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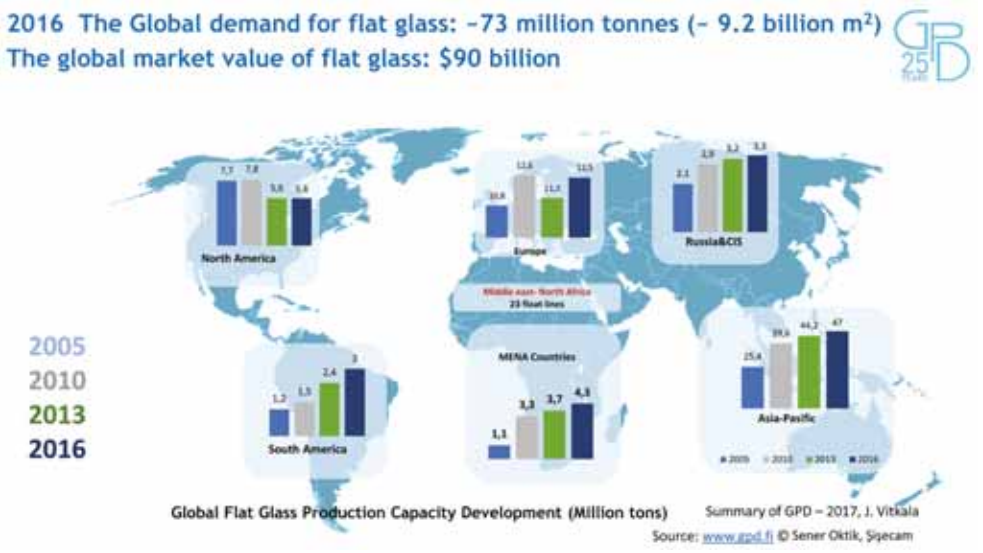
GPD WORLDWIDE GLASS TRENDS

This article groups together some of the ideas from presentations during the 25th anniversary GPD event, providing a global overview of the trends of the glass industry, covering design, automotive, Internet, daylighting, and new technologies, to name a few.

The Glass Performance Days (GPD) is the world's leading glass industry conference. The nature of GPD is well illustrated by a quotation from an Indian poet Bhartrihar: 'knowledge really grows when it is shared'. In fact, the purpose of the event is to develop the whole glass supply chain globally.

At the 25th anniversary event in Tampere, experts in the field held 180 presentations on new technologies, trends and innovations, some of which have been used to create this article.



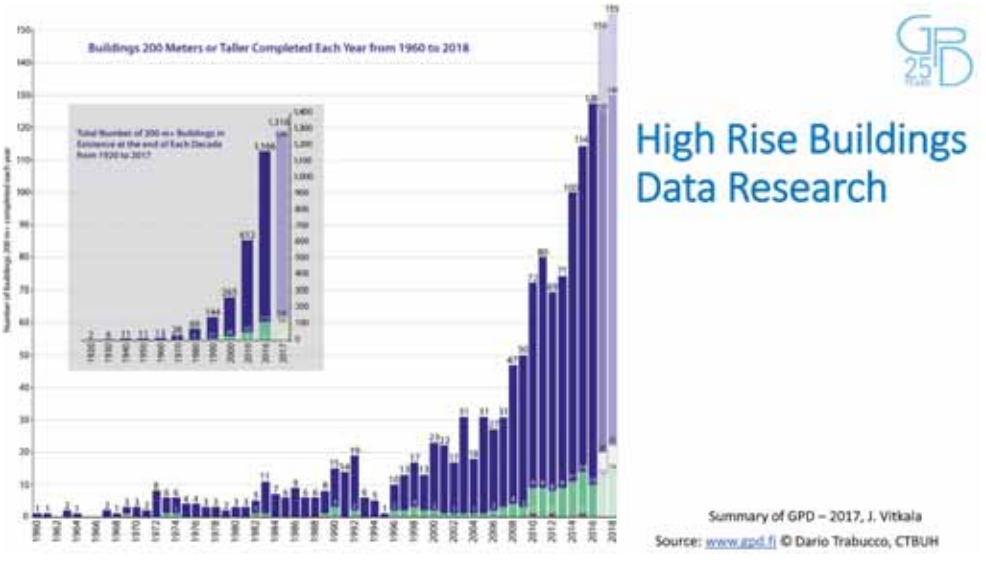
"KNOWLEDGE GROWS WHEN KNOWLEDGE IS SHARED" (BHARTRIHAR)

Worldwide glass market trends

The glass industry has experienced significant changes over the past 25 years. New players have entered the market and production has grown. Twenty-five years ago there were 150 float lines, now there are more than 500. Just a quarter of a century ago Europe, the United States and Japan produced 60 per cent of all the glass in the world, now their share has dropped to below 20 per cent. Correspondingly, the rise of the Far East, especially China, is reflected in the market in many ways: in Asia demand and manufacturing are both on the rise. More than half of the float lines and production capacity are located in China, and there are more than 7,000 Chinese glass patents nowadays – a significant growth from the slightly more than 300 patents there were 25 years ago.

