



## Window and Glazing Topics – Glass timeline

**TANGRAM  
TECHNOLOGY**

**Consulting  
Engineers**

Tangram Technology Ltd.

33 Gaping Lane, Hitchin, Herts., SG5 2DF

Phone: 01462 437 686

E-mail: [sales@tangram.co.uk](mailto:sales@tangram.co.uk)

Web Pages: [www.tangram.co.uk](http://www.tangram.co.uk)

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## Introduction

Glass is one of the oldest of materials known by man. The first actual glass objects (arrowheads and simple tools) were from natural glass (obsidian) created by sudden volcanic eruptions followed by rapid cooling.

Many of the discoveries were accidental but it took great men to turn from accident to reality.

If there are any events that you would like recorded on the Timeline then please let me know – amusing stories are always welcome but serious ones have to be really interesting!

<b>12,000 BC</b>	<ul style="list-style-type: none"> <li>• Glazed ceramic pottery used to improve the water tightness of jugs, bottles and vases.</li> </ul>
<b>4,000 BC</b>	<ul style="list-style-type: none"> <li>• Mesopotamian area uses first manmade glass objects (as opposed to simply melting and re-forming natural glasses). Coloured glass was very valuable as 'gemstone' for jewellery and coloured glazes were used for coating beads. The secrets of glass making were restricted and secret.</li> </ul>
<b>3000 BC</b>	<ul style="list-style-type: none"> <li>• Egyptians produce glass objects very similar compositions to those of modern soda lime silicate glasses. These use readily available soda ash (from fires), limestone (from seashells) and silica sand (from the beaches) for production.</li> <li>• Glass used as decoration in the tombs of the Pharaoh's.</li> </ul>
<b>1500 BC</b>	<ul style="list-style-type: none"> <li>• Hollow containers first made by covering a sand core with a layer of molten glass. When the glass solidified the sand was scooped out, leaving small vessels. These were decorated by applying threads of coloured glass to the surface and arranging them in attractive patterns.</li> </ul>
<b>900 BC</b>	<ul style="list-style-type: none"> <li>• Glass production starts in Syria &amp; Rhodes and glass recipes start to be formulated.</li> </ul>
<b>650 BC</b>	<ul style="list-style-type: none"> <li>• First glassmaking handbook published, Assyrian Assurbanipal's Library.</li> </ul>
<b>500 BC</b>	<ul style="list-style-type: none"> <li>• Venetian glass artists begin to create vases and glass pieces.</li> </ul>
<b>300 BC</b>	<ul style="list-style-type: none"> <li>• Syrian glassmakers invent the blowpipe to enable the production of glass in hollow shapes. This is soon followed by the invention of the two-part mould that enabled mass production of products.</li> </ul>
<b>200 BC</b>	<ul style="list-style-type: none"> <li>• Greeks and Romans start to use mosaics made of pebbles and coloured ceramic glass chips.</li> </ul>
<b>50 BC</b>	<ul style="list-style-type: none"> <li>• Glassblowing advances and flourishes in Phoenicia.</li> </ul>
<b>25 BC - 400 AD</b>	<ul style="list-style-type: none"> <li>• Roman Empire allows rapid development and expansion of glass melting, working and forming technology in the Mediterranean. Flat window glass was produced by casting molten glass onto an iron table and stretching it. Flat glass was also produced by blowing glass bubbles or cylinders and mirrors by applying a silver amalgam to the flat glass.</li> <li>• Mosaic art flourishes in Roman civilisation and reaches a peak in the mosaics in Ravenna created during the rule of Justinian (they are still brilliant enough to take your</li> </ul>

