

Forty Years of Innovation

Innovation established Glasstech, and innovation continues to spur the company's growth into systems that produce glass parts for solar energy production. Glasstech's innovations are chronicled through an active worldwide patent portfolio.

Following is a chronological look at these innovations through the years:

1972

- Roller Hearth Tempering System

1974

- Batch (Oscillating) Tempering System

1978

- Quick-Sag™ Bending and Tempering System

1985

- Deep Bend 4™ System (DB 4)

1991

- Advanced Cylindrical Bender System (CRB)

1992

- Forced Convection Heating

2001

- DB 4™ Quick Change and Fast Cycle System

2002

- External Press Bender System (EPB-T™) for Tempered Parts

2007

- Solar Parabolic Bender System (CRB-S™)

2009

- External Press Bender System (EPB-L™) for Windshield Parts

2010

- Automotive Glass Inspection System (AGI)

Glasstech Celebrates 40-Year Legacy With Transition Into the Future

It was a hot, dusty August day in 1971. Three friends, all veterans of the glass business, met in the second-floor offices of a building in the small Northwest Ohio village of Woodville to breathe life into an idea they shared.

The resulting company became the world's premier designer and marketer of glass processing systems, initially for the automotive and architectural markets and now in a market the company helped create, solar energy production.

The company is Glasstech, Inc., which celebrates its 40th anniversary later this year.

Glasstech has been headquartered in Perrysburg, Ohio, since 1979 and is a global company with its glass processing systems installed in over 40 countries on six continents.

The three friends were Harold A. McMaster, Norman C. Nitschke and Frank A. Larimer.



Harold A. McMaster and Norman C. Nitschke, two of Glasstech's co-founders.

McMaster and Nitschke worked together for the former Libbey-Owens-Ford Glass Company, Toledo, Ohio. In 1949, McMaster left to start his own glass company, Permaglass, Inc., Millbury, Ohio.

Nitschke joined McMaster in 1951 and Larimer joined in 1952.

In 1969, Permaglass merged with Guardian Industries of Detroit, Michigan. By 1971, the three had left Guardian, paving the way for Glasstech's creation.

