

Evolution and innovative development  
of  
a nonassembled product :

# Glass

Prepared  
By  
Fuat Berk Kiri

20/11/2003

ITTM  
Innovation Management

## Glass Industry

- ③ **Glass** obtained by the fusion of several inorganic substances.
- ③ This fused mass is mainly composed of three elements : sand (silica) 51%, limestone/dolomite (calcium oxide) 16%, soda ash 17%
- ③ By the time, creative people learned to shape molten glass into artistic forms, and to color it through the introduction of common minerals

20/11/2003

Fuat Berk Kiri

ITTM  
Innovation Management

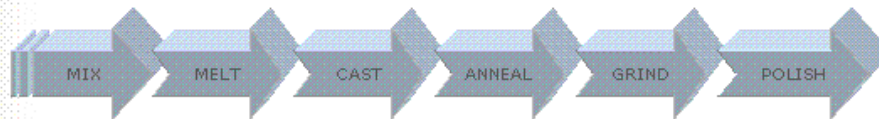
## Evolution of an Industry

Glass have been a part of civilization for an estimated 3,000 years ...

- ❧ Ancient Syrians
- ❧ Egyptians, Phoenicians and the other civilizations
- ❧ Artisans in Alexandria and elsewhere in Roman world
- ❧ In England, France & Germany


## Plate Glassmaking

- ❧ These steps show how plate glass was first manufactured in the late 1600's.



- ❧ This early production processes were flexible but inefficient. Each phase of the production process was discontinuous.
- ❧ Between the discontinuous processes applied 1600's and today's glass industry consisting building of modern glass-faced skyscrapers technologies, plate glass making history can be viewed as an evolution towards highly specific production. That **evolution** took place between 1800s and the present.
- ❧ **Evolution or Innovation chains followed five steps :**

## Step 1. "Continuous mixing and melting" & Brothers

- ⌚ '1856' : Friedrich Siemens developed the regenerative furnace with gas heating to produce extremely high temperatures.
- 
- ⌚ '1861' : Introduction of the gas-fired furnace with regenerative heating for the mass production of glass.
- ⌚ By '1880', Siemens furnaces were equipped with an important innovation, "**continuous melting tanks**"
  - ⌚ Combination of mixing & melting steps provided
  - ⌚ Continuously pouring of molten glass to casting step
  - ⌚ Quality improved
  - ⌚ Capacity increased to twice
  - ⌚ Efficiency increased

## Step 2. "Continuous annealing"

- ⌚ In traditional annealing method, plate glass continued to be cast onto metal tables after melting held in annealing kiln for days, and then ground and polished
- ⌚ In 1880s, the idea of using **a tunnel annealing kiln, or "lehr"**, was introduced. It allowed glassmakers to skip one of the unproductive steps.
  - ⌚ Operational steps in former annealing method were decreased seven to one.
  - ⌚ Operational process was decreased from days to hours.

### Step 3. "Continuous casting" & PILKINGTON Brothers

- ⌚ Bicheroux process, was the **first innovation** in plate casting, which combined casting and rolling to cut production time and produce more uniform thickness
- ⌚ In 1922, the **second innovation** in plate casting came from the Pilkington Brothers in England. They provided casting of a continuous ribbon of plate glass through rollers onto conveyor that passed through the tunnel kiln. **This** linked together two formerly separate processes (casting and annealing)

### Step 4. "Float process" & Sir Alastair Pilkington

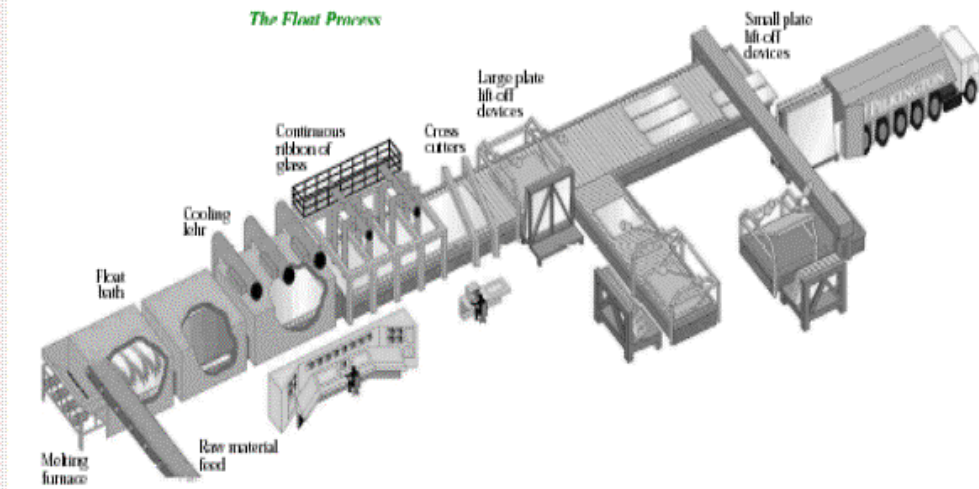
- ⌚ In 1952, Alastair Pilkington introduced his own revolutionary "float process" method
- ⌚ **The Pilkington float glass plant** linked together all the islands of automation into one continuous process, and in so doing took the last big step in turning plate glassmaking from a labor-intensive craft into a highly efficient and automated industry
  - ⌚ The length of the production line was reduced more than half
  - ⌚ Labor costs were reduced by 80%
  - ⌚ Energy costs were reduced by 50%
  - ⌚ Capital costs were reduced



1920 - 1995



**Glass Industry**



Sir Alastair Pilkington patented and introduced (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.