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	<p>breath away). The collapse of the Roman Empire led to glassmaking being transferred around the Mediterranean area but many of the secrets were closely guarded by individual glassmakers and were lost during the collapse.</p>
<b>680</b>	<ul style="list-style-type: none"> <li>• First evidence of the British glass industry in the areas of Jarrow and Wearmouth.</li> </ul>
<b>1000</b>	<ul style="list-style-type: none"> <li>• Venice starts to dominate glass production and Murano Island is established as a major glass centre to reduce the risk of fire to the main town and to isolate the glassmakers to prevent secrets being revealed.</li> </ul>
<b>1000 - 1100</b>	<ul style="list-style-type: none"> <li>• Stained glass becomes available because of the expansion of cathedral building in Europe. Cities wanted to have the largest most beautiful cathedral and coloured "see through" stained glass was developed to meet the demand, this 'cathedral' stained glass was a clear glass with coloured 'stain' applied to it.</li> </ul>
<b>1226</b>	<ul style="list-style-type: none"> <li>• 'Broad Sheet' first made in Surrey and Sussex, (although fairly opaque and of poor quality). Broad sheet glass is made by a process of gathering molten glass onto a blowpipe and then blowing this into a balloon, the ends are cut off and the cylinder is split and flattened out into a sheet. The glass had many imperfections and was generally used only for small leadlights in windows.</li> <li>• Glass from Chiddingfold used to glaze the old chapels of St. Stephen and St. George at Windsor.</li> </ul>
<b>1330</b>	<ul style="list-style-type: none"> <li>• 'Crown Glass' first produced in Rouen, France (or in 650 AD in Syria – depending on the source of information). Crown glass is made by taking a balloon and forcing this into a flat sheet, the flat sheet is rotated quickly until a thin disc is created. The disc is then cooled rapidly and the resulting flat sheet is cut up to form glass panes. This method remained the production method of choice until around 1850. The central area from the production is the 'bull's eye' and this was the cheapest area of the glass – it is still possible to buy 'bull's eyes' but they cost more than flat glass!</li> </ul>
<b>1449</b>	<ul style="list-style-type: none"> <li>• Henry VI grants earliest known Letters Patent (signified by open letters marked with the King's Great Seal) for invention to Flemish-born John of Utynam for a method of making stained glass. This gave John of Utynam a 20-year monopoly on the method and it was used for making stained glass for the windows of Eton College.</li> </ul>
<b>1500</b>	<ul style="list-style-type: none"> <li>• Venice establishes ruthless penalties for anybody taking glass production secrets abroad and threatening the Venetian monopoly. In spite of these precautions, some glassmakers escape and set up glassworks elsewhere in Europe. Venetians discover how to make mirrors using mercury-foiling process. Many people died of mercury poisoning at a young age but the mirrors could be sold at an enormous profit – and the death penalty was instituted for anyone who revealed the secret of the manufacturing process.</li> <li>• Angelo Barovier invents 'cristallo' a clear and colourless glass.</li> </ul>
<b>1575</b>	<ul style="list-style-type: none"> <li>• Patent granted to Jacopo Verzelini (Italy) to make "drynkyne glasses such as be accustomed in the town of Murano" and to teach British workers how to make them.</li> </ul>
<b>1590</b>	<ul style="list-style-type: none"> <li>• Glass telescope and microscope lenses are developed in Netherlands and used for the first time.</li> </ul>