The production capacity of float lines and the life cycle of furnaces have increased. There have been technical developments, for example in efficient energy use, melting technology and various coating technologies. The thin glass developed for cellular phones and tablets is used more and more in architecture, interior design and automotive industry.

Fabrication processes have also improved significantly in 25 years. The size of safety glass and insulating glass elements has increased considerably and the new coatings raise energy efficiency to a whole new level. Energy balance is given special attention today. Glass can be bent into more complex shapes, and different coatings give it new features and possibilities. Process automation has increased and improved production



efficiency. Better quality control, on the other hand, has reduced the number of complaints and errors in the various stages of the fabrication process.

The total demand for flat glass in the 2016 was 73 million tons, or 9.2 billion square meters (calculated on 3-millimetre glass) dominated by China (51 per cent). The growth in demand is very fast in China because of the current construction boom. There is also a great number of buildings with single glazed windows about to be renovated in China, and in Central Europe as well. In Europe, triple glazing is becoming a new standard. In energy-efficient modern construction, all this means an increased use of coated insulating glass elements.

The development of new technologies and products has remained mostly in Europe and in the US. Automotive and automotive glass industries are also focusing on Asia, but in this area too, R&D and design is often carried out in Europe.

Glass is used above all for architectural purposes (façades, interiors and refurbishment). Building glass accounts for about 80 per cent of total flat glass demand. The automotive industry uses 10 per cent of the glass and the remaining 10 per cent go to different special applications, such as fast-growing solar glass applications.

It is worth noting the growing amount of buildings 200 meters tall or taller. The construction of high-rise buildings has increased rapidly as a result of the sharp rise in urbanization and land plot prices. On the other hand, climate consciousness favours high buildings as close construction reduces carbon dioxide emissions from traffic. In 2017 there were already over 1,300 buildings in the world that rise over 200 meters.

> "It is in this intersection of science, art, materials, and construction where design and technology, art, and science become architecture. Beauty is more than skin deep." (Keith Boswell, SOM Architects)

INDUSTRY 4.0 AND INTERNET OF THINGS

Industry 4.0 is the concept for the fourth industrial revolution first coined in Germany. IoT (Internet of Things, the industrial internet) is changing production and operating methods significantly. Automation and digitalisation bring productivity to a new level in efficiency, flexibility, quality and time-to-market.

Glaston and other players have developed the collecting and processing of big data, as it opens up a whole new kind of potential. For example, the properties of every single piece of glass can be traced over the decades. In buildings, the database used for building materials, their properties and recyclability will greatly improve security of supply.

WORLDWIDE GLASS DESIGN TRENDS

No matter if it is a city centre skyscraper or a small town house on the design board, the surrounding nature and buildings are carefully taken into consideration by the architect. How the building fits in its environment: where the sun shines from, how are the winds blowing, how does the local climate affect the energy consumption of the building.

One of the biggest trends is total transparency, where glass is the most natural choice. Transparent glass connects the building with its surroundings, nature and people; on the other hand, it separates and protects against natural forces. In advanced glass technology, the transparency of the glass can be dynamically adjusted, which offers new opportunities for glass interior decoration and for managing energy flows in the facade of a building.

Large, uniform glass surfaces are nowadays energy-efficient and able to keep heat either indoors or outdoors, whichever is required. In tall buildings façades can be converted into attractions. For example, in Hong Kong, skyscrapers are used as platforms on which computer-controlled LEDs illuminate impressive animated images. In the future this will be utilized in many ways in entertainment and communication. On the other hand, a glass bottomed bridge over a canyon is a major attraction and a sure WOW effect, but at the same time it offers a safe passage to the other side of the canyon.

Fondation Louis Vuitton in Louis Vuitton Paris, France
Architect: Frank Gehry
Structural Engineer: RFR
Laminator: Sunglass
Interlayer: 1.52 mm (60 mil) Ionoplast
Given the complexity of the sails and their multiple facets, all of which required unique geometries Ionoplastwas the best choice.