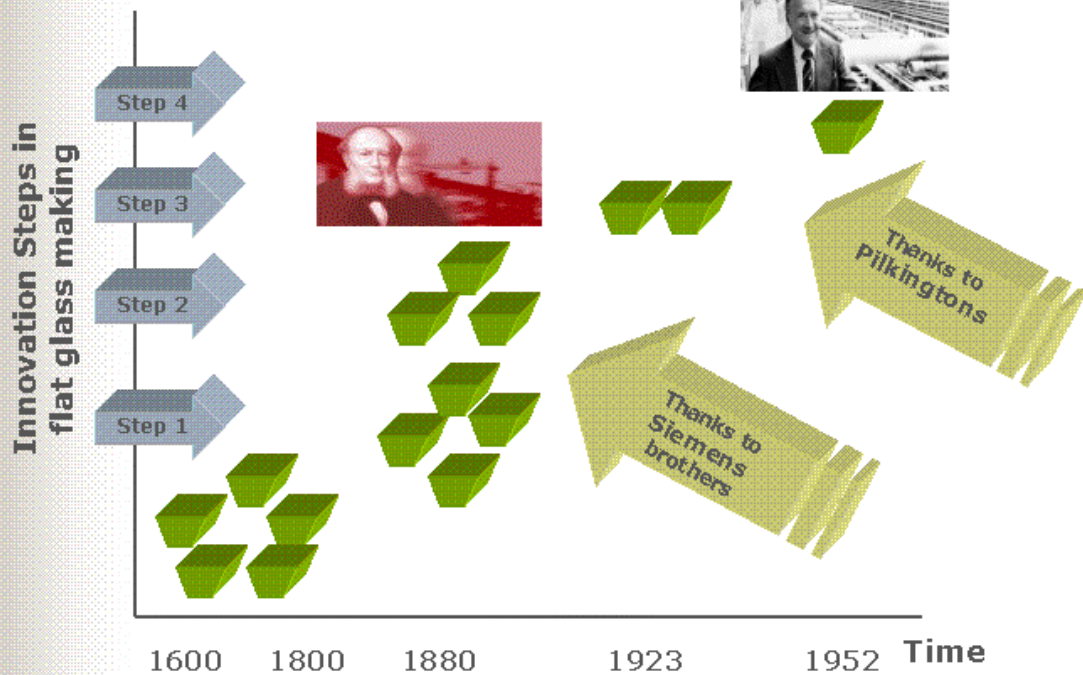
20/11/2003

Fuat Berk Kiri

ITTM  
Innovation Management

**Glass Industry**

Summary

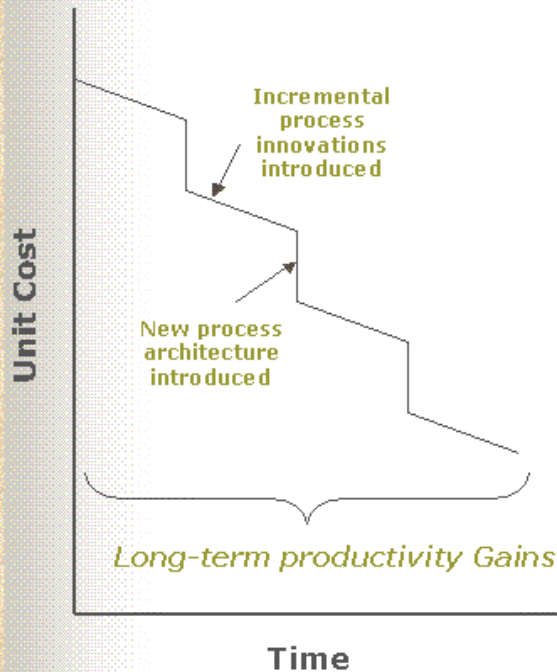


20/11/2003

Fuat Berk Kiri

ITTM  
Innovation Management

## Summary (Discontinuous Change in Process Architecture)



⊛ The relationship between time and unit cost look like a downward staircase

⊛ Mixing and melting of glass ingredients is combined into one step and unit costs drop; time passes before continuous annealing is introduced but when it is, costs drop again; and so it goes for continuous casting and for float glass.

⊛ Progress toward improved productivity is not frozen between the occurrences of new process architectures. These are followed by a number small incremental improvements.