

Diffusion of Innovation in Centrally Planned Economies – Float Glass in the USSR

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Abstract

This paper examines the diffusion of manufacturing technologies of simple, nonassembled products in the USSR. We are not looking the transition period of the USSR starting in 1991. Astakhov et al. (1990) and Falstman (1992) have made quantitative studies of diffusion of technologies in the USSR. We apply qualitative method and follow the diffusion of Pilkington's float glass (introduced in 1959) to the USSR. In the Western World float glass revolutionized the flat glass industry in the 1960s and 1970s and emerged as a dominant design (Uusitalo, 1995). It was licensed to the USSR in 1967 and the production started in 1969- 1970. The aim of this paper is to test with the diffusion of float glass the applicability of technology management literature such as (Anderson and Tushman, 1990, Tushman and Rosenkopf, 1992) in a centrally planned economy. According to them there is little interorganisational influence on the emergence of dominant design for nonassembled products. However, the USSR government's role in the diffusion of Pilkington's float glass was important. In fact, the licensing agreement to manufacture cars in the USSR under Fiat's license ignited the licensing of Pilkington's float glass.

Keywords: diffusion of innovation, nonassembled products, transition economies

Track: Combining the social and technological sides of innovation

A WORK IN PROGRESS PAPER

INTRODUCTION

This paper examines the diffusion of manufacturing technologies of simple, nonassembled products in the USSR. Astakhov et al. (1990) and Falstman (1992) have made quantitative studies of diffusion of technologies in the USSR. Holliday (1979) studied several cases of technology transfer to the USSR. He had, for instance, from the 1960s the Fiat automobile case licensing Fiat 124 model. However, he did not include float glass in his study. Astakhov et al. (1990) asked for comparative cross-national studies in both centrally planned and Western economies of technology diffusion. We apply qualitative method and follow the diffusion of Pilkington's float glass (introduced in 1959) to the USSR. In the Western World float glass revolutionized the flat glass industry in the 1960s and 1970s and emerged as a dominant design as it was shown for only OECD countries but not for the rest of the world (Uusitalo, 1995). Float glass It was licensed to the USSR in 1967 and the production started in 1969-1970. The aim of this paper is to test with the diffusion of float glass the applicability of technology management literature such as (Anderson and Tushman, 1990, Tushman and Rosenkopf, 1992) in a centrally planned economy. According to Tushman and Rosenkopf (1992) there is little interorganisational influence on the emergence of dominant design for nonassembled products. However, the USSR government's role in the diffusion of Pilkington's float glass was important. In fact, the licensing agreement to manufacture cars in the USSR under Fiat's license ignited the licensing of Pilkington's float glass. It seems that the high authorities created a hole for a western type of economy there.

The R&D process of float glass in Pilkington, that time a UK based family owned company, took seven years. During the R&D process the company made a strategic decision to position float glass as a readymade product in the plate glass industry and not too quickly in between two industries. In the 1960s Pilkington developed the float glass technology so that it was able to compete with the float glass technology also in the sheet glass industry (see Figure 1.).

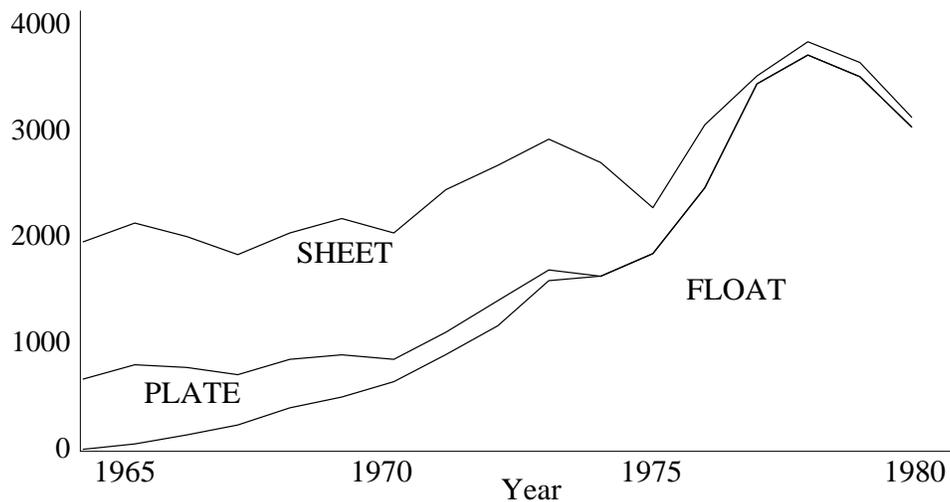


Figure 1. Flat Glass Production in the U.S., 1964-1980 (Millions of Sq. Ft.) (Edge, 1984).¹

¹ In the USSR the terminology was different. Flat glass had two types: Window glass and polished plate, which had two types of polished plate glass: polished and thermopolished. Again thermopolished had two types: two stage float glass and Pilkington float glass.

Our intention is not to compare the float glass diffusions in the USA and in the USSR. However, we make some notes on them. The float glass technology diffused very fast in whole flat glass industry of the Western world and particularly in the USA. In the Soviet Union float glass had to compete with existing technologies and another existing float glass process.