Paris, designed by Frank Gehry, is an excellent example of the diversity of glass in construction. The trend is to use unconventional, softer or more organic forms in the buildings. This has raised the demand for bent glass. As bending technologies have also developed, the multifunctional use of glass can add shape, spectacularity and distinctiveness to any building.

DAYLIGHTING

There is a lot of research data on the effects of daylight. For example, it improves work performance and learning achievements and it makes patients recover faster. Daylight utilization is therefore justified in the design of buildings by well-being, profitability and sustainability.

By using glass, daylight can be brought into the building and reflected further in the interior. Transparent structures in the interior also allow light to pass deeper into the building and it can also be redirected with reflecting surfaces. To get the best of daylight and energy balance, we can add movable sunshades, switchable glazings, solar panels and – the latest development – transparent solar panels that are integrated into windows. There are already a lot of ways to utilize daylight for the comfort and well-being of inhabitants as well as for the energy production in the building – while creating things that please the eye.

WORLDWIDE AUTOMOTIVE DESIGN TRENDS

The development of glass technology will bring new trends to the automotive industry, especially to commercial vehicles. The glass is an important part of the load-bearing structure. Glass sizes and shapes become more challenging for manufacturers, but at the same time they bring new experiences and applications to vehicle users. Commercial and passenger vehicle displays improve when display data can be projected on a windscreen or shown on an in-built transparent display. The driver no longer has to take his or her eyes off the road or work area as the required information is displayed on the windscreen.

In addition to safety, the automotive industry emphasizes energy efficiency. The need for cooling or heating can be reduced by using coated glass or smart glass to help regulate the vehicle's interior temperature.

NEW TECHNOLOGIES

Thin glass

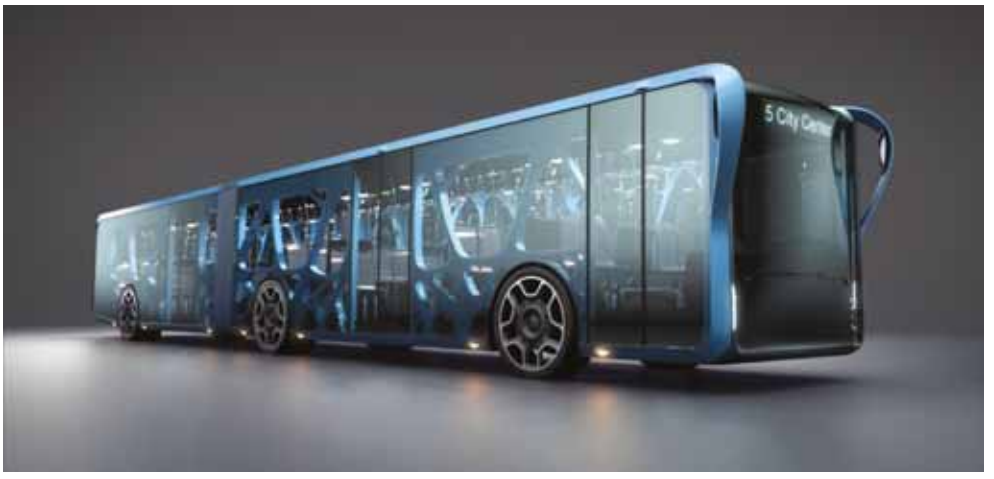
Thin glass is already in use, for example, in mobile phones and tablets, and it is coming into the construction and the automotive industries. Ultra-thin glass (0.01 to 0.3 millimetres) is so thin that it can be rolled. There are already successful cases of the first roll-to-roll coated glasses, although they are still too narrow for architectural use.

Thin glass applications will be greatly diversified as manufacturing, coating and lamination technologies are improving. It will be possible to produce the wider sizes required by architecture and, on the other hand, coating technologies will allow many new properties for mass-produced glass. There will be things like furniture laminated with ultra-thin glass or wall paper made of it – and they will be durable and easy to clean in the same way as cell phones and tablets already are.

In architectural use structural features can be added to the glass in many ways, most typically by laminating tempered glasses with special films, by bonding the honeycomb structure inside the insulating glass or by laminating a wire into a glass beam. Good design and glass bending will offer additional features. 3D printing has also taken its first steps in glass industry, but so far it has had few applications.