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<b>1600</b>	<ul style="list-style-type: none"> <li>• France established as major power in the glass industry, Henry IV confers exclusive rights to some Italians to produce glass in selected cities in France.</li> </ul>
<b>1615</b>	<ul style="list-style-type: none"> <li>• Royal Proclamation issued in Britain forbidding the use of wood for glassmaking. Wood was in demand by the shipbuilding industry and furnaces were changed over to coal-fired furnaces. The need for coal and other raw materials decided the location of the new furnaces and the North West of England and Yorkshire became centres of production.</li> </ul>
<b>1620</b>	<ul style="list-style-type: none"> <li>• 'Blown Plate' first produced in London by grinding and polishing Broad Sheet.</li> </ul>
<b>1664</b>	<ul style="list-style-type: none"> <li>• Incorporation of Worshipful Company of Glass Sellers of London.</li> </ul>
<b>1665</b>	<ul style="list-style-type: none"> <li>• Jean Baptiste Colbert centralized glass making in France and established dominance in the production of flat glass and used the Palace of Versailles as a lasting symbol of their art and technology.</li> </ul>
<b>1673</b>	<ul style="list-style-type: none"> <li>• George Ravenscroft sets up glass furnace and begins research into a 'sort of Christaline Glass resembling Rock Christall'. The result was a new glass recipe for 'lead glass' that was far superior to previous recipes. It was softer and easier to decorate but most importantly, it had a higher refractive index giving it more brilliance and beauty and making it invaluable to the optical industry for the production of optical lenses for astronomical telescopes and microscopes.</li> </ul>
<b>1674</b>	<ul style="list-style-type: none"> <li>• George Ravenscroft applies for patent for his new crystal.</li> </ul>
<b>1678</b>	<ul style="list-style-type: none"> <li>• 'Crown Glass' first produced in London and because of the high quality the process was used significantly until up to 1850.</li> </ul>
<b>1688</b>	<ul style="list-style-type: none"> <li>• 'Polished Plate' first produced in France in larger sizes by casting and hand polishing. Polished plate is made by casting glass from a crucible into pan-shaped moulds and then grinding and polishing the surface until it is smooth. This was originally done by hand but later by machine.</li> </ul>
<b>1693</b>	<ul style="list-style-type: none"> <li>• France is a dominant producer of flat glass for mirrors and windows, Saint Gobain factory becomes the 'Manufacture Royle des Glaces de France'.</li> </ul>
<b>1697</b>	<ul style="list-style-type: none"> <li>• Window tax imposed in Great Britain – leading to a greatly reduced number of windows in houses.</li> </ul>
<b>1745 - 1845</b>	<ul style="list-style-type: none"> <li>• Excise duties levied on the amount of glass produced by each glasshouse in the UK. Much of the industry relocated to Ireland (at least until a similar Act was introduced in Ireland).</li> </ul>
<b>1765</b>	<ul style="list-style-type: none"> <li>• Start of 'Crystal Glass' production.</li> </ul>
<b>1773</b>	<ul style="list-style-type: none"> <li>• British Cast Plate Glasses Company formed in Ravenhead, St. Helens, Lancashire to produce 'Polished Plate'.</li> </ul>

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<b>1800</b>	<ul style="list-style-type: none"> <li>• Industrial revolution creates a new era in glass manufacturing. 'Synthetic' chemicals for glass making are available for the first time and synthetic glasses with improved properties become available.</li> <li>• Steam engines and power introduced to grind and polish cast glass.</li> </ul>
<b>1826</b>	<ul style="list-style-type: none"> <li>• Pilkington Group founded as St Helens Crown Glass Company.</li> </ul>
<b>1827</b>	<ul style="list-style-type: none"> <li>• Glass pressing machine invented in the USA.</li> </ul>
<b>1834</b>	<ul style="list-style-type: none"> <li>• 'Improved cylinder sheet' (made by German process) introduced to Britain by Robert Lucas Chance. This allowed larger panes and finer quality products for window glass.</li> </ul>
<b>1847</b>	<ul style="list-style-type: none"> <li>• 'Rolled Plate' first produced by James Hartley. This is obscure glass with a rolled edge.</li> </ul>
<b>1850 - 1910</b>	<ul style="list-style-type: none"> <li>• Stained glass begins to be used in non-religious windows for large European homes. These still used 'cathedral' stained glass. 'Opalescent' glass (a translucent "milky" stained glass) developed in USA and use of stained glass as an art material expands.</li> </ul>
<b>1851</b>	<ul style="list-style-type: none"> <li>• Joseph Paxton's Crystal Palace for the Great Exhibition of 1851 uses improved cylinder sheet and encourages the use of glass in public, domestic and horticultural architecture.</li> <li>• Window tax finally removed for Great Britain.</li> </ul>
<b>1859</b>	<ul style="list-style-type: none"> <li>• Air pressure pump introduced in England, improves and automates glass blowing.</li> </ul>
<b>1863</b>	<ul style="list-style-type: none"> <li>• Solvay process dramatically reduces cost of a main ingredient in glass, sodium oxide.</li> </ul>
<b>1867</b>	<ul style="list-style-type: none"> <li>• Siemens brothers patent and develop first regenerative glass furnace in Dresden, Germany.</li> </ul>
<b>1870</b>	<ul style="list-style-type: none"> <li>• Rolled glass produced by Chance Brothers.</li> </ul>
<b>1871</b>	<ul style="list-style-type: none"> <li>• William Pilkington invents machine to automate the production of plate glass made using the cylinder method.</li> </ul>
<b>1873</b>	<ul style="list-style-type: none"> <li>• Furnace advances make plate glass manufacture a continuous process.</li> </ul>
<b>1875</b>	<ul style="list-style-type: none"> <li>• Technical glasses are developed in Germany, Abbe, Schott, and Carl Zeiss. University of Jena, Jena, Germany becomes a major glass science and engineering centre.</li> </ul>
<b>1879</b>	<ul style="list-style-type: none"> <li>• Patent for first electric light bulb taken out by Thomas Alva Edison. Where do they get those names?</li> </ul>
<b>1888</b>	<ul style="list-style-type: none"> <li>• 'Machine Rolled' patterned glass introduced by Chance Bros.</li> </ul>