The remaining part of the paper is organized in the following way. First, we introduce theoretical foundations of our study, including the literature of technology management, networks, stakeholders and centrally planned economies. Second, we describe the methodology of the study. The methodology is based on a longitudinal, historical and contextual case description applying multiple sources of data. Third, we report our empirical case the diffusion of float glass manufacturing in the USSR flat glass industry. Finally, we draw conclusions and discuss implications and further research.

LITERATURE

Technical progress in an industry usually consists of long periods of incremental change (Figure 2). A technological discontinuity inaugurates an era of ferment in which competition among variations of the original breakthrough ends with the selection of a single dominant design of the new technology. The era of ferment has two processes: the design competition and the technological substitution. The incremental evolution of this standard design goes on until a new discontinuous technological change will come. (Anderson and Tushman, 1990) Technological discontinuities are not all alike. Tushman and Anderson (1986) characterized technological discontinuities as competence-enhancing or competence-destroying. On the one hand, competence-enhancing discontinuities significantly advance the state of the art yet build on, or permit the transfer of, existing know-how and knowledge. Competence-destroying discontinuities, on the other hand, significantly advance the technological frontier, but with a knowledge, skill and competence base that is inconsistent with prior know-how.

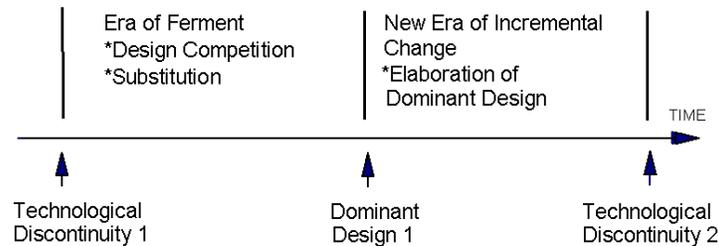


Figure 2. The cyclical model of technological change

Technology is as systems composed of component and linking technologies. The more complex the product is, the more subsystems exist, the greater the number of internal and external interfaces becomes and the greater the technical and contextual uncertainty is. Thus, while the technical system itself may suggest logical evolutionary paths, as the system gains complexity, nontechnical forces weigh more heavily on the process of technological evolution (Figure 3). The greater these uncertainties are, the greater the intrusion of socio-political dynamics in the evolution of a particular technology becomes. (Tushman and Rosenkopf, 1992). According to authors there is little social/political/organisational influence on the emergence of a dominant design for non-assembled products such as cement and flat glass.

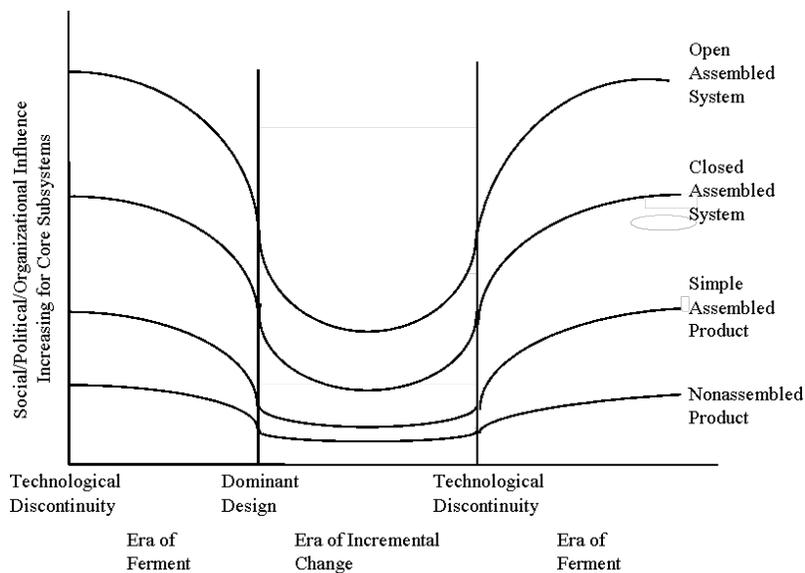


Figure 3. Toward Sociology of Technology

The political embeddedness of a business network may have four forms: 1) political institutions, 2) political actors, 3) the political activities of firms and 4) political resources (Johanson and Mattsson, 1991). States and other political institutions provide evolving networks “a framework of rules and regulations within which private actors have to play” (Salmi, 1995:68). Research on political institutions has focused on the effects of “political turbulence” as a discontinuous change in political ideologies such as the fell of iron curtain (Hadjikhani and Johanson, 1996) or incremental change such as the European integration. Political actors include bureaucrats, government ministers, members of parliament, opposition parties, interest groups and the media (e.g. Hadjikhani and Håkansson, 1996). Western World and the USSR can be described from the point of social/political/organisational influence as open access society and limited access society (natural state). (North et. al., 2009).

Centrally planned economy is an economy in which "individual firms produce and employ resources primarily by virtue of specific directives (commands, targets) from some higher authorities. Thus economic plans are implemented by administrative means (the "command mechanism"), rather than through the interaction of economic units in markets; economic outcomes are largely determined by the decisions and commands of the central authorities” (Grossman in Ericson, 1982: 345).

Central planning is defined as “A system of extensive central government control of an economy, including organizing production and making allocation decisions. This was the popular method of allocating resources and answering the three basic questions of allocation under the communism/socialism economic systems of the Soviet Union, China, and others during the 1950s, 1960s, and 1970s. Applying the communist/socialist philosophy that private property and market allocation were "bad," central planning relied on extremely detailed plans made by government. These plans would set specific production quotas for individual products, parts, components, and inputs fabricated by all of the factories and farms across the economy. This was a daunting, complex task that required detailed production information for hundreds of thousands of different commodities.” (<http://glossary.econgurur.com/economic-term/central+planning>).

