai (Harvard Center Shanghai) and Assistant Program Manager Vina Tang (Harvard Center Shanghai). It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. Certain details have been disguised. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

was used to in China, and he was still getting used to the difference in management approaches that the American factory seemed to call for.

Fuyao Industry Group

Fuyao Glass Industry Group Co., Ltd., traced its roots to a Sino–foreign equity joint venture in Fuzhou, China, that was established in 1987. By 2013, before its stock exchange listing, it had become China's No. 1 and the world's No. 2 automotive glass manufacturer by sales volume, with 65% market share among Chinese passenger vehicle OEMs, and 20% market share globally (see **Exhibit 1** for a timeline). By 2016, Fuyao's lead in China expanded to over 70%, even as the China market grew to 28 million vehicles produced, compared to 12 million in the U.S., both out of a total of 95 million produced worldwide. Unlike its competitors, Fuyao was the only company that specialized exclusively in automotive glass production.

Fuyao produced a complete range of automotive glass products. **Exhibit 2** illustrates the range of offerings for its OEM customers. The Fuyao customer roster read like a who's who in the automotive industry. It served upscale brands like BMW, Mercedes, Rolls-Royce, and Bentley, as well as mass-market names like GM, Ford, Toyota, Nissan, and Kia. **Exhibit 3** shows the logos of major customers.

Fuyao was a very profitable company, which meant substantial tax collections by local governments wherever it operated in China. This meant it was welcomed by those governments, which were very supportive and helpful when it was trying to establish new operations. Cho was quite influential in his own right, because of high-profile donations supporting relief efforts after natural disasters, but also because of contributions to education and religious groups. He was a member of the Chinese People's Political Consultative Conference (CPPCC), and was well known to the populace at large because of frequent appearances on CCTV.[b]

Manufacturing Glass

The manufacturing process for plate glass began by mixing sand, sodium carbonate (soda ash), dolomite, limestone, and other minerals in a batch process. This mixture was blended with waste glass in a controlled ratio, and fed into a furnace that was heated to 1500°C. In a process known as the Pilkington float glass process, the mixture was poured onto a bath of molten tin (see **Exhibit 4** for a picture of one of Fuyao's Chinese float glass lines). Because molten tin was denser than the glass, the glass floated on the surface and formed a smooth ribbon of uniform thickness that was flat on both sides. The temperature was gradually reduced as the glass ribbon was pulled off the bath by rollers. It then passed through an oven (known as a *lehr*) where it was annealed[c] to relieve stresses in the glass (see **Exhibit 5**). Then it was cut by machines into flat pieces.

Float glass plants were very capital intensive, and once commissioned, they had to operate continuously. If production was stopped even for a minute, all the bricks lining the furnace might crack and then would have to be replaced. The production lead time for float glass, the time between placement of a new order and when it was received, could be as long as three months. It took one week to change the glass color and several days to change the thickness on a production line. During a changeover, all of the glass that was produced had to be scrapped, so Fuyao centralized production

[b] CCTV is China Central Television, the predominant state television broadcaster in the People's Republic of China.

[c] *Annealing* is a process for slowly cooling glass to relieve internal stress introduced during manufacturing.

and then produced particular colors and thicknesses in batches to reduce the number of changeovers. Automakers typically produced a car model for at least five years, so the order volume for each project was forecastable. Thus, centralized production and the holding of inventory of float glass was deemed to be low risk.

Energy and raw material costs were a substantial part of the overall cost of the plate glass, and because it was both heavy and relatively cheap, distribution costs for plate glass were relatively high as a percentage of its value.[1]

Automotive glass was manufactured starting with plate glass. Every vehicle order had specifications for the thickness, color, and shape of cut for each window. Sheets of plate glass of the specified thickness and color were scored with a computer-controlled tungsten carbide cutting wheel, and then automated clamps were pressed on the surrounding pieces to snap them off. After the cut edges were smoothed and polished, the completed piece was washed.

Curved windows were made using a bending process. Fuyao used two variants of this process. In gravity bending, glass cut to the desired shape was loaded onto custom molds carried by a conveyor through a 600°C oven. As the glass passed through the oven, it sagged to the desired curvature. A newer process known as press bending used a hydraulic press, forming the heated glass into a shaped mold.

Front windshields needed a special process for making laminated safety glass. Two pieces of thin plate glass were cut to the correct shape and bent to the specified curvature. One piece had a slightly larger radius than the other to account for the difference in curvature when the two were stuck together. After washing, the glass was moved via conveyor into a clean room where workers made a sandwich consisting of the inner glass, an interlayer sheet of polyvinyl butyral (PVB), and the outer glass. The PVB was a translucent plastic that, when melted, bonded to the two glass surfaces and held fragments together in case the glass was shattered. The heating also turned it into a clear interlayer. A worker fitted a rubber collar around the edge of the sandwich and attached a vacuum hose to suck air out to prevent bubble formation as the assembly passed through an oven. After coming out of the oven, the windshields were stacked on special pallets and moved to an autoclave where they were heated under pressure for additional time.

Glass used in the side or rear windows of a car needed to be tempered, a process that strengthened it and ensured that if it broke, it would shatter into small granular pieces rather than large jagged shards. Glass cut to the correct shape was fed via conveyor through an electric oven where it was heated to 620°C. It was then cooled rapidly with blasts of high-pressure air from an array of nozzles covering the entire surface. This quenching process cooled the outer surfaces of the glass much more quickly than the center, and as the glass cooled, it pulled back from the outer surfaces. The center remained under tension as the outer surfaces shrank, which gave the resulting glass its strength.