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<b>1890 - 1910</b>	<ul style="list-style-type: none"> <li>• Louis Tiffany (1848-1933) part of the 'Art Nouveau' movement uses stained glass for art forms such as lamps and windows.</li> </ul>
<b>1892</b>	<ul style="list-style-type: none"> <li>• Vacuum bottle for liquid gases devised by Sir James Dewar as the 'Dewar vessel'.</li> </ul>
<b>1898</b>	<ul style="list-style-type: none"> <li>• Wired glass first made as 'Hexagonal Rolled wired cast' introduced by Pilkington.</li> </ul>
<b>1900</b>	<ul style="list-style-type: none"> <li>• Mechanized forming processes begin to be introduced.</li> </ul>
<b>1901</b>	<ul style="list-style-type: none"> <li>• Homer Brooke produces the first successful automatic feeder device.</li> </ul>
<b>1903</b>	<ul style="list-style-type: none"> <li>• 'Machine drawn cylinder glass' invented in USA. This was the first mechanical method of drawing glass, large cylinders of glass were drawn vertically from a circular tank, annealed and then cut into 2 to 3 metre cylinders before reheating, cutting and flattening.</li> <li>• Laminated glass discovered by the French scientist Edouard Benedictus. He accidentally knocked a flask containing a residue of nitrocellulose onto the floor. Instead of the conventional shards forming, the flask retained its shape when broken. When he later heard about facial injuries in auto accidents, he decided that the use of nitrocellulose could reduce this and patented celluloid lamination as 'Triplex'.</li> </ul>
<b>1904</b>	<ul style="list-style-type: none"> <li>• First commercial production of fused silica.</li> <li>• Domestic vacuum flask produced by Burger and Aschenbrenner in Munich and Thermos GmbH founded.</li> </ul>
<b>1907</b>	<ul style="list-style-type: none"> <li>• First fully automatic Owens machine was used in Manchester, making 2,500 bottles per hour.</li> </ul>
<b>1910</b>	<ul style="list-style-type: none"> <li>• Mechanical cylinder drawing machine.</li> <li>• Triplex patented.</li> </ul>
<b>1913</b>	<ul style="list-style-type: none"> <li>• 'Flat drawn sheet' first produced in Belgium by Emile Fourcalt. Flat drawn sheet is produced by drawing molten glass vertically from a furnace in a thin stream that is then flattened and cooled by pulling it between asbestos rollers. If the rollers are textured then the glass itself can be textured and this led to the introduction of patterned glass.</li> </ul>
<b>1918</b>	<ul style="list-style-type: none"> <li>• Bicheroux process for casting, grinding and polishing of plate glass.</li> </ul>
<b>1919</b>	<ul style="list-style-type: none"> <li>• 'Flat drawn sheet' first produced in the UK.</li> </ul>
<b>1920</b>	<ul style="list-style-type: none"> <li>• Griffith theory of the strength of brittle materials first applied to glass bulbs deliberately weakened by scratches, dramatically improves understanding of and how to improve the strength of glass.</li> </ul>
<b>1923</b>	<ul style="list-style-type: none"> <li>• 'Polished plate' first produced using single grinding system. Single and twin ground polished plate is produced by casting the glass and then grinding and polishing it on a conveyor belt, to a fine quality without distortion.</li> </ul>