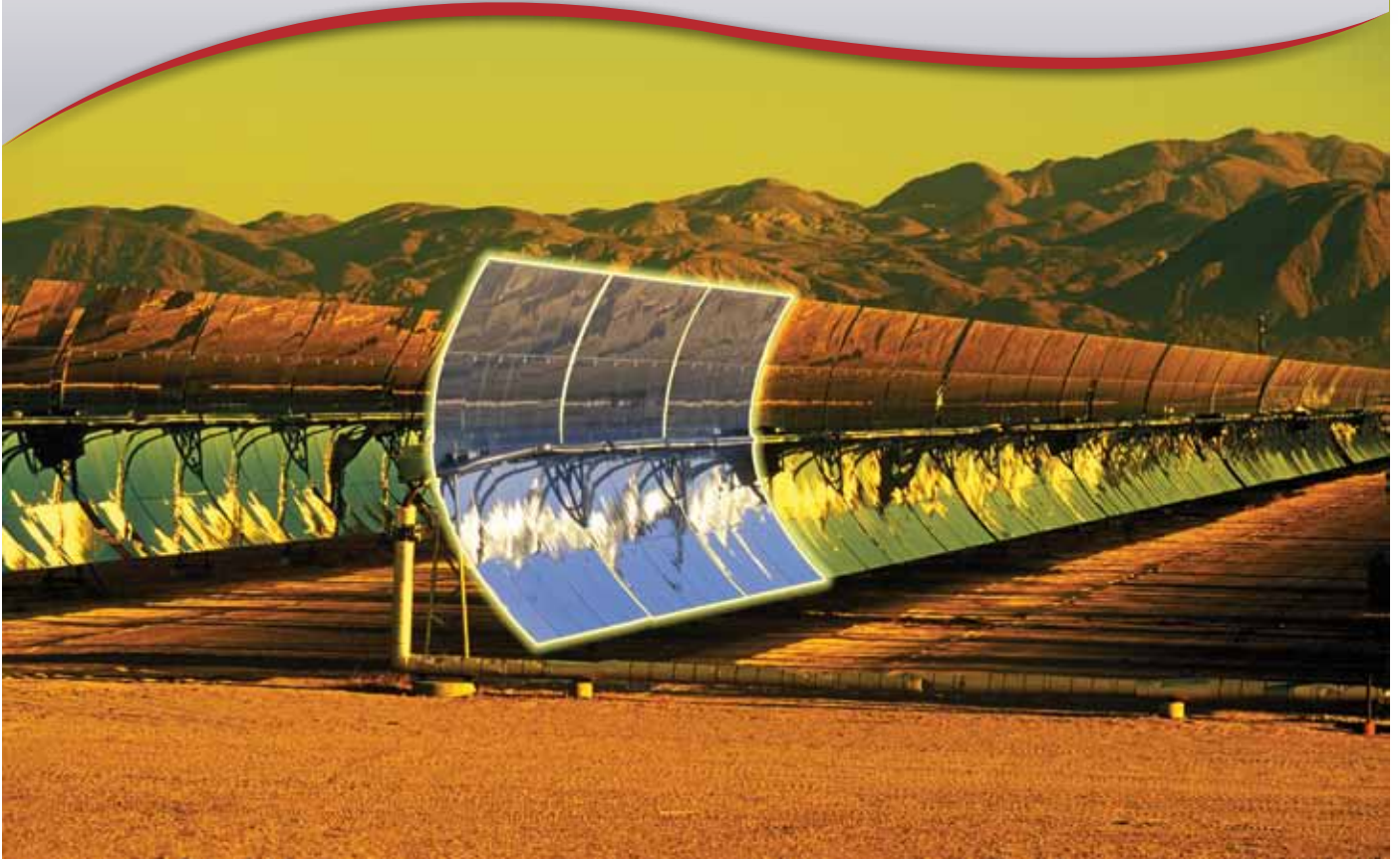
Glasstech's reach during its 40-year history goes from the very basic F-200, Glasstech's first system, designed to continuously temper glass for architectural applications, to bending and tempering systems for automotive glass applications, to state-of-the-art glass bending and tempering systems for producing parabolic glass troughs for the concentrated solar power market.

During these 40 years, Glasstech technology has made possible the advancement of designs in the architectural and automotive markets, and Glasstech is now doing the same thing in the solar energy market. A chart on this page provides a quick overview of some of Glasstech's major technology innovations.

McMaster and Nitschke saw solar energy production as a way to ensure a market for glass processed on Glasstech's systems. That foresight has never been clearer than today.

Glasstech's past achievements have set the stage for its future accomplishments, and that future looks dazzling today based on the sun's reflection off automotive, architectural and solar energy glass processed on Glasstech systems.

Glasstech positioned to meet global demand.



SOLAR

Growing Solar Industry Increases Demand for Tempered Glass

Are you surprised to learn Glasstech solar systems are being used or installed currently by glass processors worldwide to produce mirror blanks for the concentrated solar power industry?

With the startling speed that solar energy production facilities are being sited, designed and built, the penetration of Glasstech's production-proven systems should come as no surprise. With a heritage of 40 years of innovation and ruggedness, Glasstech systems are leaders in the automotive and architectural markets and now occupy a similar position in the solar marketplace.

A strong demand exists for the unique shaping and strengthening abilities that Glasstech's industry-leading systems bring to the solar energy market. The company provides precisely bent- or curved-glass equipment solutions for concentrated solar power (CSP) and concentrated photovoltaic (CPV) markets, as well as equipment solutions for fabrication of extremely flat glass for the photovoltaic (PV) market.

Glasstech systems for solar glass processing provide tempered or heat-strengthened glass solutions that offer significant advantages, as tempered glass accounts for fewer installation

failures and in-service failures from wind, hail and debris, as well as less collateral damage in the event of an in-service failure.