Fuyao believed strongly in vertical integration. It supplied its four float glass plants in China from its own sand quarries, and it produced its own molds and tooling equipment for its 10 automotive glass plants (see **Exhibit 6**). It invested substantially in R&D to produce innovations like embedded heating elements, raindrop sensors, embedded antennas, infrared (IR) reflective coatings, and other features to distinguish its products and command higher margins.

Overseas Production Facilities

In the 1990s and 2000s, production costs in China were much lower than in the rest of the world, so even though automotive glass was heavy and relatively expensive to ship, Fuyao felt it could overcome the shipping component of the final delivered cost to its OEM customers. In 1994, Fuyao established a

sales office in the United States to sell automotive glass in North America. Between 2006 and 2008, it established subsidiaries in Germany, South Korea, Japan, and the United States to provide sales and customer support services to OEM customers in those markets. It met with good success supplying high-profile customers like Audi in Ingolstadt, Germany.

As Chinese labor and energy costs continued to rise, Chinese companies increasingly set up factories overseas or made foreign acquisitions. While wages in China were increasing as much as 30% per year, wages for U.S. auto parts company workers had been in steady decline, on average decreasing 9.45% from 2003 to 2013.[2]

In 2011, Fuyao established a production facility in Kaluga Oblast, Russia, but its big move was in 2014 when it acquired a Mt. Zion, Illinois, float glass factory from Pittsburgh Glass Works, a subsidiary of PPG Industries. The Mt. Zion factory produced architectural, industrial, and specialty glass products, and it was equipped with two glass production lines, one of which was dedicated to producing automotive glass.

Beginning in early 2015, the company invested $200 million at Mt. Zion, redesigning, remodeling, and upgrading both production lines to produce automotive glass exclusively.[3] Fuyao installed new state-of-the-art glass handling, cutting, and stacking equipment from Grenzebach Maschinenbau GmbH. Starting at the end of the annealing lehr, conveyors transported the continuous glass ribbon through the cutting and snapping operation, defect inspection, and stacking. Grenzebach's cutting optimization and process control systems linked with Fuyao's enterprise resource planning (ERP) system to maximize cutting yields based on current orders, routing individual glass sheets to one of 12 robot stackers that picked parts on the fly from the line and stacked them onto racks for delivery.

The Moraine Factory

Apart from labor costs, everything else is cheaper in the U.S. than in China.

— Cho Tak Wong

Fuyao bought roughly half of a former General Motors Truck & Bus Group assembly plant in Moraine in May 2014 for $15 million. The factory had formerly manufactured products like the Chevrolet Trailblazer; GM had closed the plant in 2008. (**Exhibit 7** shows a photo of the facility.) Fuyao received a $9.7 million tax credit from the state of Ohio, which also kicked in a $1 million grant for road work surrounding the site. Fuyao then spent close to $700 million to reconfigure it into the world's largest single-site auto glass factory, with extensive investments in automation and new tooling.[4]

Fuyao bid for the manufacturing of windshields by individual car program. A program specified the model, the anticipated volumes by year, and the number of years spare parts would be available. Float glass arrived from the Mt. Zion, Illinois, factory 293 miles away via Interstates 72 and 74 (see **Exhibit 8**). Automated cutters shaped the glass based on specifications for specific vehicle models, and matched pairs of front windshield layers were layered with PVB before heating in an oven (see **Exhibits 9** and **10**). Most of the glass handling was automated (see **Exhibit 11**).

Finished glass sets were shipped to the distribution center in Plymouth, Michigan, close to FCA factories in Sterling Heights, Warren, and Detroit, and to GM factories in Flint, Lake Orion, and Lansing. For each car program that Fuyao was contracted to supply, it liked to keep one week of safety stock inventory on hand. Its customers imposed penalties, some quite severe, if Fuyao failed to supply glass sets at the scheduled time, as supply shortfalls shut down vehicle assembly. The relative proximity of the Moraine factory to its customers' assembly plants was advantageous, but Fuyao

managers were always nervous about disruptions caused by strikes, adverse weather, or things beyond their control.

The Tianjin Factory

Fuyao originally had an automotive glass factory on the east side of Beijing at the East Sixth Ring Road, but the Beijing government wanted to push local industry out of the inner ring roads surrounding the city. With the proactive support of the Tianjin government, Cho chose a new factory site in the Xiqing District on the southwestern side of the city. He retained the land in Beijing, which turned out to be a very prescient move, as the Beijing government later decided the area should be used for tourism and entertainment, including a new Universal Studios Asia, causing real estate values to skyrocket.

Li's first experience in Fuyao was starting up the Tianjin factory. She had been recruited from her family business in Jinan, Shandong Province, a small commercial printer that she had restructured after stepping in during a health emergency of her father, the founder. In Tianjin, she worked closely with the local government while they built and developed the facility.

The Tianjin factory included 230,000 m^2 of building and factory space on a 270,000 m^2 site. It had multiple lines that produced laminated, tempered, and encapsulated products. It was the most advanced factory in the Fuyao Group, with the highest level of installed automation. It also employed the latest technology, including the capability for making heat-reflective coatings, embedded heaters for defrosting, heads-up displays, semi-tempered laminated glass, and other value-added features. The factory was 70 km from the Tianjin port and served the vehicle assembly plants of Beijing Benz Automotive Co. (BBAC), Changan Automobile Group, Daimler, Foton Motor, GM, Great Wall Motors, Hyundai, Inalfa Roof Systems, Toyota, Volkswagen, and Webasto (a supplier of roof modules).

There were three press bending lines and three gravity bending lines for making windshields. The combined design capacity was 5 million units per year. The tempered glass plant had a total of 10 lines for making door glass, the quarter glass found in many doors, backlights (rear windows), and sunroofs. Total design capacity for all types was close to 31 million pieces per year. Finally, there were 24 encapsulation lines for making glass sections that were encased in a polymer that "framed" the glass and provided edge protection.