“A centrally planned economy is one in which basic economic decisions are made by public authorities rather than by private persons. The key decisions involve investment in plant and equipment; this determines what will be produced. Other decisions usually include how to combine resources and how to distribute the product to households. The productive facilities (natural resources and capital) are held and controlled by the state rather than owned and controlled by private persons.” (<http://www.encyclopedia69.com/eng/d/centrally-planned-economy/centrally-planned-economy.htm>).

“Entry into economic, political, religious, and educational activities without restraint” (North et. al., 2009, p.114) is one of the open access order characteristics. “As long as the ability to form organizations remains a privilege, access is not open. Open access does not require universal access, nor does it require complete elimination of all privileges; but it does require that a sufficiently large portion of the population be able to create political, economic, and other organizations at will.” (North et. al., 2009, p. 191).

A centrally planned economy cannot be defined as an open access society according to the above mentioned definitions because it is not a market economy and there **is** no market competition in it. In a centrally planned economy there are no opportunities to create significant economic (business), political (parties) and religious organisations at will independently from dominant coalition or precisely independently from the ruling communist party. Economic, political and religious activities are restricted.

METHODOLOGY

The present study adopted a longitudinal, historical and contextual case study approach. According to Yin (2009) a single case study is an appropriate design under when the case represents a critical case in testing a well-formulated theory, proposition or model (in this case toward sociology of technology, Tushman and Rosenkopf, 1992). Pettigrew (1985) argues that to understand a change one has to study it as a continuing process in the context in which it appears, and he encourages one to adopt a contextual and historical perspectives on processes of change, whatever the content of the change might be. The aim in this research is to choose "a video camera view instead of a snap shot" as Pettigrew and Whipp (1991) put it.

A single case study design has certain advantages compared with multiple cases. The most important is the depth of the analysis, both in terms of the number of factors studied and sources of information used (Yin, 2009). A single case analysis is the best way to get a holistic picture and understanding of the research problem. Patton (1990, p. 95) has argued that "qualitative inquiry is highly appropriate in studying processes because depicting a process requires detailed description". Since the unit of analysis in the present study was the float glass innovation in the Soviet flat glass industry, the final design of this study was an “embedded, multiple case study design” (Yin, 2009).

Although the focus of this paper is the diffusion of float glass in the USSR, we also compare that diffusion to the one taken place in the US. This is interesting both from theoretical and empirical points of view. The US and the USSR were chosen for comparison of innovation diffusion as classical examples of market and centrally planned economies with commensurable sizes of glass industries in 1960s. Diffusion of float glass for both countries happened at the same time and for both of them Pilkington was outsider. Dominant design theory was proved on the base of well documented the US industries and was not applied for non-market economies and for the Soviet economy in particular. Besides, the US and the USSR in 1960s were in rivalry

with each other in weapons, productivity and in technical and scientific progress achievements. It was the car industry that accelerated the float glass diffusion in both countries.

Since the purpose of this paper is to re-examine theory, the number of industries and technological changes enhances the depth and quality of data collected, as recommended by Berg and Smith (1988) and Eisenhardt (1989). The research periods for the sheet glass and plate glass industries are 1920-1991 and 1920 - 1991, respectively. The technological change, float glass, was introduced in 1959, respectively, and thus the research period was long enough to analyze the diffusion of these innovations.

To improve the validity of our “analysis” we used the triangulation methods described by Jick (1979) and Pettigrew (1990) to construct case studies from a variety of information sources: personal interviews in 1993-1996 (business managers in Pilkington, the author of Pilkinton’s histories), interviews with experts from nowadays representatives of major Soviet glass plants and two glass industrial research institutes (three of them have worked in the USSR glass industry), company and industry histories (Barker, 1977 and 1994; Hamon, 1988; Boldyreva, 1967; Shepalov, 2003), industry and technology studies or books (Bricknell, 2007 and 2009; Grundy, 1990; Tooley, 1984), business periodicals (Wierzynski, 1968), and journals, news clippings from the mass media, statistics and trade journals (The Glass Industry and Ceramic Industry Magazine; all from the period 1950-1984; Glass and Ceramics journal translated from Russian to English from the period of 1956-1991). The information given in these magazines has been compared and the critical events have been checked and verified in at least two of them. The data analysis is crucial in the case of causal studies. Internal validity deals with establishing a causal relationship, whereby certain conditions are shown to lead to other conditions. The internal validity can be increased by using pattern recognition (Mintzberg, 1979) or seeing evidence through multiple lenses (Eisenhardt, 1989).

FLOAT GLASS AND THE USSR **Russia in 1500-1922 and the USSR in 1922 -1991**

First steps of English business in Russia.

Modern capitalism appeared in Europe under the Reformation influence and proved to be a long-lasting source of new technologies for the rest of the world. Sometimes it was not even invention of new technology but just commercialization of forgotten innovations. Among them was, for example, the steam engine that was used like prototype in ancient period². The institutional and technological conditions were among the main reasons why forgotten innovations were not fulfilled immediately after invention.

