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## GLASS

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Glass is a mystery and its effects are immense. It is neither a true solid nor liquid and has been described as a 'fourth state of nature'. The major constituent of glass is silica, which comprises 44 per cent of the earth's mantle. To this is added soda or potash and also lime. The compound is melted in a furnace at about 1500 degrees to make it fluid.

For thousands of years after its first accidental discovery in the Middle East it was moulded into objects. This technique was known all over Eur-Asia by 500 B.C. Somewhere in Syria or Iraq in the century before the birth of Christ, the method of glass-blowing was invented and this technique was known all over Eur-Asia by 500 A.D. Yet until the early nineteenth century, the potentials of glass were only really exploited in one civilization.

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Glass beads, counters, toys and jewelry were made in all the civilizations of Eurasia. For this, glass blowing is not absolutely required, nor does this use have much influence on thought or society, but rather on luxury goods and aesthetics. Another use is for vessels, vases and other containers. Until after 1800 this use was largely restricted to the western end of Eurasia. There was very little use of glass for vessels in India, China and Japan, where pottery and porcelain were used instead. Even in the Islamic territories and Russia, the use of glass declined dramatically from about the fourteenth century with the Mongol incursions.

Window glass was also only to be found at the western end of Eurasia until recently; China, Japan and India hardly developed this use. The most dramatic development of window glass was even more limited. The great window revolution mainly occurred in Europe north of the Alps, linked to climate and Gothic architecture.

A further use comes from the reflective capacity of glass when silvered. The development of glass mirrors covered the whole of western Europe, but largely excluded Islamic civilization. Glass mirrors were also not developed in India, China and Japan. A final major use of glass is for lenses and prisms and in particular their application to human sight in the form of spectacles. Only in western Europe did the practice of making lenses really develop, mainly from the thirteenth century.

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The reasons for the differential development of glass are largely accidental. The differences of climate, of religion, of drinking habits (hot and cold drinks), the availability of pottery, the Mongol invasions and many other things made glass more or less desirable. The development of glass has nothing much to do with long term planning or individual psychology.

Glass did not force the amazing deepening of knowledge which we call the scientific revolution, but it did make it possible by providing new scientific instruments: microscopes, telescopes, barometers, thermometers, vacuum flasks, retorts. At a deeper level it literally opened people's eyes and minds and turned western civilization from the aural to the visual mode of interpreting experience. The collapse of glass manufacture in Islamic civilizations and the fading away in India, Japan and China made it impossible that they could have had the type of knowledge revolution that occurred in western Europe.

Without clear glass there would have had no gas laws, no steam engine, no internal combustion engine, no electricity, no light bulbs, no cameras and no television. Without clear glass we would not have had the visualization of bacteria, little understanding of infectious diseases which is at the centre of the medical revolution since Pasteur and Koch.

Without the chemistry which depended crucially on glass instruments we would have had no understanding of nitrogen and so no artificial nitrogenous fertilisers. Much of the agricultural advance of the nineteenth century would not have occurred without glass. There would have been no way of demonstrating the structure of the solar system, no measurement of stellar parallax, no way of substantiating the conjectures of Copernicus and Galileo. Furthermore, without glass we would have no understanding of cell division (or of cells), no detailed understanding of genetics and certainly no discovery of DNA. Without spectacles a majority of the population in the west over the age of fifty would not be able to read this article.

It is quite clear that without mirrors, lenses and panes of glass the new developments which we label the 'Renaissance' would not have occurred. The new understanding of the laws of optics, the new accuracy and precision in painting would have been impossible without mirrors, lenses and panes of glass. The divergence of world art systems in the period between 1350 and 1500 is impossible to conceive of without the development of fine glass.

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Just as it improved comfort and the length of the working day through the development of windows, glass also affected health. Glass lets light into interiors and is a hard and cleanable surface. It not only altered the private house, but in due course transformed shops, which began to arrange their merchandise behind glass windows.

The new substance began to transform agriculture and knowledge about plants. As glass became cheaper and particularly flat window glass improved in quality, the development of glass houses began to exceed the Roman use. As this happened glass cloches and greenhouses improved the cultivation of fruit and vegetables, bringing a healthier diet to the population. In the nineteenth century, glass made it possible to bring plants from all over the world to enrich European farms and gardens.

Among other inventions dependent on glass which altered material life were storm-proof lanterns, enclosed coaches, watch-glasses, lighthouses and street lighting. Travel and navigation were improved. The sextant requires glass and the precision

chronometer invented by Harrison cannot be used at sea without glass. Glass bottles increasingly revolutionized distribution and storage, particularly of drinks such as wine and beer.

So the accidental fact that only in western Europe did glass developed its full potential between the birth of Christ and 1800 A.D. is a major reason for the divergence of civilizations. Although glass did not make anything inevitable, it is clear that without this amazing substance, the most powerful extension to man's most powerful sense, the Renaissance, Scientific and Industrial revolutions could not have occurred. We shaped glass and glass made the world as we know it.

(1050)