Igloos made of electrically heated glass

Electrically heated glass has brought some good financial results to developers, for example in the accommodation industry. Accommodation customers are willing to pay for their experiences, for example, staying in a transparent igloo under the star-



ry sky and with good luck in the glow of the Northern lights.

There is no draft in the proximity of an electrically heated glass to spoil the customers experience. Finnglass, one of the pioneers in the field, has been developing the electrically heated glass for 20 years now, and it would be suitable for many applications in modern construction.

The heated glass wall is more expensive than traditional glazing but it generates substantial savings in energy consumption and it increases available floor space.

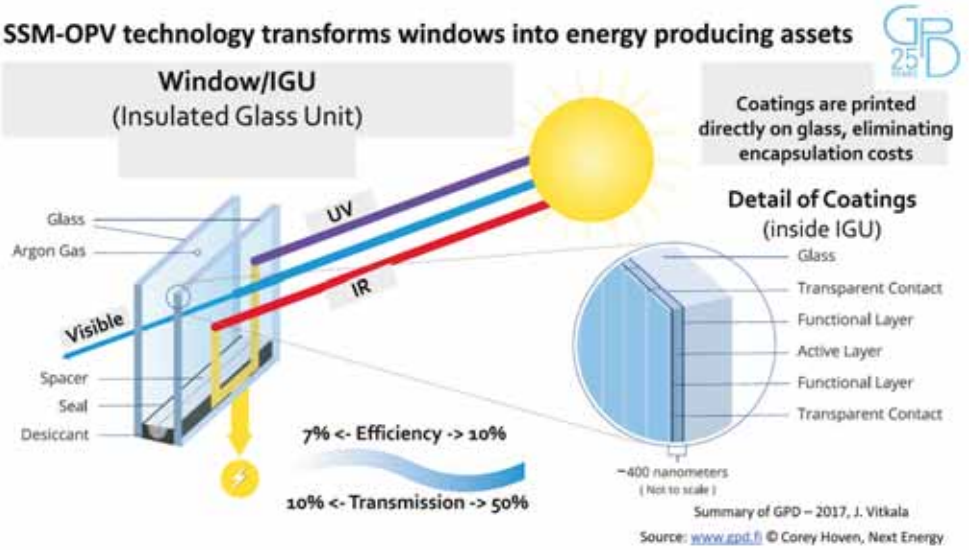
The inner surface of the electrically heated glass is warmed 1-2 degrees above room temperature, hence the cold wall effect and the convection are prevented. The energy consumption is only 20-40 watts per square. Radiators or fans are not required, so the interior space is free for other uses.

This will bring significant benefits to space use and increase the building area. Electrically heated glass can also be used in glass ceilings to melt snow and ice and to prevent condensation.

WORLDWIDE GLASS ENERGY TRENDS

Buildings account for 44 per cent of total energy consumption in the EU countries (industrial buildings 7 per cent, domestic and tertiary buildings 37 per cent). Switching to more energy efficient windows would allow significant savings, as windows are estimated to be responsible for 24 per cent of heating needs in the EU and for 9 per cent of cooling needs.

The impact of buildings on energy consumption is enormous: they use 60 per cent of the electricity



produced and account for more than one third of the greenhouse gas emissions. It is not just about how windows keep the heat inside (reducing the need for heating) or outside (the need for cooling decreases). An intelligent facade can convert sunshine into energy. Integrated solar panels are also becoming popular in Finland and the Nordic countries. Transparent solar panels are integrated into windows, and the user does not notice the difference compared to a traditional window. With regard to solar collectors, new ideas on how to produce warm air and hot water or to apply them to cooling the building are already in use.

In the digital printing on glass, a resolution up to 1,400 dpi is achieved, and it is possible to create large surfaces, such as different views on the outside and inside walls of a building. At the same time, the energy balance of the building can be improved as the ceramic ink used for printing absorbs the excess energy.

The building of the future produces at least part of the energy it uses and automatically balances its energy streams. Its windows can regulate the amount of heat and light passing through them and also use infrared and ultraviolet components of light to produce electricity. Smart glass/media façade technologies are being developed, so interesting news are to be expected.

STRUCTURAL GLASS APPLICATIONS

Tim Macfarlane was one of the first ones to start developing the use of glass as a structural material in the buildings in the 70s and 80s, and this has given rise to the idea of total transparency: wind and structural loads can also be borne with glass structures and thus create new types of buildings. Of course, this has put demands on glass machine manufacturers and glass processors for new products and equipment for handling and transferring large and heavy glasses.