Producing Windshields: Cost Elements in the Bill of Materials

Production costs for making the same windshield varied between Tianjin and Moraine. The major components of cost were:

Cost Item in Bill of Materials	*Examples*
Raw materials	Float glass sheets purchased from Tongliao or Shuangliao (Tianjin) or Mt. Zion, Illinois (Moraine); ink and silver for screening patterns on glass; polyvinyl butyral sheets
Labor	Direct labor expense (worker compensation)
Electricity	Manufacturing process was power intensive Ovens used electricity
Depreciation	Capital equipment costs for production lines

Other manufacturing costs	Tools, consumables (such as gloves to handle glass, cleaning pads), safety equipment
Sales, General, and Administrative costs (SG&A)	Selling expense, management, financial expenses
Packaging and transportation	Final product packaging, warehousing, freight, import duties as applicable

Production yield was a major cost lever, because defective units that were scrapped meant that the many costs of operating the line had to be allocated across fewer salable units. If a windshield was scratched, it might be possible to rework it by polishing the scratch out, but this required more labor.

New factories inevitably suffered from lower initial yields as operators became familiar with their tasks and learned how to both do them more efficiently and produce better quality. **Exhibit 12** illustrates this learning curve for a new production line at another Fuyao plant in China.

Exports from Tianjin to the U.S.

Exports from Tianjin utilized standard intermodal containers. Automotive windshields were packaged 40 per box; 30 boxes could be put in a standard 40-foot (2 TEU[d]) container (see **Exhibit 13**). Full containers were trucked to one of the terminal operators, such as the Tianjin Port Pacific International Container Terminal or Tianjin Orient Container Terminals Company. While Tianjin was a large port, its service to North America was not as frequent compared to the mega ports of Shanghai or Busan, Korea. Maersk Line's TP10 eastbound trans-Pacific (TransPac) service to Jacksonville, Florida; Savannah, Georgia; and Charleston, South Carolina, was one possible routing; its schedule is shown in **Exhibit 14**. Alternatively, MSC provided a comparable TransPac service to the U.S. East Coast, as well as a faster service to Long Beach, California, where containers could be put on a train for the Midwest, as shown in **Exhibit 15**. Container rates fluctuated depending on demand. Fuyao logistics managers assumed a planning rate of $7,000 for door-to-door Tianjin-to-Plymouth service per 40-foot container. Spot market rates were much more volatile. Fuyao logistics managers typically requested bids from shipping companies quarterly and selected services based on the best combination of prices and service guarantees.

From loading at the factory to outbound customs, clearance was very fast, typically 48 hours, and inbound customs clearance at a U.S. East Coast port like Savannah, Georgia, was also quick. Trucking the container to Plymouth typically took an additional two days, including truck waiting times at the port. Fuyao managers planned on 40 days to ship a packed container from Tianjin to Plymouth. At Plymouth, workers had to unpack the windshields and put them into special racks that customers used to feed their auto assembly lines. These were the same racks that workers at Moraine used; they also shipped finished goods to Plymouth, where they were held pending customer shipment releases. Thus all products destined for customers passed through Plymouth. Shipping times and costs from Plymouth to Ontario were comparable to shipping times and costs for supplying other plants in Michigan, Indiana, and northern Ohio, thanks to the free movement of goods under the North American Free Trade Agreement (NAFTA).

Exports to the U.S. from China also had some risks that were hard to predict. In 2001, PPG Industries petitioned the U.S. Department of Commerce and the U.S. International Trade Commission (USITC),

[d] TEU stands for twenty-foot equivalent unit, the capacity of a standard 20-foot cargo container, 20 feet long and 8 feet tall. Nine to 11 pallets fit in one TEU. Most containers are one or two TEUs.

complaining about the import of automotive windshields from the People's Republic of China (PRC).[5] The Department of Commerce treated the PRC as "a non-market economy," and the USITC issued a preliminary determination that "an industry in the United States was materially injured by reason of imports of the subject merchandise from the PRC."[6] The Department of Commerce issued an initial finding that certain windshields were being sold below fair value, and then set an antidumping duty margin of 9.79% on Fuyao. After a series of counter-petitions, the U.S. Court of International Trade ultimately found fault in Commerce's methodology. In 2004, Commerce settled on a 0.13% duty rate. The situation took a dramatic turn in 2018 with the increasing threat of the U.S. imposing broad-based tariffs on imports from China.

The Sourcing Decision

Our customers, all they care about is that their cost doesn't increase.

— Jeff Liu, President, Fuyao Glass America Inc.

Sourcing decisions were quite complex. It took time to bid and design the glass set for a new model, and the bid had to factor in the future capacity plan at the site for producing the glass. The site also had to produce the tooling (molds) needed for bending. The choice of a site meant that the production base would be committed two to three years in advance of mass production, and it would then have to serve the customer for the entire production lifecycle, typically six years. Once a customer approved the bid and signed a production contract, Fuyao would not be able to change the production location, regardless of whether factor costs such as energy or labor changed. Additionally, the chosen plant had to supply replacement spare parts for 10–15 years after the end of production of every car model for which it supplied glass.

Client preferences also were critical. Toyota required 100% local supply, while BMW qualified only Fuyao's Shenyang, China, and Moraine, Ohio, factories for its global supply chain. Li explained that clients also set expectations for future price decreases:

> A typical project lifecycle is six years. Usually the client will ask for a 2%–3% discount on the initial price for each of three consecutive years, starting in the second year of scaled production. Of course, we have to have our cost reduction timelines to match this. Usually in the first and last years of production for a specific vehicle project, we don't produce a lot of volume. The years in between we usually see stable demand numbers. We plan our revenues accordingly. We usually calculate a lifecycle profit margin for each program.