William the Conqueror displaced the existing power structure and created a new fragile natural state after the invasion of England in 1066. Then more stable basic natural state emerged within few centuries and due to further changes England moved to a mature natural state since late sixteenth century. (North et. al., 2009). “The signature feature of a mature natural state – organizations independent of the state – began to emerge in the form of trusts, merchant firms, business corporations, political associations, and religious groups”.(North, Wallis, Weingast, 2009. pp. 105-106).

² So called aeolipile described by Hero of Alexandria is considered to be the first recorded steam engine. See "aeolipile." Encyclopædia Britannica. Encyclopædia Britannica Online. Encyclopædia Britannica Inc., 2012. <http://www.britannica.com/EBchecked/topic/7176/aeolipile>.

The need for new weapons and technologies for military purposes was one of the arguments why Russian elite and namely Czar Ioann IV welcomed British business and trade. "Moscovy company" chartered in 1555 can be considered as a prototype of the transnational company in Russia. It received rights for free trade in Russia from Czar Ivan IV. Since then, the history of the Western business expansion and technology transfer to Russia began. (Kagarlitsky, 2004)

Centrally planned economy of the USSR.

The Soviet planned economy model was created in the late - 1920s and remained in its main features for 70 years. Private ownership of the means of production was completely replaced by public ownership. The gross output instead of the profit was the most important indicator of enterprises' performance. The main idea was that the whole Soviet economy was considered as a single corporation working according to a single plan created from a single centre. Enterprises were put into position to execute the plan. Command and administrative managing methods were combined with moral motivations on the basis of collectivism and enthusiasm. (Ekonomicheskaja istorija SSSR: ocherki., 2007).

The Stalinist model of the economic development was characterized by channelling labor, capital and materials into the leading sectors (primarily heavy and defence industries). Leading sectors were growing at the expense of the others (primarily agricultural sector). Imports of capital and technology were also concentrated in the leading sectors. The Post-Stalinist model of economic growth was characterized by a more balanced growth pattern with more resources allocated to formerly low-priority sectors and reliance on increasing productivity (Holliday, 1979)

There was market planning approach from so-called geneticists in 1920s. They argued that planning should be directed by consumer demand and thus market forces should be taken into consideration. The idea that planning should be done according to the will of planners with primarily planning of leading branches was proposed by so-called teleologists who won in the discussion. (Gregory and Stuart, 1986, p.101)

The created central planning system was based on four main principles "First, Gosplan was to be a central coordinating planning body to which all other planning bodies were to submit their proposals. Second, the annual control figures prepared by Gosplan were to provide general direction for the economy on an annual basis. Third, the actual detailed operational plans for industries and for enterprises (the promfilplans) were to conform to the control figures prepared by Gosplan. Forth, materials were to be allocated through a system of balances, compiled from the control figures and promfinplans, which would elaborate the supplies and uses of basic industrial materials". (Gregory and Stuart, 1986, p.103)

During Stalinist period, finances and profits were carrying more support function, manipulation of resources was mainly considered. Strength of the state and its defence were at the first place. The rapid introduction of scientific achievements was mainly considered for defence industry and R&D spending for civilian remained much lower than in developed countries of the Western world. The 1960s were characterized by disorder in strongly centralized planned system (overestimated heavy industry, uncovered growths of wages, overproduction of some goods). (Goldman I. M., 1965) Growing problems caused Kosygin reform in 1965. Functions of management and planning were decentralized. Income and profitability were chosen as key performance indicators of economic efficiency. (Prasad S. B., 1966) In the situation of such partly decentralized system some niches appeared to be open to foreign

companies. By 1965 automobile industry failed to satisfy consumer demands and Soviet leadership initiated modernization of automotive industry. During 1966-1970 period investments to the automotive industry increased by 220%. (Holliday, 1979, p.140).

In our case we also can see that western companies were dealing with organizations in the USSR that represented the central government as their creator and controller. The USSR can be defined as mature natural state as there were achieved doorstep conditions and some open access order characteristics: perpetually living state, consolidated political control over violence, a widely held set of beliefs about the inclusion of and equality for all, rule of law enforced impartially for all citizens. (North et. al., 2009, p. 114)³

Contract with Fiat signed on August 15, 1966 planned construction of new passenger car factory that would produce 600 000 vehicles yearly. The Fiat project that was not created inside central planning system opened opportunities for participation of other foreign companies. The glass industry in the Soviet Union was part of the single planned national economic complex and belonged mainly to the civilian sector in general and thus required the development of such as the passenger car industry.

The Flat glass industry in the USSR

All over the world as late as 1970 the flat glass industry had two separate industries, sheet glass (also known as window glass) and plate glass (see Figure 4). The float glass innovation has its origins from both industries. It aimed to have optical quality from the plate glass industry and “fire-finished” manufacturing method from the sheet glass industry.