Shortly after Harold McMaster, Norman Nitschke and Frank Larimer founded Glasstech in 1971, McMaster and Nitschke began investigating and investing in the possibility of solar energy. Their early financial and technical involvement in photovoltaic research provided the foundation for what is today's largest manufacturer of thin film solar modules.

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SOLAR – Continued from page 2.

Through this leadership role, Glasstech has gained an insider's understanding of the industry's requirements, which has led to the development of a family of systems expressly for the solar power generating industry.

CSP Applications

Installation is underway on Glasstech's newest and largest solar-glass processing system – the CRB-S 1900 for Solar Parabolic Shapes. This system is capable of shaping and tempering or heat-strengthening parts to LS2, LS3 and LS4 industry-standard sizes used in CSP-based generating systems.

Along with the slightly smaller CRB-S™ 1700, these systems are known for forming flat glass into

parabolic or cylindrical shapes with high output, ease of operation and high repeatability, along with advanced surface strengthening. The systems also are capable of meeting precise tolerances for high-level geometric reflection.

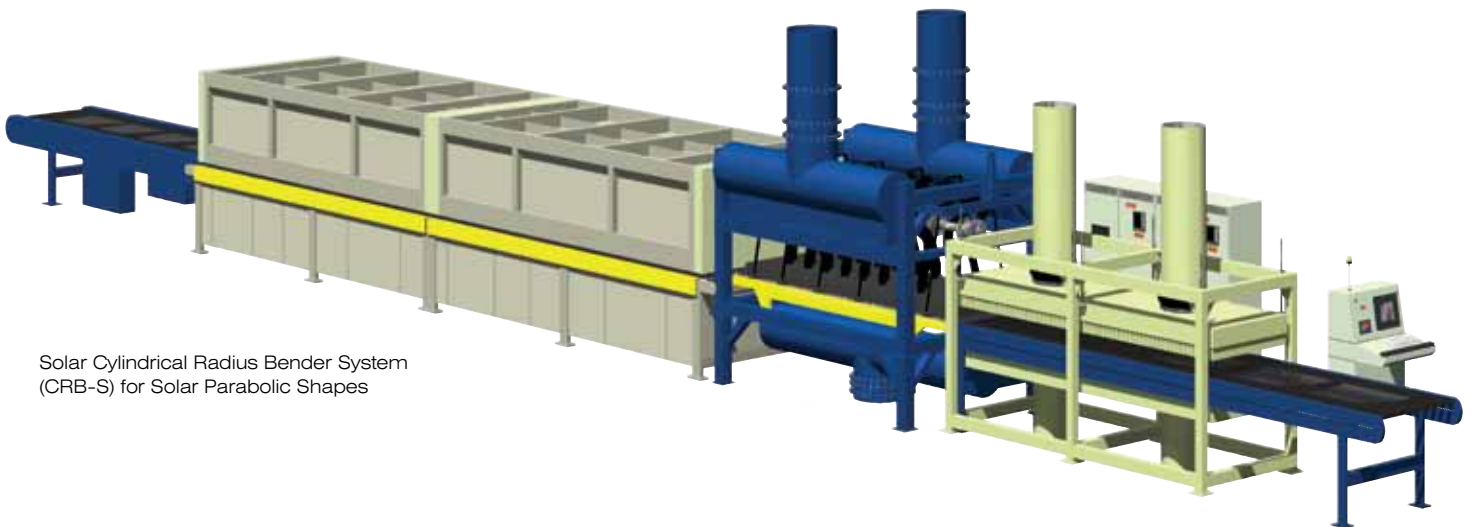
These systems are the only commercially available solar-glass processing systems that temper or heat strengthen glass and are ideal for the high speed production of parabolic-shaped trough reflectors. Fully tempered glass is up to five times stronger than annealed glass and provides increased impact and wind-load resistance. If tempered parts are broken, the resulting glass pieces are small and are safer for workers and other nearby components.