As Li looked at the data, she thought about the pros and cons of Moraine versus Tianjin. (**Exhibit 16** shows a projected cost comparison for the program at the two sites, with a target price of $50.00.) Comparing ex-factory costs, Moraine was 21% above the target cost, while Tianjin was 19% below. Some of this was driven by the newness of the Moraine site, and the relative inexperience of the production workforce. First-pass yield at Moraine was 10% lower than at Tianjin, and the Tianjin team's ability to perform rework meant that they could boost the yield by an additional 2%. Output per shift at Moraine was also considerably lower, again probably due to inexperience. This was likely also a factor in the greater number of workers assigned per line and hence, the lower productivity.

But sourcing from Tianjin also incurred substantial packaging and shipping costs, as detailed in **Exhibit 17**. Tianjin would have to package the glass in cardboard boxes and pack them densely into an intermodal container. Upon arrival at Plymouth, these would be unpacked and repacked onto the custom racks used by individual auto assemblers, which expected to pull them on a daily or twice-

daily schedule. In contrast, workers could load finished goods in Moraine on the custom racks and load them into a 54-foot (16 m) trailer, 900 per trailer, and ship them to Plymouth for $1,500.

Li was a little concerned about the sustainability of low container shipping rates as well. Spot market rates tracked by the Shanghai Containerized Freight Index (SCFI)[e] had dropped over 62% to record lows in 2016 because of rampant overcapacity arising from new megaships that carried as many as 20,000 TEUs at a time. But the bankruptcy of Hanjin Lines[f] and continuing growth of Chinese exports led to a recent uptick in TransPac eastbound container shipping rates.

Auto assemblers were very strict about deliveries, as most had moved to just-in-time pull systems with their suppliers. Failure to deliver glass parts on time could cause a line stoppage, and some of Fuyao's customers mandated severe financial penalties for causing one. One day of penalties could wipe out the profitability of an entire program; thus, Fuyao kept seven days of safety stock inventory on hand at both Tianjin and Moraine. Production lead times were typically one week starting with float glass sheets, which was fungible between specific models. The big difference was that transit time from Tianjin was as much as 50 days door-to-door, and the company liked to keep an additional 50 days of safety stock in Plymouth for Tianjin-sourced glass because of the risk of longshoremen's strikes or other possible disruptions.

As Li studied the numbers, her past experiences with other projects suggested a few things to her:

> I know we should be able to get Tianjin to 93% first-pass yield, 95% with rework. There's no reason Moraine shouldn't be able to get to the same first-pass yield over time. If anything, Moraine is more automated, so as the team there learns more, it should become just as good as Tianjin, if not better.

The line layout was also slightly different. Moraine had more automated inspection machines, and the entire production line was connected in a single flow. Tianjin was a little more flexible, but this meant shorter lines with buffers in between. Workers transferred products on racks. "I think Moraine should be able to get down to 50 workers per line," she thought. "That's why we invested in all that automation, after all!" She also thought daily output could be raised to 800 at both plants, but since the final annealing step used a lot of electricity, that would also raise electricity consumption.

Li was very conscious of the risks:

> Any time you deal with large inventory stocks, it slows your ability to react. In an emergency, we could use airfreight. But that costs 10 times as much or more. The other thing I worry about is potential trade restrictions. You never know when we might face another trade action or new tariffs. We might want to preserve the Moraine capacity for U.S. factories, as it is not likely that Canada and China will get into any trade actions, and we have plenty of capacity in China.

Li reminded herself that the Chairman's main purpose in setting up Moraine was to be close to its U.S. customers. "If we used that capacity to serve Canada and then had to import from China to serve

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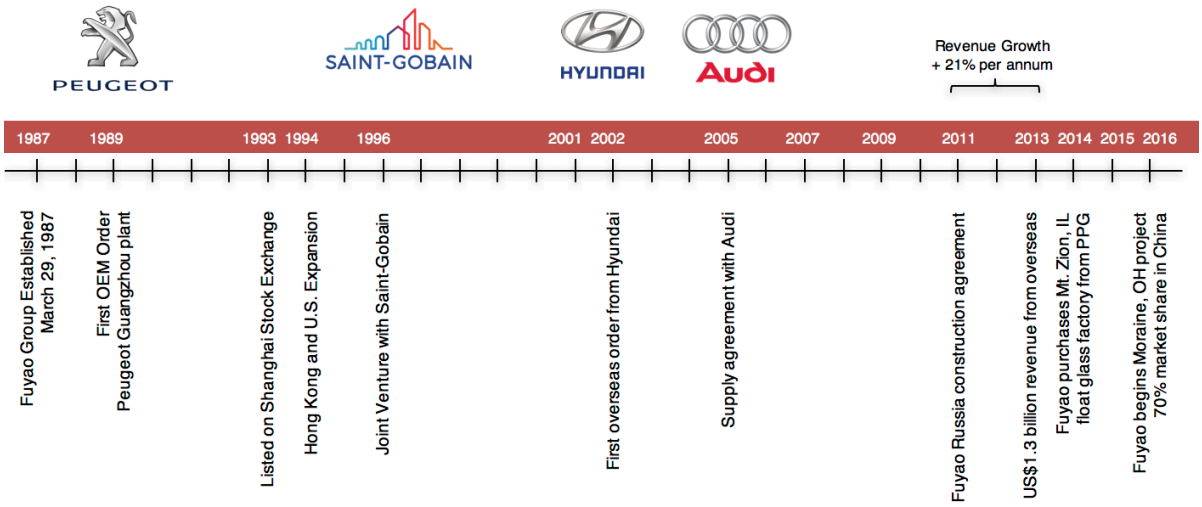
[e] The Shanghai Containerized Freight Index is maintained by the Shanghai Shipping Exchange, an organization founded by the Ministry of Transport and the Shanghai Municipal People's Government under approval of the China State Council. It maintains a range of indices. See http://en.sse.net.cn/indices/ccfinew.jsp.