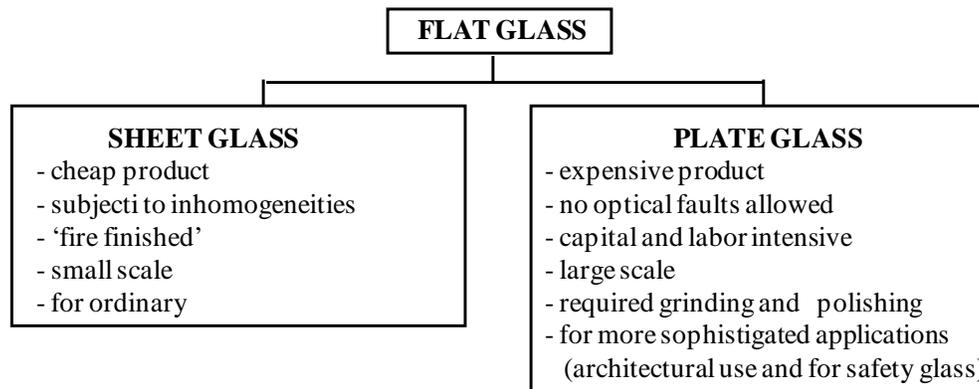


Figure 4. The Division of Flat Glass in the 1950s

The USSR flat glass technologies

In the 1960s the USSR flat glass industry thought of several technologies. They 1) planned to use Pennvernon drawing process, 2) have invented a two stage float glass process and 3) looked the opportunities of licensing the Pilkington’s float glass. All these processes are illustrated briefly.

³ Dominant coalition (communist party) reforms during last years of the USSR existence as they included private business permission and some political pluralism may be considered as attempts to go to the open access order that finally failed.

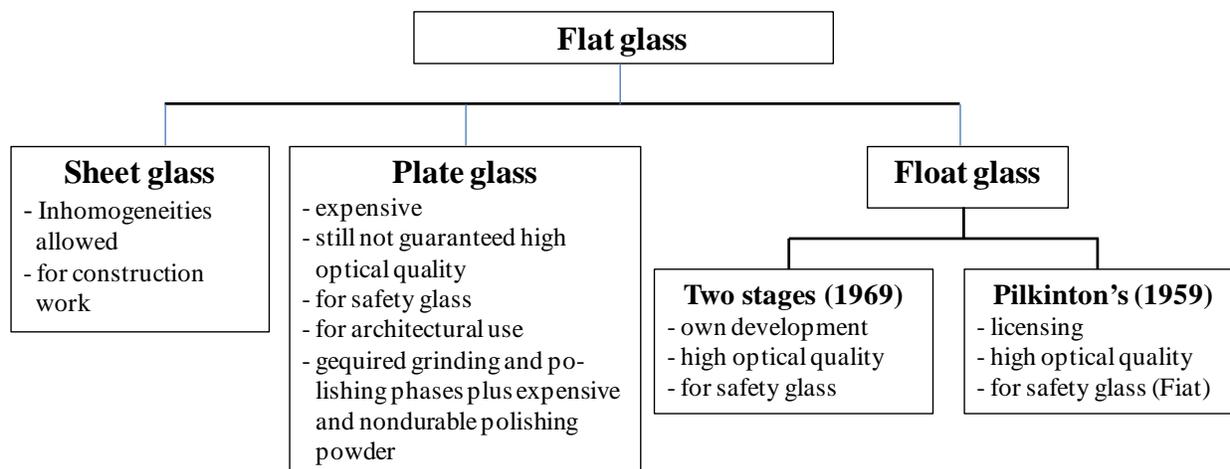


Figure 5. The Russian flat glass technologies by 1967⁴.

The USSR flat glass industry characteristics

First we illustrate the USSR flat glass industry characteristics. Then we discuss of the flat glass technologies used in the USSR in 1945 until 1970. That is the time when float glass was developed (1952-1959) and introduced in the Western market (1959) and the USSR in 1970. Then we illustrated the USSR flat glass industry characteristics.

The USSR sheet glass in the 1945 and 1970s.

While Pilkigton was licensing float glass, plans for improvement of vertical drawing (Pittsburgh Plate Glass' Pennvernon and Asahi) methods were done in the USSR. The gradual conversion of a number of glass factories to the more advanced sheet glass production method for 1966-1970 was planned. New method was expected to improve quality and increase the output in comparison with the float glass method. (Anonymous, 1965). Such plans were also supported by appearance of Pennvernon method and achieved higher output in comparison with the float glass method. For the 5-year plan, till 1970, it was planned to extend the sheet glass production volume by 40%, to double the output of polished glass, to increase share in the total output of sheet glass from 2,5 % to 30%. (Anonymous, 1966).

The entire period of the Soviet Union can be divided into three periods: the period of Stalin's rule and two periods before and after. Industrialization was carried out mainly during the Stalin's rule. Glass plants complex with vertical stretching technology was created mainly during industrialization period and large part of them was destroyed during the Second World War.

During the Second World War, 10 of 18 factories producing sheet glass were totally or partially destroyed. Over 55% of the total production of sheet glass, the entire production stalinite and polished glass was focused on the damaged plants. Part of the production facilities was evacuated to the east, where flat glass production continued. For example, during the war the Bor glass factory began to produce glass with thickness of 20-30 mm using a vertical drawing and organized polished glass production. In 1947 at the Lvov plant was installed the first floatless vertical drawing line in the Soviet. Installed at the Gusev glass factory grinding and

⁴ In Soviet statistical year book sheet glass is tracked under window glass while both plate glass and float glass under polished plate glass. Now in Russian statistics float glass is tracked under thermopolished. Sheet glass was manufactured with drawing technologies.

polishing line allowed to increase polished glass production almost three times: from 1 400 sq.m. daily production in 1952 to 4 100 sq.m. daily production in 1955. (Boldyrev (ed.), 1967).