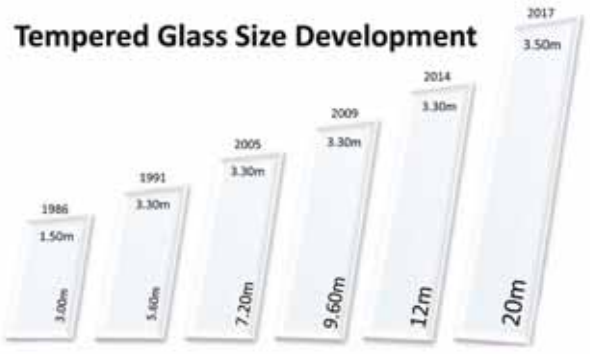
Cold bent glass has been used in buildings for over ten years, and because the experiences are good, the use has increased and diversified. In cold-bending the insulating glass element made of tempered flat glass is mechanically bent in the shape of the building frame when installed. However, the sharpest bends are always made by thermal bending. The latest and most demanding process is the lamination bending, which is carried out in connection with the autoclave process. This method requires a lot of experience and know-how, but it will diversify the possibilities in glass construction.

The latest addition is the introduction of transparent structural silicones on the market. They enable making of even more transparent structures and applications.

WORLDWIDE GLASS QUALITY TRENDS

Tempered glass sizes have grown considerably over the last couple of decades; today the largest glasses are 3,3x20 meters. Growth in glass sizes and new coatings create particularly strict demands for the tempering and lamination processes, so quality control and the various measurement methods are important.

Product development in Glaston and Viprotron has focused, among other



things, on the development of anisotropy and/or roller wave distortion measurement methods, and thus enables better quality to be achieved to suit the most demanding applications. Sparklike, for its part, has developed a method for measuring the argon gas content of the insulating glass element through the element. This can be done either on the production line, after production at the factory or on the construction site. It ensures that elements not meeting the agreed values are not used in buildings. Measuring in these projects is always cheaper than replacing faulty elements after construction work.

THE AUTHOR JORMA VITKALA

Jorma Vitkala is the founder of the Glass Performance Days Conference (GPD) and has been chairing the organizing committee since the beginning. He is the first recipient of the 'The Jorma Vitkala Award of Merit' awarded by the international glass industry by Dow Corning and Kuraray . The prize was announced and handed over at the opening of the GPD conference in the summer of 2017. On the same occasion, Vitkala received several recognitions: the special awards of the HKFA (Hong Kong Façade Association) and the KAFA (Korean Architect Façade Association), the USGlass plaque and a honorary membership of GANA (the Glass Association of North America). Finnish Flat Glass Association has nominated Vitkala the Glass builder of the Year 2013 and he received the Tampere Congress Award in 2001.

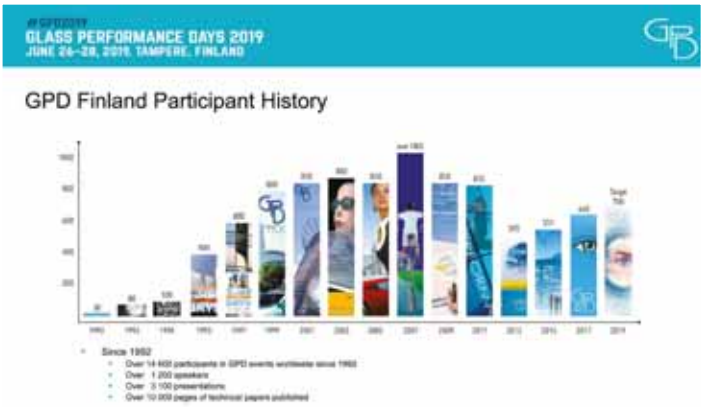
GPD – FACTS AND FIGURES

GPD 1992–2017 – impressive record

- 14,600 delegates
- 1,200 speakers
- 3,100 presentations
- 10,000 pages of technical documents

GPD 2017: The GPD Conference celebrated its 25th anniversary. The Tampere event attracted more than 650 international participants and top of that 160 participants in High Rise workshop in Helsinki, with the leading companies in the supply chain all over the world.

Step Change: The first Step Change event was organized in 2017 GPD, as a meeting forum for start-ups and leading companies in the glass industry. The aim of the event was to accelerate the development of the glass industry by helping the new technologies and innovations to enter the market, thereby improving the competitiveness of glass products in relation to other materials.



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