[f] Hanjin Shipping Co. Ltd. was a South Korean integrated logistics and container shipping company. Before its bankruptcy filing in early 2017, it transported over 100 million tons of cargo annually.

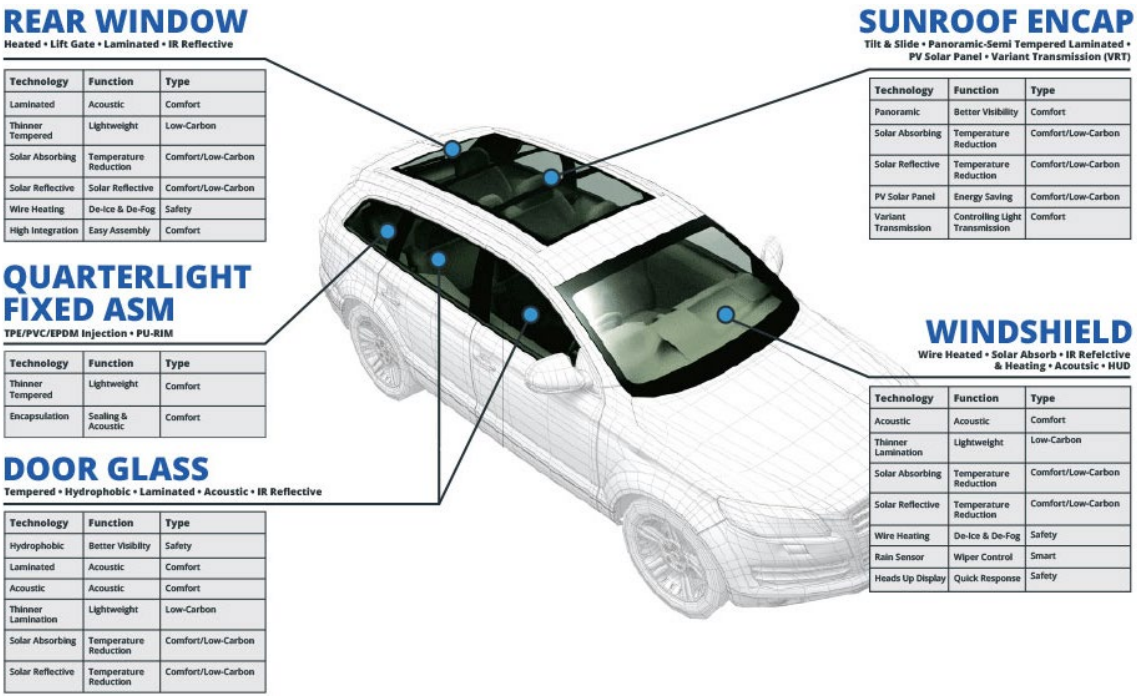
future U.S. customers, we might end up with a much higher cost position if we have to pay duties crossing the U.S. - Canada border," she thought, as she got ready for her meeting with Chairman Cho.

Exhibit 1 Fuyao Glass Timeline



Source: Compiled from company data.

Exhibit 2 Fuyao Glass Automotive Products for OEMs



Source: Company illustration.

Exhibit 3 Fuyao Glass Customers

Source: Company website.

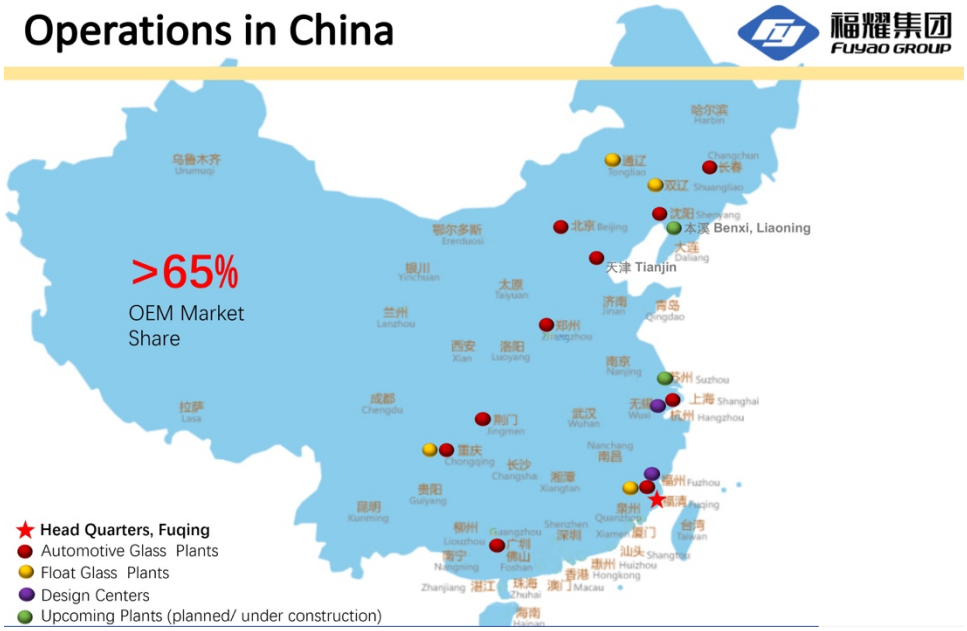
Exhibit 4 "Hot" End of Fuyao Float Glass Line

Source: Company photo.

Exhibit 5 Fuyao Glass Annealing Lehr

Source: Company photo.

Exhibit 6 Fuyao Operations in China



Source: Company presentation.