By 1965, grinding and polishing lines were installed at the "Proletarian", "Autoglass", and Saratov glass factories, the Gusev glass factory grinding and polishing line was reconstructed as well. Development of the glass industry from 1950 to 1965 was as follows - the number of flat glass furnaces has increased from 35 to 40, with a total area of the furnaces from 5145 sq. m. to 9268 sq. m., vertical glass drawing machines quantity increased from 197 to 274, the number of employees in the whole glass industry increased from 42 092 to 62 355 (Boldyrev (ed.), 1967).

As it is described in Shepelev (2003) improvements of the vertical drawing process continued at the Bor glass plant after float glass line installation. Thus, in 1980 experimental works for the Asahi method implementation were done. Vertical drawing capacities were stopped at the Bor plant partly in 1984 and finally in 1987.

Dynamics of sheet glass production since 1945 is shown in Figure 6. Since 1970 for 20 years production volume remained almost constant. Meanwhile production by drawing method stopped in Canada in 1978, in Great Britain in 1980, in Japan in 1982 and in the USA in 1985. (Orlov E. et. al.,1987).

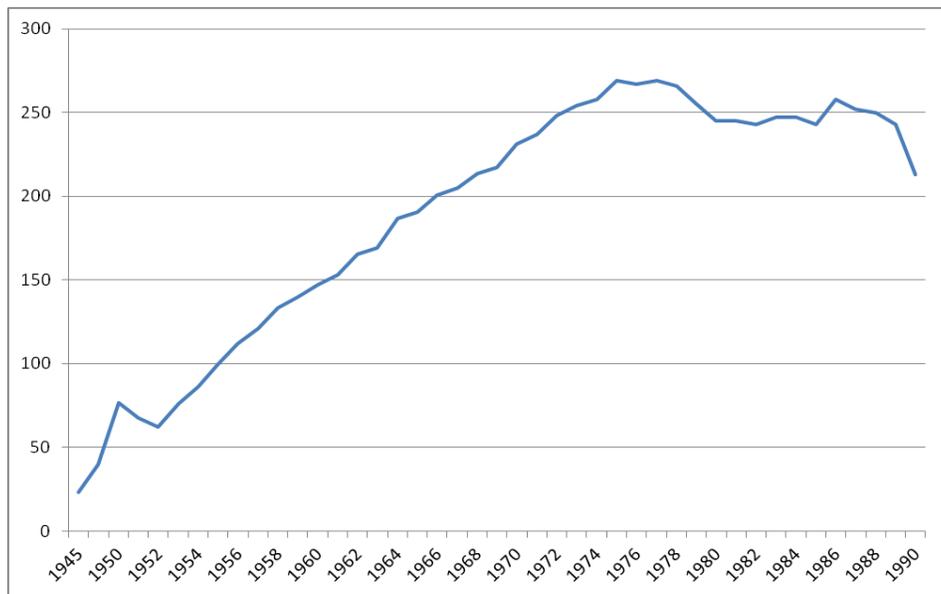


Figure 6. Sheet Glass Production in the USSR (million sq. meters). (Narodnoe hozjajstvo SSSR v 1960 g. Statisticheskij ezhegodnik. M.: Gosstatizdat CSU SSSR, 1961. and for other years.) (Promyshlennost' SSSR: statisticheskij sbornik. Gosudarstvennyj komitet SSSR po statistike.)

Sheet glass export also increased since 1945. Import was very small in comparison with the production volumes and was larger than export only during some period after the war.

Two stage float glass process in the USSR.

Domestic two-stage technology of float glass glass was invented in the USSR independently from Pilkington's license. The first installation of was in 1969 (Zhymalov and

Kondrashov, 2001). Installations at the Saratov Glass in 1973 and Salavat Glass Plants in 1975 were the introduction of two stage float glass technology in flat glass industry. (Kondrashov et. al., 2000). Altogether, six two stage lines were installed at the Saratov Plant and seven at different plants of the USSR glass industry (Zhymalov and Kondrashov, 2001). The period since 1970 was period of increasing float glass production by Pilkington and domestic two-stage methods. Plate glass was the first to be replaced by float glass, production of polished glass for automotive industry stopped immediately after installations of first two stage capacities. (Figure 7).

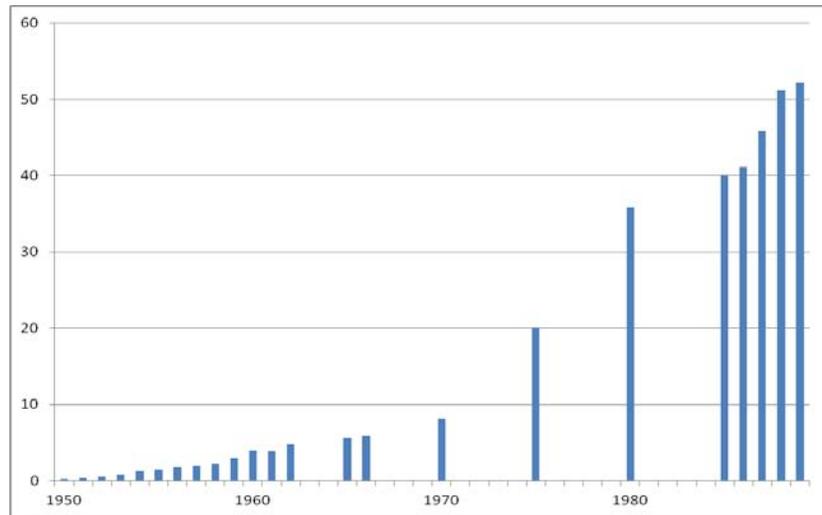


Figure 7. Polished glass production (plate and float) in the USSR (mln. m2). Data source: (Stekol'naja promyshlennost', v kn.: Promyshlennost' stroitel'nyh materialov v SSSR. 1917-1967, pod red. A. S. Boldyreva, M., 1967), (Promyshlennost' v SSSR: statisticheskij sbornik., for different years).