Additionally, Glasstech's CRB-S systems:

- Use much less energy than the traditional sag-forming systems, since the CRB-S system heats only the glass
- Can change shape set-ups in 60 minutes or less
- Cost less to operate since glass is formed without dedicated tooling

CRB-S systems can be ordered with a Glasstech electric radiant heater or with a Glasstech convection heater, either electric or gas fired.

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Solar Cylindrical Radius Bender System (CRB-S) for Solar Parabolic Shapes

Precisely forms flat glass into parabolic or cylindrical shapes.

High-volume, energy-efficient ultra-flat panels.



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Photovoltaic Applications

Some photovoltaic (PV) panels come with specialty coatings that require the unique, uniform heating provided by Glasstech's convection heating options to deliver the ultra-flat panels manufacturers require.

PV is the area of Glasstech's original research and an area the company understands quite well. The millions of square feet of PV-panel glass processed each year on Glasstech continuous systems in the United States alone are testimony to Glasstech's understanding and technical achievements in this market.

Because Glasstech high productivity machines have such market penetration, they have helped lower the cost of processing glass for PV cells.

A key is Glasstech's highly energy-efficient Solar Forced Convection Heater Flat Glass Tempering System (FCH-S™). This system features a combination of natural gas fired, forced convection heating, reduced heating costs and superior tempering technology.

The FCH-S system processes high volumes of glass very precisely, yielding extremely flat glass. The system will efficiently process low-iron float and pattern glass, TCO-coated and clear glass for PV panels.

The FCH-S system will heat TCO/Low-E glass in about half the time of typical radiant systems, 33 to 35 seconds per millimeter of thickness, depending on the specific coating. The system will heat clear glass at the rate of 30 seconds per millimeter.

In addition to the two CRB-S systems and the FCH-S system, Glasstech's comprehensive line of solar glass processing systems includes:

- Solar External Press Bender System (EPB-S™) for tempering and heat strengthening smaller, high volume spherical and parabolic shapes
- Solar Advanced Deep Bend and Tempering System (DB 4-S™) for complex and deep bend-shaped parts for dish segments and parabolic collectors
- Solar Electric Radiant Heater Flat Glass Tempering System (ERH-S™) for a continuous, electrically powered flat glass tempering for photovoltaic panels

Press-forming technology caters to the glass needs of any vehicle.

AUTOMOTIVE

Press-Forming Technology Produces Compound and Complex Lites Quickly.

You see them everywhere.

They are vehicles, especially top-of-the-line vehicles from the world's high-end automakers, with even more compound and complex glass lites than before. Windshields, backlites, doorlites and sunroofs that curve and flow into stylish shapes that demand precise and strict tolerances.

"It used to be we'd get glass designs with three-to-ten probe points to check the surface conformity of the glass produced," said Jim Schnabel, Glasstech's Vice President, Product Development. "Now, we're seeing windshield designs, for example, with 100 or more checking points. The best way to produce these complicated designs is by using Glasstech's press-forming technology."

Glasstech has three systems utilizing its press-forming technology to meet all automotive glass needs:

- **Windshields** – External Press Bending System for Annealing Automotive Safety Glass (EPB-L™)
- **Sidelites, Sunroofs and Backlites** – External Press Bending and Tempering System (EPB-T™)
- **Backlites** – DB 4™ Quick Change/Fast Cycle Advanced Bending and Tempering System (DB 4 QC/FC)

The EPB-L system is an innovative, highly versatile glass windshield bending system currently operating on the European and Asian continents and will begin production soon in North America. The system satisfies the automotive OEM demand for tighter surface tolerances with superior optical quality while also meeting the glass processor's need for greater productivity, repeatability, economical tooling and energy conservation.

Using only a single tool set ensures the EPB-L uses significantly less energy, when compared to gravity-sag systems.