Exhibit 7 Fuyao Glass America, Moraine, Ohio

Source: Company photo.

Exhibit 8 Float Glass Sheets from Mt. Zion, Illinois, Factory

Source: Photo taken by casewriter and approved by company.

Exhibit 9 Automated Glass Cutter

Source: Photo taken by casewriter and approved by company.

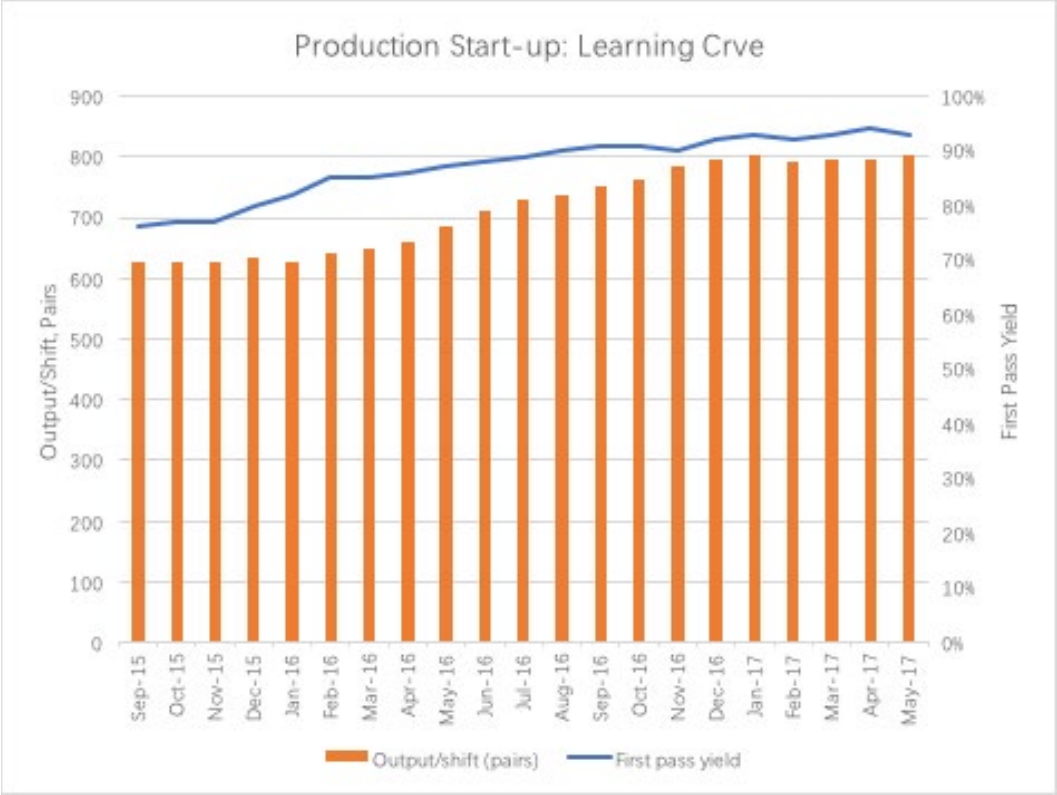
Exhibit 10 Layering Front Windshields with Polyvinyl Butyral Sheets

Source: Photo taken by casewriter and approved by company.

Exhibit 11 Automated Glass Handling, Fuyao Moraine Factory

Source: Photo taken by casewriter and approved by company.

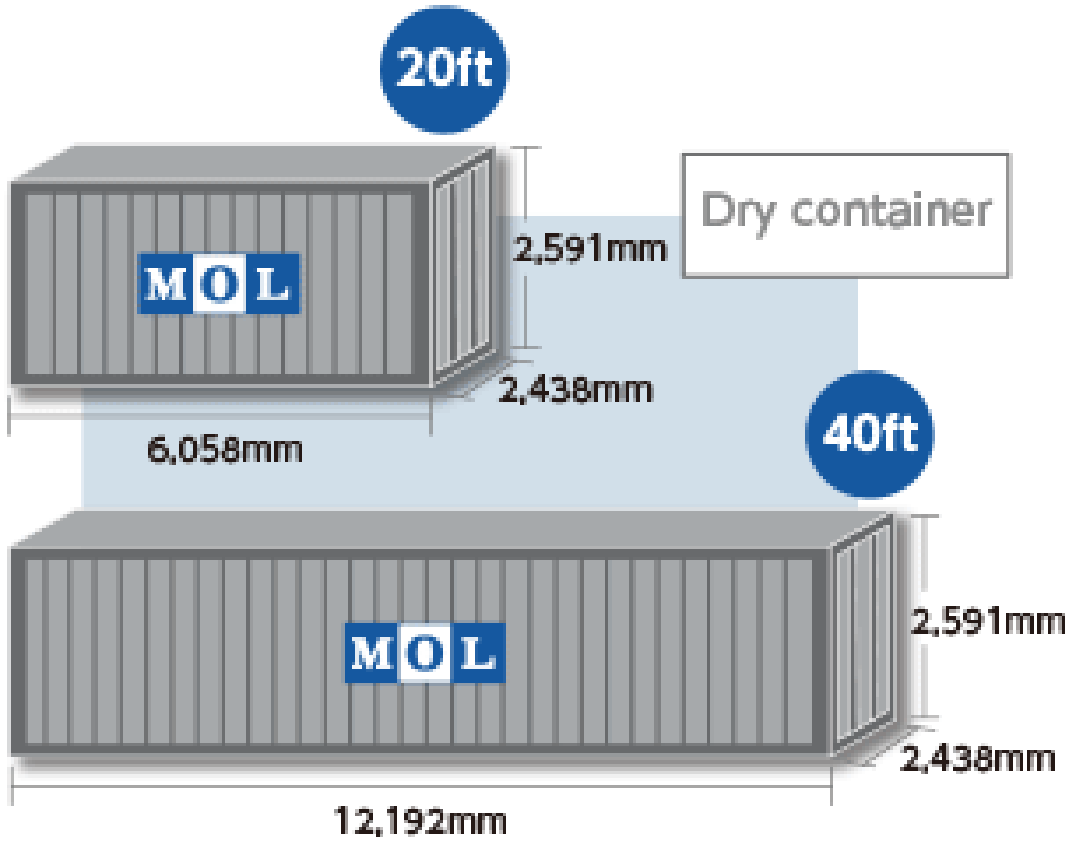
Exhibit 12 Production Start-up: Learning Curve for Another Fuyao Plant in China