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<b>1923</b>	<ul style="list-style-type: none"> <li>• Gob Feeder introduced worldwide.</li> </ul>
<b>1925</b>	<ul style="list-style-type: none"> <li>• I.S. bottle machine (IS standing for Individual Section or Ingle and Smith, the inventors) used with the gob feeder to dramatically increase and reduce cost of producing glass containers. 1925 Invention of the IS Machine, which consists of individual sections fed from a central feeding mechanism, instead of a rotating table. The IS machine is still predominant in the glass container industry and speeds well above 12,000 bottles per hour can be achieved.</li> <li>• John Logie Baird demonstrates television for the first time using glass tube as a central component.</li> </ul>
<b>1926</b>	<ul style="list-style-type: none"> <li>• Arthur Wood and David Gray of Corning Glass Works develop the "399" machine later called the "Ribbon" machine to make light bulbs. Bulbs can be made at speeds of 1000 per minute.</li> </ul>
<b>1927</b>	<ul style="list-style-type: none"> <li>• Beginning of fibre-optics.</li> </ul>
<b>1932</b>	<ul style="list-style-type: none"> <li>• William Zachariasen publishes the "Random Network Hypothesis" of glass structure and his rules of glass formation in Journal of the American Chemical Society.</li> </ul>
<b>1936</b>	<ul style="list-style-type: none"> <li>• Fading and discolouration of celluloid in Triplex is overcome by the use of PVB (polyvinyl butyral) as interlayer.</li> </ul>
<b>1937 - 1938</b>	<ul style="list-style-type: none"> <li>• Twin ground polished plate system developed by Pilkington.</li> </ul>
<b>1947</b>	<ul style="list-style-type: none"> <li>• Development of photo-sensitive glass.</li> </ul>
<b>1957</b>	<ul style="list-style-type: none"> <li>• Development of glass ceramics.</li> </ul>
<b>1959</b>	<ul style="list-style-type: none"> <li>• Sir Alastair Pilkington patents and introduces (on behalf of Pilkington) the 'float glass' process in UK. Float glass is produced by floating continuous stream of molten glass onto a bath of molten tin. The molten glass spreads onto the surface of the metal and produces a high quality, consistently level sheet of glass that was later heat polished. The glass has no wave or distortion and is now the standard method for glass production and 90% of the flat glass produced in the world is float glass.</li> </ul>
<b>1970</b>	<ul style="list-style-type: none"> <li>• First silica optical fibre produced at Corning Glass Works using chemical vapour deposition techniques to reduce attenuation and improve signal transmission.</li> </ul>
<b>1970 - 1980</b>	<ul style="list-style-type: none"> <li>• Introduction of low-iron glasses for photovoltaic applications.</li> </ul>
<b>1984</b>	<ul style="list-style-type: none"> <li>• Marcel &amp; Michel Poulain and Jacques Lucas discover first fluoride glass in Rennes, France.</li> </ul>
<b>2001</b>	<ul style="list-style-type: none"> <li>• Glass research is now moving beyond oxide glass chemistries and traditional melting processing. Entirely new processes such as sol-gel processing, chemical vapour deposition are being developed. New glass chemistries are being developed all the</li> </ul>

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	<p>time, especially non-oxide chemistries such as halide glasses, chalcogenide glasses and chalcohalide glasses.</p> <ul style="list-style-type: none"><li>• Introduction and development of low-emissivity coatings ('low-E') coatings to improve energy efficiency of windows.</li></ul>
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