”From 1963 to 1969 Saratov Glass Institute, irrespective of Pilkington (England), created its own alternative industrial float glass process. In short term the Institutes’ scientists developed the two stage method where a glass ribbon is formed within two stages: firstly on the molten tin and secondly on the gas cushion. The first home float glass line with the output of 100 tons per day was put into operating at Saratov Glass Institute in 1969 – a year and a half earlier than the Pilkington float glass line at the Bor Glass Plant. From the start-up of the home line technical modernization of the whole glass industry of the former USSR rises.” (Zhymalov and Kondrashov, 2001). Incremental changes of Pilkington process were restricted to be done only under Pilkington’s ownership. Incremental changes of the two-stage technology included, for example, protective atmosphere producing stations, two-canal float glass lines. (Zhymalov and Kondrashov, 2001)

At the Saratov factory in January 1959 was put into operation the first Soviet glass grinding and polishing line (SHPS - 1000) with 2 million square meters of glass production per year. February 25, 1973 it was stopped for reconstruction and November 7, 1973 started up the float glass (two stage) line for production of polished glass designed for the production of 5.5 million square meters of glass per year. The cost of reconstruction was paid off during the first year of the float glass line operation. In September 1975, second float glass (two stage)

production line was installed with a capacity of 5 million square meters of glass per year. (<http://www.saratovstroysteklo.ru/history.html>).

Pilkington process

In the float glass process a continuous ribbon of glass moves out of the melting furnace and floats along the surface of an enclosed bath of molten tin. Float glass is “fire finished” having no grinding and polishing phases. The quality of float glass is equal to that of plate, but the investment and production costs were much less than those of plate. At the beginning the only possible thickness was 6.5 mm, which just happened to match the most used thickness in the auto industry (as safety glass for side panes). Pilkington gradually introduced float glass into safety glass without anyone knowing the difference. Pilkington launched float glass in 1959 to replace the labor- and capital-intensive plate glass process (Salmans, 1980). The new process was a total surprise to the industry. Furthermore, in the late 1960s a thinner float glass enabled float glass to enter also the sheet glass industry. In the late 1960s float glass was sold for the car industry used as safety glass and glazing in applications; in schools, offices, buildings, and increasingly in residential construction. (Uusitalo, 1995).

In the USSR the first float glass line under Pilkington’s licence was installed at the Bor Glass Plant in 1970 and the second in 1986 at the same plant mainly for for the developing USSR automobile production. Float glass was licensed to fulfil the agreement of the Soviet government with the Fiat (Italy), which was one of the largest industrial projects in the USSR.

The polished glass production of at the Bor plant in 1967 was about 800,000 square meters. In the late 1960s in the Soviet Union all the plants together produced about 5.9 million square meters of polished glass. With the launch of Fiat project (the Bor plant was designated a major supplier of automotive glass for constructed auto plant) the need for a polished glass in the USSR was more than 20 million square meters. The first Bor float glass line launched in 1970 was able to produce thicknesses within the range from 1.5 mm up to 6.7 mm. at production speeds from 300 to 1,200 meters per hour. In the first year the float glass line produced over 5 million square meters of float glass. (Shepelev, 2003).

Second float glass line under Pilkington’s licence was installed in 1986-1987 according to the decision of Soviet authorities. Bricknell explains this decision mainly not by the need of large quantities of high quality glass, but as the result of settlement of Pilkington arbitration claims in infringement of Pilkington patents in the two-stage process. (Bricknell, 2009 p.191)

DISCUSSION

Sheet glass production in the USSR was large included many production units (plants) and comparable to that in the US. In fact, there was no forced replacement of existing technology to the new one. According to the official statistics, sheet glass production remained constant since 1970 until 1991. Float glass was regarded as polished glass but not as sheet glass though, undoubtedly, float glass was used as sheet glass, as well. Official statistics about sheet glass production means that the increase in production by drawing technology stopped in 1970 and further growing demand and reduction of aging vertical drawing production facilities was covered by increased float glass production . Thus, on the evidence from the USSR sheet glass subindustry we propose a “creative addition” model that can describe diffusion of new technologies in a centrally planned economy. New technology is in addition to the existing one. Such model is described as an evolutionary model in comparison to the revolutionary model of “creative destruction” common for the OECD countries.

Linear model of float glass “creative addition” is shown at Figure 8.