Date	First-Pass Yield	Gross Output per Shift
Sep-15	76%	625
Oct-15	77%	628
Nov-15	77%	626
Dec-15	80%	633
Jan-16	82%	628
Feb-16	85%	641
Mar-16	85%	650
Apr-16	86%	660
May-16	87%	685
Jun-16	88%	710
Jul-16	89%	728
Aug-16	90%	737
Sep-16	91%	750
Oct-16	91%	763
Nov-16	90%	784
Dec-16	92%	797
Jan-17	93%	802
Feb-17	92%	793
Mar-17	93%	797
Apr-17	94%	797
May-17	93%	802

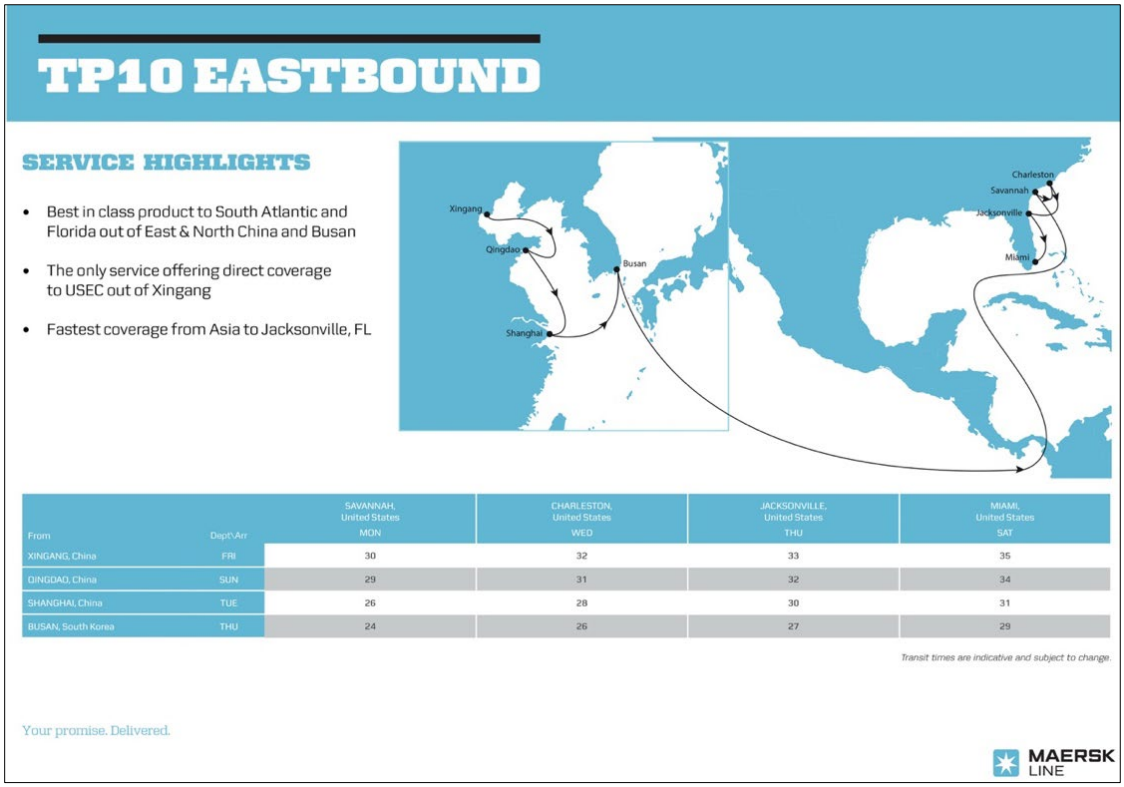
Source: Prepared by casewriter based on company data.

Exhibit 13 Sizes of Standard Intermodal Containers



Source: Mitsui OSK Lines, https://www.mol.co.jp/iroiro_fune_e/03product.html, accessed July 7, 2017.

Exhibit 14 Maersk TP10 TransPac Eastbound Service from Tianjing (Xingang) to U.S. East Coast



From	Dept\Arr	SAVANNAH, United States MON	CHARLESTON, United States WED	JACKSONVILLE, United States THU	MIAMI, United States SAT
XINGANG, China	FRI	30	32	33	35
QINGDAO, China	SUN	29	31	32	34
SHANGHAI, China	TUE	26	28	30	31
BUSAN, South Korea	THU	24	26	27	29

Source: Maersk Line, http://www.maerskline.com/~/media/maersk-line/Countries/int/Routenet/pdfs/2m-east-west-network-2015/asia-to-north-america/tp10-eastbound-rev.pdf, accessed April 28, 2017.

Exhibit 15 MSC Eastbound TransPac Service from Tianjin (Xingang) to U.S. East and West Coasts

ASIA TO USA EAST COAST

AMBERJACK

EASTBOUND

- North and Central China connections to the South Atlantic seaboard through Panama.
- Fast transit times from North and Central China to Savannah, Charleston, Wilmington and Jacksonville.

