

# TECHNOLOGICAL AGE

## Discoveries

Collected and edited by Prof. Zvi Kam,  
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Johnson's book picked 6 areas with significant effect  
in human scientific history:

Glass  
Cold  
Sound  
Higiene  
Time  
Light

and he outlined the discoveries in each of these areas.

This is in my mind a fresh angle of look at science history.



# Glass - $\text{SiO}_2$

The most abundant compound in earth crust.

Why did life start from Carbon and not Silicates?

Silicate are chemically inert. They have high melting temperature (1400-1600°C)

Glass was known to the Paraos: A glass beetle at the center of decorative gold jewelry found at Tut-ankh-Amun grave

The Peonicians made perfume bottles, first with colored glasses, color depended on site from which the sand was collected, and the metals mixed with the silicates. They then learnt to clarify the glasses.

Wine bottles were commonly used by the Romans.  
They also used glass in windows.



**1204** Fall of Constantinople to the Turks. Glass artisans migrated to Venice.

**1291** Glass ovens cause fires in wood-built Venice. The workshops are “exciled” to Moreno.

Monks used glasses and magnifiers while studying old scripts at dim candle light.

**1400** Angelo Barovier added ash from sea weeds (rich in Manganese and Phosphate) to get crystal clear glass, which accelerate the production of vision spectacles.

Glass mirrors are common. They are coated by lead-mercury amalgam. Back mirror coating is very stable.

Portraits are that period “selfi” that unlike mirror preserve (or beautify) youth.

**1440** Gutenberg opened printing houses, making books cheaper, and increasing the need for reading spectacles.

Hans & Zacharias Janssen (father & son) lens polishing workshop. Built two-lenses

**1590** microscope. 20 years later built a telescope from lenses and mirrors.

**1660** Robert Hook built a microscope and report “cells” in cork sections.

Hans Lippershey patented telescope

**1620** Galileo built a Lippershey telescope and discovered the Jupiter moons.

Significance in throwing away the geocentric model of the sky.

Lenses provide a mean to image scenes for painting, and photography.

Charles Vernon Boys shoot glass fibers with a bow. Glass fibers are strong. Used in torsion balances and fiberglass

**1970** Corning produce fiber optics for light transmission. Specially clean glasses to minimize attenuation, in cladding for internal reflection, and jacket for mechanical stability.

Glass is used in vacuum tubes, light bulbs, television tubes and the front surface of modern displays.

Adaptive Optics correct atmospheric aberrations for telescopes.

Last, Silicon crystals, from Si, the element composing glass silicates, is the basis of all the semiconductor industry. Pure Silicon is an isolated, but when “impurities” are diffused in a controlled way, it forms semi-conductors. Structures built on Silicon create diodes, transistors and integrated circuits, as well as various types of detectors, solar cells, LED and more.

Glass is a highly viscous liquid, and “flows” at very slow rates.



Unlike heat, that humans learnt to make early in history igniting and controlling fires, cooling was not made artificially before 150 years ago !

Ice cream: Alexander the great enjoyed mixture of nectar and ice. Neron sent for ice from the alps to mix into his drinks. Chinese used to eat crushed fruits with ice, and Sorbet receipts were probably brought to Italy by Marco Polo, and appear on kings tables in England, France and Italy.

**1660 Café Procope** in Paris served a Sicilian milk receipt with ice, crème, butter and eggs

**1770** ice-cream start to appear in café menus at the USA.

Importance of cooling for food preservation and supply to large cities.

**1834 Frederick Tudor** decided to ship ice in ships from boston to the hot south. Was considered crazy, but motivated development of isolating cold ice (two walls with straw in-between), and building of cooled storages for meat (till then only salted meat), and cold shipments in trains, ships and carriages.

Within less than 100 years every home in the US had a cooling box, and bought ice blocks for its cooling.



**1824** Sadi Carno The advancement of theormodynamics gave birth to “Carno machine”, a hypothetical idea that drove development of conversion of mechanical energy for cooling.

**1851** Dr. John Gorrie cooled hospitals by ice hanging from the ceiling, to exchange “bad air”. Develped a refrigerator by compressing and fast release of air, but the English Jacob Perkins (“father of refrigerators”) held a previous 1835 patent.