The EPB-L can achieve a cycle time of 8 seconds per glass part, which means the two parts required for lamination can be produced every 16 seconds. To achieve these speeds, the system is equipped with a final heating section that pre-forms glass by means of a patented FanRoll system.

The EPB-T system is available in two versions. The EPB-T-SS™ is a narrow version that forms and tempers a single stream of sidelites. The EPB-T-DS™ is a wider version and forms and tempers a dual stream of sidelites or a single backlite.

This system achieves Audi/Volkswagen's strict optical performance requirements and BMW's demanding shape tolerances.

The EPB-T press-forms using a full-surface mold and a full-periphery female ring. The system also features fast transfer from heater to quench and a FanRoll option, which pre-bends relevant parts in the heater. Pre-bending reduces subsequent bender cycle time and permits lower exit temperatures.

The DB 4 QC/FC Advanced Bending and Tempering System uses a single tool set to produce high optical quality glass to precise and exacting tolerances in complex shapes. The system's quick tool-change feature permits changeover from one production part to the next in 90 minutes, instead of 6 hours for the original design. The fast cycle allows complex deep bend parts to be produced in as little as 17 seconds.

The Glasstech DB 4 QC/FC is used by every major automotive glass processor and meets the very exacting demands of the automotive companies. It is the world standard for the production of complex backlites and is the standard by which other glass processing systems are measured.

Glass Demand Grows in China, India

Their names are Yang Ping and Ramesh Srinivasan, and they are the face of Glasstech in China and India.



Yang Ping



Ramesh Srinivasan

Ping heads Glasstech's Representative Office in Shanghai, China, and Srinivasan runs the company's India Liaison Office in Mumbai, India.

The Shanghai office was opened in 2004, and the Mumbai office opened two years later.

The presence of both offices is testimony to the importance Glasstech assigns to these markets. In "Asia-Pacific Markets Outlook 2011," issued in mid-March by Standard & Poor's, India's Gross Domestic Product (GDP) is predicted to grow at 8 to 8.5 percent in 2011, and China's GDP is expected to be 9.6 percent in 2011.

Both countries and the region surrounding them exhibit rapid growth and an expanding need for the glass products processed on Glasstech systems. Specifically, glass parts for the automotive, architectural and solar energy production markets.

The Chinese market has evolved into one of the largest world markets for automotive glass such as produced on the company's Deep Bend 4 system (DB 4™). The demand for glass parts for solar energy production also is robust, especially for the large LS4-sized, bent and tempered glass parts produced on Glasstech's new Cylindrical Radius Bender (CRB-S™ 1900). The demand for the ultra-flat glass plates for photovoltaic cells from Glasstech's flat tempering systems also is strong.

India mirrors China's need for processed glass parts as produced on Glasstech systems. The country's auto industry is emerging as a global supplier, and India's need for solar glass parts is increasing rapidly as a result of the country's national plan to foster solar development.

The offices in China and India enable Glasstech to increase its presence in these countries and the surrounding areas and to provide a critical link to customers and prospects. These offices provide more timely response to customer and prospect needs, as well as quickly react to new sales opportunities.

Additionally, the Shanghai office's Ping and the Mumbai office's Srinivasan are both native to the areas covered by their offices and can react to customer

needs on a real-time basis.

Ping is Glasstech's Chief Representative – China and heads the company's Shanghai office. Previously, he was a Chinese marketing consultant for a United States company, and an assistant manager in the supervision and control department of China Chemical Building Materials Company. He holds a Master of Business Administration from the University of Texas Arlington, a Master of Arts in Financial Economics from the University of Maine, U.S.A., and a Bachelor of Arts in Economics from Renmin University of China, Beijing.

Enquiries specifically targeting the China market should be sent to either Ping at yping@glasstech.com or sales@glasstech.com.

Srinivasan is Country Manager for India and heads the Mumbai Liaison Office. Srinivasan joined Glasstech after serving as Chief Sales Manager for the Bauer Division of International Combustion, Ltd. He holds mechanical engineering and advanced marketing management degrees from Bombay University.

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