POL	POD SAVANNAH	CHARLESTON	WILMINGTON	JACKSONVILLE
QINGDAO	31	33	34	36
XINGANG	30	31	33	35
SHANGHAI	27	28	30	32
NINGBO	26	28	29	31

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TRANSPACIFIC WEST COAST USA

ORIENT EASTBOUND

EASTBOUND

- North China, S Korea and Japan loop to Pacific South West and US hinterland.
- Xingang, Ningbo and Yokohama added as a direct call.
- Oakland added as a direct call.
- Upgraded vessel size to 11,500 TEU segment to cater for current Sequoia Service flows.

POL	POD LONG BEACH	OAKLAND
XINGANG	19	24
QINGDAO	17	22
NINGBO	15	20
BUSAN	13	18
YOKOHAMA	10	15

NOTE: Transit times are indicative and subject to change

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Source: Mediterranean Shipping Company, SA 2017 East-West Services guide, https://www.msc.com/getattachment/dfebb208-935e-4060-b0c7-a514efd1cfdd/636235563167557757, accessed April 28, 2017.

Exhibit 16 Comparison of Total Costs per Windshield: Tianjin versus Moraine

Cost Item (US$ unless otherwise specified)	**Tianjin**	**Moraine**	**Target Cost**
Raw materials	$13.01	$19.90	
Labor	2.28	23.93	
Electricity	1.55	1.58	
Depreciation	1.55	3.17	
Other manufacturing costs	0.88	1.73	
SG&A	6.00	8.00	
Packaging and transportation	15.33	2.13	
Total	40.60	60.44	$50.00
Other Cost Factors	Tianjin	Moraine	
Yield	93%	81%	
- First-pass yield	91%	81%	
- Rework and repair	2%	No repair - Lack of skills - Low productivity	
Output per shift	780 pairs	650 pairs	
Salary per month	CNY5,000/month	$25/hr.	
Working hours per month	8 hr./day, 25 days	8 hr./day, 22 days	
Number of workers per line	57	63	
Electricity, cost per kilowatt-hr.	CNY 0.69	$0.0600	

Source: Compiled from company data.

Note: Other cost factors such as output per shift, salary per month, working hours, number of workers per line, and electricity costs apply to gross output before yield is calculated. Purchased parts and 17% VAT not included; Chinese VAT on FOB price 100% is refunded for exports; $1=CNY 6.9.

Exhibit 17 Additional Costs/Inventory Holding to Ship from Tianjin vs. Moraine

Additional Cost to Ship a Windshield from Tianjin or Moraine to Plymouth, Michigan (US$ unless otherwise specified)	**Tianjin**	**Moraine**
Paper packaging, 40 pieces/package, amortized cost per unit	2.90	
Repackaging labor – 6 people, 12 packages per shift	2.50	
Transportation		
- Tianjin to Plymouth, per piece based on full container	5.83	
- Moraine to Plymouth, truck, 16 m truck, 900 pcs/truck		1.67
Tariff and customs clearance (6%)	3.00	n.a.
Inventory carrying costs Calculated at 2.2% for Tianjin, 0.9% for Moraine	1.10	0.46

Inventory (days)	**Tianjin**	**Moraine**
- Inventory held at Tianjin	60	
- In transit ocean/truck	50	
- Safety stock held at Moraine		60
- Safety stock held at Plymouth	50	7

Source: Compiled from company data.

Note: 60-day inventory held at Tianjin consists of 46 days of raw material inventory + 7 days production throughput time + 7 days finished goods safety stock. 60-day inventory held at Moraine consists of 46 days of raw material inventory + 7 days production throughput time + 7 days finished goods safety stock. Raw material inventory is predominantly float glass sheets from supplier factory.

Endnotes

[1] "Pilkington and the Flat Glass Industry, 2010," https://www.pilkington.com/resources/pfgi2010.pdf, accessed April 28, 2017.

[2] Lewis Wallace, "A Look Inside The Fuyao Glass Factory—And Why Chinese Companies Are Coming To The U.S.," WYSO, February 12, 2015, http://wyso.org/post/look-inside-fuyao-glass-factory-and-why-chinese-companies-are-coming-us, accessed April 28, 2017.

[3] Chris Lusvardi, "Fuyao ready for glass production after $200 million investment," *Herald & Review,* October 6, 2016, http://herald-review.com/business/local/fuyao-ready-for-glass-production-after-million-investment/article_47d82600-3084-5a8e-8906-65b9f479e189.html, accessed April 28, 2017.

[4] "Fuyao continues growth and development in US," Glass Online, http://www.glassonline.com/site/news/channelname/Automotive-glass/channel/129/id/26339.

[5] See *Fuyao Glass Industry Group Co. Ltd., Greenville Glass Industries, Inc., Shenzhen Benxun Automotive Glass Co. Ltd., TCG International, Inc., Changchun Pilkington Safety Glass Co., Ltd. Guilin Pilkington Safety Glass Co., Ltd., Wuhan Yaohua Safety Glass Co., Ltd., and Xinyi Automotive Glass (Shenzhen) Co., Ltd., Plaintiffs, v. United States, Defendant, and PPG Industries, Inc., Safelite Glass Corporation, and Viracon/Curvolite, a subsidiary of Apogee Enterprises, Inc.,* Consol. Court No. 02-00282, Slip Op. 03-169, http://cases.justia.com/federal/appellate-courts/cit/02-00282/02-00282-2003-12-18.pdf?ts=1411167355, accessed October 10, 2017. The original case was "Certain Automotive Replacement Glass Windshields From The P.R.C.," 67 Fed. Reg. 6482.

[6] "Automotive Replacement Glass Windshields From China," 66 Fed. Reg. 20,682.