**1861** Ferdinant Carré developed Amonium refrigerator. Became common during the civil war, when shipment of ice from the north stopped.

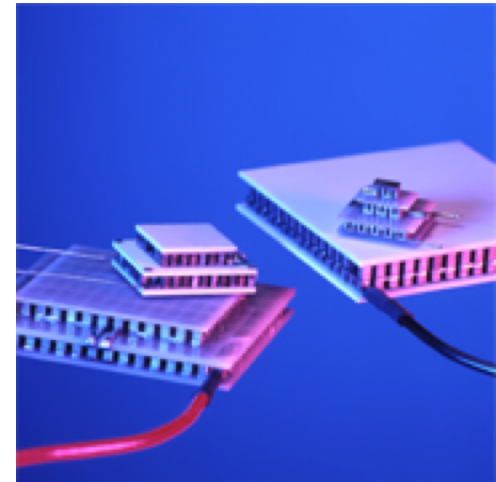
**1912** Clarence Birdseye TV dinners: preserving meals frozen.

**1902** Willis Carrier Air conditioners. Brough a huge increase in population of southern US cities

### **Paltier cooling & heating created by electric**

Current flowing through a junction between metals.

The inverse of voltage creation by temperature gradient in junctions. Today more efficient solid State coolers, used for car refrigerators, and on board cooling of electronics: CPU, CCD imagers, IR detectors and more.





Human voice was central in evolution of speech and society, and the structure of the tongue provides the capability to create a wide range of vowels as well as singing incomparable to the rest of the living creatures.

1857 Édouard-Léon Scott de Martinville registered a patent for voice visualization – Phonograph, where sound vibrations scatter carbon dust. No facility to record or replay.

1877 Thomas Edison - developed a recording and playing phonograph  
Alexander Graham Bell – invented the telephone, based on voice to electric signals and back conversions. Increasing use of telephones created the Bell labs, where Radio was developed, vacuum tubes for signal amplification, coaxial cables to send electric signals with minimal noise interference to long distances, the transistor, solar cells (to power distant telephone transmissions amplification stations), lasers, microprocessors, computers, fiber optics and more, and obviously all developments possible were recruited to advance telephone technology.

Radio – Marconi

Telegraph – Morse

Speakers – voice and music to large crowds

Sonars – to track submarines, for underwater geology, and oil search.

Ultrasound – in medicine

Digital encoding of voice – computer files of audio and video

Acoustic design – for concert halls, speakers, isolated quiet rooms, and  
motor noises.

Noise cancellation – by generating a wave negatively interfering with the  
noise

Musical instruments



Hygiene – was not a part of every day environment, but related to festivity and sacred religious events.

Sick people with visible (e.g. skin) diseases were secluded from inhabitation centers (e.g. out of the camp of the children of Israel migrating from Egypt in the desert). In Greece they were exiled to isolation in an island.

Sewage evacuation became a necessity in large cities, and the Romans built aqueducts and a system of clay and lead pipes to supply clean water and evacuate dirt. Plagues during the middle age spread fast due to bad hygiene in villages and cities, where swage flew to streets and dumped in open fields.

1370 Paris city paved the streets, and installed underground sewage system started at Monmarter and spanned through the city. Pasteur lost three children who died from Typhus. After WWII Paris built centers to process swage water before dumping into the river.

1850 Chicago houses, built on hard rock, were lifted to span sewage system underneath. It was dumped into Michigan lake, the source of drinking water...

## TRAIN TRANSPORTATION TO REDUCE POLLUTION

1863 London - underground ("The Tube")

1900 Paris - "Metro"

1900 New York - "Subway"

1898 Ottoman empire – 1100 km long network of trains from Istanbul to Mecca & Medina with side branches.

1964 Japan – "Shinkansen" ("bullet train") speed up to 320km/h , now span all Japanese cities

1994 England-Paris "Eurostar" fast train via the "Channel Tunnel"

## MEDICAL HYGIENE

**1847 Ignaz Semmelweis** – Suggested to obstetricians to wash hands before treating woman in birth.

**1850 John Snow** – Proved that Cholera plague in London spread via the drinking water system.

**1870 Pasteur & Koch** bacteria cultures in petri dishes with agar to test drinking water quality

**John Leal** Disinfection by Chlorine dramatically reduced death of soldiers in the American Civil War. 1908 he added chlorine to New-Jersey drinking water without approval of authorities.