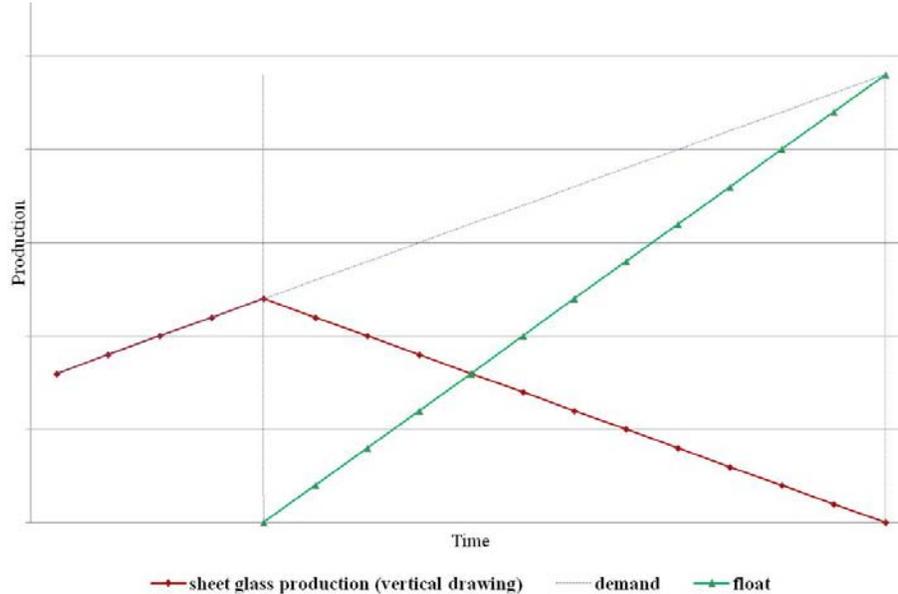


Figure 8. Float glass evolution in sheet glass subindustry - “creative addition” linear model

Additional research should be done to prove and to explain proposed “creative addition” model. Such research can be done for other countries that used central planning, for example, China and Eastern European countries. Diffusion of other technological innovations besides float glass can be checked, for example dry method in cement industry.

As we can see now, existing empirical evidence of dry method diffusion in cement production in the USSR does not destroy proposed “creative addition” model. Share of cement produced by the dry method in the USSR in the whole cement production increased smoothly from 13,9 % in 1970 to 19,6 % in 1989 (Promyshlennost' v SSSR: statisticheskij sbornik)⁵

The proposed model may be transformed to the new “transition” models for the economies in transition. Such “transition” model will describe transition from the centrally planned economy technology diffusion model to the model typical for the OECD countries. Developing of such model will give not only theoretical but also managerial outcome for successful commercialization of innovations in nowadays Russian Federation and other countries that used central planning before and in countries that do not have open access societies and are out of the OECD.

CONCLUSION

In the USSR the diffusion of float glass was not straight forward. The sheet glass industry continued to use existing vertical drawing production processes until the collapse of the USSR and for long time after the collapse. The quality of the sheet glass was good enough for the market. In the plate glass industry float glass was introduced by licensing for the co-operation of the USSR with the Italian Fiat car manufacturer and by domestic two stage lines installation. The applicability of Tushman and Rosenkopf’s (1992) concept of toward sociology of technology for the USSR flat

⁵ Actually in the statistical books “Industry in the USSR” energy-saving methods of cement production are mentioned but not dry method.

glass industry is interesting. The high authorities of centrally planned economy while making a licensing agreement with a foreign car manufacturer opened a capitalistic window. However, in Tushman and Rosenkopf's (1992) typology it meant high social, political and organizational influence for a nonassembled product, flat glass. This is contrary to Astakhov et. al's (1990) findings. They applied the Fisher and Pry (1971) simple technology substitution model developed for market economies in the coal mining industry and despite the shortcomings of the model it worked surprisingly well.

This study of the diffusion of float glass in the USSR emphasized the link of innovation in its context. Just as in the US the car industry as a heavy user of the safety glass accelerated the diffusion of float glass. The value chain, such as flat glass – safety glass – the car industry, is important to take in the account in the research design.

Comparison of the USSR and the US shows that Schumpeter's (1942) "creative destruction" did not work in the case of the USSR sheet glass industry. We propose "creative addition" model instead. Astakhov et. al (1990) also saw that external factors such as planning "may result in a strong discontinuity in diffusion and substitution patterns", which means the loss technological and economic advantages in the long-term. This gives support to our "creative addition".

History of Pilkington's breakthrough via high administrative barriers with displacement of the domestic two-stage technology with absolute governmental support shows that. Governmental and business technological development logics are different. This helps us to understand better role of socio-political factors in the technological evolution. Research on the impacts of technological changes based on the cyclical model of technological change (Anderson and Tushman, 1990) needs to be extended across international markets and especially across economies in transition. Non-assembled products would appear not to be simple. Here the literature on networks can be of great help.

The term "centrally planned economy" is often used as names of social-economic model in countries where principles of market economy were rejected by the communist theory. According to this theory public ownership of means of production is considered to be more effective than private. A centrally planned economy is considered to be more effective than market economy mainly because it manages to avoid market unbalances and overproduction capitalist crises. Central planning of economy is done from a single center according to the political decisions. Such decisions are usually done by the will of planners without taking into consideration market forces. Control figures of the central plan are transferred to each enterprise in the form of individual plan for each enterprise involved into the system. Balance and iteration methods for coordination of control figures and individual plans for enterprises are widely used.

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