**1920** Bleach sold for home cleaning. Chlorine added to pools.

SOAP was used at antiquity for washing clothes.

Clean Rooms – at less than a single particle per cube meter – required for the optical & electronic industry.





Day & night – earth rotation around itself  
Month – moon rotation around earth  
Year – Earth rotation around the sun  
Shorter time spans – water and sand timers  
Galileo – pendulum periods is independent on amplitude – clocks  
City clocks spread all around the world.

Importance of exact timing – for navigation by localization of earth altitudes and longitudes. But pendulums are not usable on ships. Naval chronometers – spring and wheel pendulum. Opened the possibility of regular commercial lines supplying raw material (e.g. cotton from India) for the industrial revolution. Synchrony in start and end of working day in factories.

**1850** Aaron Dennison Mass production of pocket watches.

Sears Roebuck sold tens of watch models through a catalogue.

Long distance trains needed synchrony – telegraph provided time adjustment.

**1840** Greenwich mean time

**1833 William Fi Allen** a train engineer, proposed 4 time zones in

**1928 W.A.Marrison** Quartz crystals (vibrations due to the piezo-electric effect) used to select radio station frequencies.

Digital Quartz watches with microsecond precision, measure fluctuations in day length due to tides.

Atomic clocks – count radioactive events – nanosecond precision.

Measure time expansion in satellites according to special relativity.

But radioactive-based timing also measures archaeological times – Uranium and Carbon dating.

GPS (Global Positioning System) based on triangulation with three satellites broadcasting microwaves at precise frequencies.



100,000 years ago – humans set fires using tree branches  
Oil lamps (olive oil) – Babilonians, Romans : extend working and entertaining time. Wax candles (from bee-hives) mainly used in churches and by monks to study at night and in dark monasteries.

1712 Sper whale hunted for lamps  
oil extracted from its head.

1851 the story “Moby dick” the whale,  
by Herman Melville, told about Ahab sailing to catch a huge whale who swallowed his leg.

1830 The carosine lamp: brighter light. Motivated  
Development of newspapers, read at evenings after work.

1879 Edison patented an electric lamp made of carbon fiber in vacuum. Previous lamps with platinum or iridium wires were too expensive, but Edison’s lamp had short lifetime and replaced by Tungsten helical wire lamps. Edison’s Menlow Park was a center for development of technologies for electricity, sound, and movies.



“lime light” a flash lamp creating light from magnesium fast burning with gunpowder.

The theatres illumination was a heated ball made of Calcium Carbonate

Charles Piazzzi Smyth - made photographs inside pyramid graves

Adolf Miethe & Johannes Gaedicke - generated a flash light from  $\text{Mg} + \text{KClO}_3$

Jacob Riis - Photographed lodging of workers in New York, exposing their misery to the public.

George Claude - Liquidation of air. Isolated Neon

1920 Tom Young - A factory producing Neon and Xenon filled fluorescent tubes to create lightened signs for advertizements. Las Vegas “strip” is its trade mark.

Fluorescent lamps – more efficient than incandescent light bulbs.

2000 Light Emitting Diodes – LEDs reach close to 100% efficiency of electric power conversion to visible light, were developed to be bright and in all colors, including white – wide spectral range.

The movie – “war of the worlds” anticipated laser cannons.

Gordon Gould (@Bell) & Hughes Aircraft industries long struggle with Charles Townse for laser patent rights.

Bar-code & laser scanner– Norman Joseph Woodland

Printed on products covers, and greatly accelerate cashiers work.



Matrix code – expanded for longer codes,  
Enabled by improved computer image analysis.



Fiber optics communication – with laser light

Still not implemented – artificial sun, controlled nuclear fusion, by concentrating powerful lasers to increase the temperature at a focus.

